Do changes in affective responses during physical activity predict future physical activity behavior in older adults?

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Abstract

Background: Gaining insight into factors related to moderate-to-vigorous physical activity (MVPA) behavior may assist development of behavior change interventions targeting older adults. ***Purpose:*** To explore direct and indirect associations between older adults' affective responses during MVPA and future MVPA behavior via self-efficacy beliefs and self-determined motivation. ***Methods:*** Data were collected from 82 older adults before, during, and after a walking bout; MVPA behavior was measured 1 month later via telephone. ***Results:*** Increases in tranquility during MVPA were indirectly correlated with future MVPA behavior via self-determined motivation ($p < .05$), but not self-efficacy beliefs ($p > .05$). Decreases in positive engagement and tranquility during MVPA were directly and positively linked with future MVPA behavior, whereas increases in revitalization during MVPA and self-determined motivation were directly and positively linked with future MVPA behavior ($p < .05$). ***Conclusions:*** Changes in older adults' affective responses during MVPA may be important correlates of future MVPA behavior.

Keywords: affective response, self-efficacy, self-determined motivation, older adults, physical activity

Résumé

Contexte: Mieux comprendre les facteurs associés à la pratique d'activité physique d'intensité modérée à vigoureuse (activité physique, ci-après) peut contribuer au développement d'interventions destinées à modifier le comportement chez les personnes âgées. ***But:*** Explorer les relations directes et indirectes entre les sensations des personnes âgées rapportées durant l'activité physique et l'activité physique rapportée prospectivement. Les croyances d'auto-efficacité et la motivation sont examinées comme médiateurs potentiels. ***Méthodes:*** Les données ont été recueillies chez 82 personnes âgées (âge moyen: 68.43 ans; écart-type = 4.18) avant, durant et immédiatement suivant une session de marche aiguë. Quatre semaines après la session en laboratoire, les participants ont rapporté leur niveau d'activité physique par le biais d'un suivi téléphonique. ***Résultats:*** L'augmentation de la tranquillité pendant la pratique de l'activité physique fut indirectement associée à la pratique d'activité physique future via la motivation autodéterminée ($p < .05$). L'augmentation de l'engagement positif et de la tranquillité durant la session d'activité physique ont été directement et négativement corrélées à la pratique d'activité physique future, tandis que l'augmentation de la revitalisation et de la motivation autodéterminée pendant la session d'activité physique ont été directement et positivement associées avec la pratique d'activité physique future. ***Conclusions:*** Les changements dans les sensations des personnes âgées lors de la pratique de l'activité physique peuvent être des facteurs importants associés à la pratique d'activité physique future.

Mots-clés: sensations, auto-efficacité, motivation, personnes âgées, activité physique

Chapter 1: Introduction

Older adults comprise a large proportion of the Canadian population, and this age demographic continues to grow at a rapid rate (Public Health Agency of Canada, 2014). They often experience age-related declines in health and are at a heighted risk for many chronic diseases (Diehr, Thielke, Newman, Hirsch, & Tracy, 2013; Driver, Djoussé, Logroscino, Gaziano, & Kurth, 2008). This can ultimately diminish their quality of life (Barile et al., 2013); however, regular physical activity can help to ameliorate many of these health issues (Acree et al., 2006; Paterson & Warburton, 2010; Warburton, Nicol, & Bredin, 2006). Unfortunately, few older adults participate in sufficient amounts of moderate-to-vigorous intensity physical activity (MVPA; Spinney & Millward, 2014). For this reason, efforts to promote MVPA, which is the recommended intensity for health benefits (Canadian Society for Exercise Physiology, 2014), in this population are needed. One way of approaching this is by exploring the correlates of older adults' physical activity behavior, which will provide a basis for informing the development of interventions to increase physical activity levels.

Numerous reviews of the literature have revealed that motivation and task self-efficacy beliefs are consistent predictors of physical activity behavior (Bauman, Sallis, Dzewaltowski, & Owen, 2002; Teixeira, Carraca, Markland, Silva, & Ryan, 2012). Further, a number of theories suggest that motivation and task self-efficacy beliefs are associated with affective responses to physical activity (Bandura, 1977; Cofer, 1981; Emmons & Diener, 1986), and recent empirical research supports the link between self-determined motivation specifically and task self-efficacy beliefs and affective responses to physical activity (Focht, 2013; Magnan, Kwan, & Bryan, 2013a; Schneider & Kwan, 2013). Taken together, these findings and theoretical perspectives suggest that investigating affective responses to physical activity has the potential for improving

our understanding of self-determined motivation and task self-efficacy beliefs, and in turn physical activity behavior. In light of this, it is necessary to determine if these hypothesized associations hold for older adults since most of the research has been conducted with young or middle-age adults. Researchers have observed different correlates of physical activity at different ages (Plotnikoff, Mayhew, Birkett, Loucaides, & Fodor, 2004), consequently it is possible that young or middle-age adults may have different affective responses to physical activity. Further, it is valuable to examine if self-determined motivation and self-efficacy beliefs mediate the relationship between affective responses during physical activity and future physical activity behavior as previous research has not tested this full process. As well, researchers have typically focused on total physical activity levels (Ferrand, Nasarre, Hautier, & Bonnefoy, 2012; McAuley et al., 2007). It is also important to investigate the correlates of MVPA specifically since this is the recommended intensity for health benefits. Last, previous research is predominately cross-sectional (e.g., Hansen, Ommundsen, Holme, Kolle, & Anderssen, 2014; Wendel-Vos, Droomers, Kremers, Brug, & Van Lenthe, 2007), and as a result our understanding of the correlates of future physical activity behavior is limited.

To address the aforementioned limitations in the literature, the overall purpose of this research was to develop a better understanding of the association between affective responses *during* physical activity and *future* physical activity behavior in older adults. The specific objectives were to examine if (1) affective responses *during* MVPA directly predict self-determined motivation and task self-efficacy beliefs, (2) self-determined motivation and task self-efficacy beliefs directly predict MVPA 1 month later, and (3) affective responses *during* MVPA direct and indirectly predict MVPA 1 month later via self-determined motivation and task self-efficacy beliefs in a sample of older adults.

Chapter 2: Literature Review

In Canada, more than 15% of the population is currently 65 years of age or older (Public Health Agency of Canada, 2014). While older adults are currently expected to live longer than in the past, a significant proportion experience physical declines (Diehr et al., 2013), which can lead to disability and cause activity limitations (Gopinath, Harris, Burlutsky, & Mitchell, 2013). Moreover, many older people suffer from chronic conditions such as heart disease, stroke, arthritis, type 2 diabetes, and hypertension (Statistics Canada, 2014; World Health Organization, 2011). This not only impairs their quality of life (Barile et al., 2013), but increases the economic burden of publicly-funded long-term health care programs (Gopinath et al., 2013).

Several health issues older adults' face can be prevented, reduced, or delayed. For this reason, research into sustainable strategies that can promote healthy aging and preserve older adults' health is growing (Haber, 2009). Researchers have investigated physical activity as a potential strategy to delay age-related physical declines, help prevent health problems, and promote health and wellbeing in older adults (Acree et al., 2006; Rockwood & Middleton, 2007; Warburton, Charlesworth, Ivey, Nettlefold, & Bredin, 2010). In general, this research has shown that older people who participate in regular physical activity significantly decrease their risk of developing chronic health conditions (Warburton et al., 2010) and other health problems (Buchman et al., 2012). However, few older adults meet the minimum weekly recommended amount of physical activity required to produce health benefits (Spinney & Millward, 2014). Thus, it is paramount to investigate factors related to older adults' physical activity behavior to enable the development of tailored and effective interventions aimed at promoting physical activity in this population, and in turn overcome the challenges of an aging society.

Operationalizing Older Adults

There are several definitions presented in the literature to describe 'older adults' or 'seniors'. For instance, the World Health Organization (World Health Organization, 2011) and the Centers for Disease Control and Prevention (Centers for Disease Control and Prevention, 2015) define older adults as those persons who are 65 years and older. Similarly, several Canadian authorities describe older adults as persons 65 years and older, namely – Statistics Canada (Statistics Canada, 2014), the Public Health Agency of Canada (Public Health Agency of Canada, 2014), and the Canadian Society for Exercise Physiology (Canadian Society for Exercise Physiology, 2014). However, the classification of older adults has varied in academic publications (Morris, Sargent-Cox, Cherbuin, & Anstey, 2013; Vasan, Beiser, Seshadri, & et al., 2002). In some cases, persons 60 years and older have been defined as older adults partly because adults of this age can experience similar age-related declines in health to that of adults 65 years of age (Morris et al., 2013; Vasan et al., 2002). For this reason, older adults were defined as those persons 60 years of age and older for this thesis.

Older Adults' Health and Age-Related Issues and Challenges

Older adults are at a heightened risk for many chronic diseases such as cancer, type 2 diabetes, and cardiovascular diseases (Driver et al., 2008; World Health Organization, 2011). These diseases are the leading causes of mortality and morbidity (World Health Organization, 2011). In addition, they can lead to difficulties undertaking basic activities of daily living (Barile et al., 2013; Gopinath et al., 2013), resulting in a loss of independence and increasing the need for long-term care support and services (Gopinath et al., 2013). This can cause enormous physical, psychological, and financial strain on millions of older adults and their caregivers.

The Role of Physical Activity in Promoting Healthy Aging

A compelling amount of evidence has shown that regular physical activity can lower the risks of many of the chronic diseases or disabilities that occur in older adults (Buchman et al., 2012; Warburton et al., 2010). Adults who regularly participate in physical activity are at a reduced risk of cardiovascular disease, type 2 diabetes, some cancers, hypertension, obesity, depression, osteoporosis, and premature death (Warburton et al., 2006; Warburton et al., 2010). In addition, regular physical activity is associated with improved general psychosocial and physical health (Acree et al., 2006; Warburton et al., 2006). For instance, established health benefits that older adults can experience by practicing regular physical activity are improvements in mood, muscular strength, muscle mass, and maintenance of bone density (Barbat-Artigas, Dupontgand, Pion, Feiter-Murphy, & Aubertin-Leheudre, 2014; Barnett, 2012; Warburton et al., 2006).

In light of this evidence, physical activity guidelines have been issued worldwide. In Canada, they stipulate that older adults should be encouraged to accumulate at least 150 minutes per week of MVPA, in bouts lasting 10 minutes or more (Canadian Society for Exercise Physiology, 2014). This means that older adults should engage in activities that result in hard breathing and minor sweating or that causes them to feel 'out of breath' and results in sweating. Examples include brisk walking, bicycling, swimming, and cross-country skiing. It also suggests that older adults should perform muscle and bone strengthening activities at least twice per week. This involves strength and resistance training, and higher impact activities (e.g., lifting free weights, working with resistance bands, climbing stairs; Canadian Society for Exercise Physiology, 2014).

Older Adults' Physical Activity Levels

Current self-report data for physical activity among older adults 65 years of age and older indicate that only 39.6% meet current guidelines (Spinney & Millward, 2014). In addition, current objectively-derived data indicate that only 13.1% of older adults between 60 and 79 years of age meet current guidelines (Colley et al., 2011). Further, several studies have shown that there is a smaller proportion of women meeting the guidelines compared to men (Colley et al., 2011; Spinney & Millward, 2014; Sun, Norman, & While, 2013). For example, just 31.0% of women meet guidelines, compared to 50.1% of men (Spinney & Millward, 2014). In addition to these sex differences, physical activity studies using self-report measures have shown that participation in physical activity decreases with age. For example, approximately 46.0% of adults 65 to 69 years of age, 42.7% of adults 70 to 74 years of age, 37.0% of adults 75 to 79 years of age, and 30.9% of adults 80 years of age and older meet the guidelines (Spinney & Millward, 2014). Objective data collected by Colley et al. (2011) provides a similar portrait, such that the percentage of adults meeting the guidelines decreases with age. Thus, while these data show that physical activity levels are low at each point in the lifespan, the lower rates in older adults coupled with the wide-ranging health implications of aging underscore the need to help older adults become more active. To address these low levels of physical activity in older adults further research is required to identify factors related to physical activity to inform the development of evidence-based strategies to increase levels in this growing population.

Correlates of Physical Activity in Older Adults

In the past two decades, numerous efforts have been made to identify and understand factors associated with physical activity across the lifespan (Focht, Knapp, Gavin, Raedeke, & Hickner, 2007; Koeneman, Verheijden, Chinapaw, & Hopman-Rock, 2011; Seabra, Mendonca,

Thomis, Anjos, & Maia, 2008). These span environmental (Loprinzi, Cardinal, Loprinzi, & Lee, 2012; Wendel-Vos et al., 2007), sociocultural (Edwardson & Gorely, 2010; Seabra et al., 2008), psychological (Focht, 2013; Williams et al., 2008), and physiological factors (Magnan et al., 2013a). Although this research is informative, it is necessary that we focus on psychological factors such as affective responses to physical activity since they are modifiable and have been shown to be consistently linked with physical activity behavior (Bauman et al., 2002). Further, recent empirical research investigating affective responses to physical activity has shown promise in improving our understanding of physical activity behavior correlates (Focht, 2013; Magnan et al., 2013a; Schneider & Kwan, 2013). In light of this, the following section will present research that explores the links between affective responses to physical activity and physical activity behavior via potential mediators of this association, namely self-determined motivation and self-efficacy beliefs. In reviewing this research, the goal is to present what is currently known, as well as identify gaps in the literature to provide targets for future research.

Linking Affective Responses During Physical Activity to Self-Determined Motivation and Self-Efficacy Beliefs

According to hedonic theories of motivation (Cofer, 1981; Emmons & Diener, 1986), a person's affective responses to physical activity may influence his/her motivation to be physically active. These theories stipulate that people will generally take part in activities perceived as pleasurable and avoid those perceived as displeasurable. Thus, a person's affective responses to physical activity may have an effect on his/her motivation to participate in physical activity in the future. Consistent with this notion, researchers (Hooper, Bryan, & Hagger, 2014; Kwan, Hooper, Magnan, & Bryan, 2011; Schneider & Kwan, 2013) have shown that greater increases in positive affective valence during physical activity were positively correlated with

intrinsic motivation, which occurs when a person engages in a behavior for inherent feelings of pleasure and satisfaction (Deci & Ryan, 2000), as well as with Relative Autonomy Index (RAI) scores, which reflect a person's overall degree of self-determination (Deci & Ryan, 2000). In contrast, greater increases in negative affective valence during physical activity have been shown to be negatively correlated with intrinsic motivation and RAI scores (Hooper et al., 2014; Kwan et al., 2011; Schneider & Kwan, 2013). For example, a recent study by Hooper et al. (2014) found that greater increases in tranquility, positive affective valence, and smaller increases in negative affective valence during a moderate-intensity running bout were linked with higher RAI levels in young adults (mean age = 23.6 years; Hooper et al., 2014). Similar findings were reported by Kwan et al. (2011) who revealed that greater positive affective valence reported by undergraduate students (mean age = 18.2 years) during self-reported physical activity were associated with greater RAI levels.

In addition, increases in positive affective valence during physical activity have been shown to be positively correlated with greater increases in physical activity 6 and 12 months later in adults (mean age = 43.9 years; Williams et al., 2008). While these findings offer support for the link between changes in affective responses to physical activity and physical activity behavior in the future, it is important to note that little attention has been given to the indirect links between affective responses to physical activity and future physical activity behavior. Therefore, it is necessary to investigate the association between older adults' affective responses to physical activity and self-determined motivation, and in turn if self-determined motivation is associated with future physical activity behavior.

The associations between affective responses to physical activity and self-efficacy beliefs have been recognized in Social Cognitive Theory (SCT; Bandura, 1977), which advocates that a

person's self-efficacy beliefs (i.e., a person's confidence in his/her ability to achieve a particular task) are partly influenced by a his/her affective states (Bandura, 1977). Consistent with this proposition, many studies have reported that more favourable affective responses to physical activity, including more positive affective valence, tranquility, revitalization, and less physical exhaustion during and after physical activity are associated with higher levels of task self-efficacy beliefs (Barnett, 2012; Focht, 2013; Focht et al., 2007). For example, in a longitudinal study with younger (mean age = 19.9 years) and older adults (mean age = 55.7 years), Barnett (2012) found that more favourable feeling states (i.e., lower feelings of physical exhaustion and increased feelings of tranquility) and positive affective valence during and after a moderate-intensity cycling bout were associated with greater self-efficacy beliefs to cycle at a moderate-intensity for an increasing number of minutes following the bout. In addition, Kwan and Bryan (2010) reported that greater increases in positive affective valence and smaller increases in negative affective valence and fatigue during and after a moderate-intensity treadmill session were associated with greater task and barrier self-efficacy beliefs 3 months later in young adults (mean age = 22.4 years). Similarly, Focht (2013) reported a positive relationship between tranquility and revitalization during either a 10- or 30-minute walk and self-efficacy beliefs to walk at a light-to-moderate intensity during a single 10- or 30-minute session on most days of the week for the next month in sedentary, overweight women (mean age = 26.6 years), respectively. Based on these findings, it is possible that older adults' affective responses to physical activity are correlated with their self-efficacy beliefs, and in turn their self-efficacy beliefs are associated with future physical activity behavior. This proposition needs to be tested in future research.

Overall, existing studies offer support to the propositions that affective responses to physical activity are related to self-determined motivation and task self-efficacy beliefs for

physical activity. Although these findings are beneficial in establishing that affective responses during and after physical activity are generally associated with self-determined motivation and task self-efficacy beliefs for physical activity, it is important to note that most studies have focused on younger samples (Focht, 2013; Kwan & Bryan, 2010; Schneider & Kwan, 2013). In light of this, these findings need to be confirmed in older adults as different correlates of physical activity may be observed at different ages (Plotnikoff et al., 2004). It is also important to investigate if affective responses to physical activity are linked to self-determined motivation and self-efficacy beliefs, and in turn if self-determined motivation and self-efficacy beliefs predict future physical activity behavior.

Linking Self-Determined Motivation and Self-Efficacy Beliefs to Physical Activity Behavior

A number of theories such as Self-Determination Theory (SDT; Deci & Ryan, 1985), Theory of Planned Behavior (TPB; Ajzen, 1991), and SCT (Bandura, 1977) have shown that self-determined motivation and self-efficacy beliefs for physical activity are important correlates of physical activity. Further, these findings have been corroborated by several reviews of the literature (Bauman et al., 2002; Hagger, Chatzisarantis, & Biddle, 2002; Teixeira et al., 2012). For instance, a review by Teixeira et al. (2012) showed that autonomous regulations, which are regulations that reflect a high level of individual volition and self-determination (Deci & Ryan, 2000), and the RAI were consistently associated with physical activity behavior in adults. Specifically, higher levels of autonomous regulations and RAI scores were positively correlated with higher levels of physical activity behavior. Recent research by Sweet, Fortier, and Blanchard (2014) found that autonomous regulations consisting of intrinsic motivation and identified regulation were significantly associated with physical activity behavior in adults 18 to 69 years of age. These findings corroborated results by Fortier, Duda, Guerin, and Teixeira

(2012) and those by Brunet and Sabiston (2011). Similarly, Ferrand et al. (2012) found that older adults (mean age = 75.0 years) with high levels of physical activity reported greater levels of intrinsic motivation, identified regulation, and introjected regulation (i.e., engaging in a behaviour to avoid guilt and to achieve self-worth; Deci & Ryan, 2000) compared to their less active counterparts. Together, these findings show that autonomous regulations and the RAI are consistently associated with physical activity behavior.

In contrast, controlling regulations, which reflect the control of behavior by external contingencies (Deci & Ryan, 2000), have been negatively correlated with physical activity behavior (Brunet & Sabiston, 2011; Ingledew & Markland, 2008; Teixeira et al., 2012). In one study, Ingledew and Markland (2008) found that external regulation was negatively correlated with physical activity behavior in adults (mean age = 40.4 years). Similarly, Brunet and Sabiston (2011) found that external regulation was negatively correlated with physical activity behavior in young adults (mean age = 19.4 years). However, contrary to theory (Deci & Ryan, 2000), researchers have found positive correlations between introjected regulation and MVPA. For example, Brunet and Sabiston (2011) reported that introjected regulation was positively correlated with physical activity behavior in this population. Collectively, these findings suggest that external regulation is negatively correlated with physical activity behavior whereas introjected regulation is positively associated with physical activity behavior.

In addition to self-determined motivation, a review by Bauman et al. (2002) found that self-efficacy beliefs were a consistent correlate of physical activity behavior in adults. Other research by Ayotte, Margrett, and Hicks-Patrick (2010), McAuley et al. (2007), and Suton et al. (2013) support the conclusions of this review by showing that task self-efficacy beliefs were an important predictor of physical activity behavior in different age groups. For instance, task self-

efficacy was positively correlated with physical activity behavior in middle-age adults (mean age = 58.9 years; Ayotte et al., 2010) and older adults (mean age = 66.7 years; McAuley et al., 2007). Further, a longitudinal study by McAuley et al. (2007) revealed that task self-efficacy beliefs was an important predictor of physical activity in older adults at the 3-year follow-up (mean age = 66.7 years). Taken together, these findings suggest that task self-efficacy beliefs for physical activity are an important correlate of physical activity behavior across the lifespan.

In summary, the studies presented and discussed above suggest that affective responses during physical activity may influence future physical activity behavior by influencing people's self-determined motivation and their self-efficacy beliefs. These findings suggest that a conceptual model linking these processes, such as the one depicted in Figure 1, has utility for explaining physical activity behavior, and warrants empirical testing with older adults. In addition, previous literature investigating the correlates of physical activity has predominantly focused on total physical activity levels (Ferrand et al., 2012; McAuley et al., 2007). This has provided us with general insight regarding the correlates of physical activity behavior; however, our knowledge of the correlates of MVPA – the recommended intensity for health benefits in older adults (Canadian Society for Exercise Physiology, 2014) – is limited. Thus, identifying the unique correlates of MVPA is warranted. Another limitation of previous research that has investigated the correlates of physical activity behavior is the predominant use of cross-sectional study designs (e.g., Hansen et al., 2014; Wendel-Vos et al., 2007). Experimental and longitudinal designs are temporal and are directional which allows us to distinguish between cause and effect (Mann, 2003). Unfortunately, there have only been a few experimental studies in the physical activity domain (Guerin & Fortier, 2012b; Williams et al., 2008), especially with older adults (e.g., McAuley et al., 2007). In light of this, an experimental design using pre- and post-testing

would allow for the examination of older adults' responses to physical activity and their future physical activity behavior.

Purpose of This Study

In order to extend the research described above, the purpose of this research was to identify factors that influence MVPA in older adults. The specific objectives and associated hypotheses were:

(1) To examine if changes in older adults' affective responses (i.e., feelings of positive engagement, revitalization, tranquility, and physical exhaustion) *during* MVPA would directly predict self-determined motivation and task self-efficacy beliefs. It was hypothesized that more favourable affective responses (i.e., greater increases in positive engagement, revitalization, and tranquility) and lower physical exhaustion during MVPA would directly predict higher levels of self-determined motivation and self-efficacy beliefs.

(2) To examine if older adults' affective responses *during* MVPA directly and indirectly predict MVPA assessed 1 month later via self-determined motivation and self-efficacy beliefs. It was hypothesized that more favourable affective responses (i.e., greater increases in positive engagement, revitalization, and tranquility) and lower physical exhaustion during MVPA would directly predict higher levels of MVPA assessed 1 month later. Further, it was hypothesized that self-determined motivation and self-efficacy beliefs would partially mediate the associations between affective responses during MVPA and MVPA assessed 1 month later.

(3) To examine if older adults' self-determined motivation and task self-efficacy beliefs directly predict MVPA assessed 1 month later. It was hypothesized that higher levels

of self-determined motivation and self-efficacy beliefs would directly predict higher levels of MVPA assessed 1 month later.

Chapter 3: Article

The following article presents the manuscript that emanated from the results of this Master's thesis. It will be submitted to *Annals of Behavioral Medicine* which has an impact factor of 4.14. This article fits well within the scope of this international peer-reviewed journal because it is a short-term prospective study focusing on health promotion and disease prevention.

Authors' Contributions

As the lead author, my contributions to this article include: study design, participant recruitment, data collection and analysis, interpretation of results, reviewing the literature, and drafting the manuscript. Dr. Jennifer Brunet's contributions include: study design, assistance with statistical analyses, interpretation of results, providing critical feedback, and article revisions.

Do changes in affective responses during physical activity predict future physical activity behavior in older adults?

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Methods

Design

The current study employed a quasi-experimental prospective design. Data were collected on two occasions, 1 month apart. At baseline, participants provided data on sociodemographic variables, height, weight, past week physical activity behavior, affective responses to physical activity, self-efficacy beliefs, and self-determined motivation during a 1-hour visit at the Behavioral and Metabolic Research Unit (BMRU) laboratory at the University of Ottawa. One month later, participants provided data on past week physical activity during a brief phone call.

Participants and Procedures

Following ethics approval from the Research Ethics Board at the University of Ottawa (see Appendix A), advertisements posted in community centers, physicians' offices, and churches around Ottawa, and on online social media were used to recruit older adults for this study (see Appendix B). Eligible participants had to meet the following inclusion criteria: (1) able to read and speak English, (2) able to safely engage in 30-minutes of walking at a moderate-to-vigorous intensity, (3) be between 60 to 79 years of age, and (4) not be highly active (i.e., not regularly engaging in high-intensity physical activity). Recruitment started in November 2014 and ended early in May 2015; data for the last participant were collected late in May 2015. Interested participants were asked to contact the researchers to gain more information about the study. At this time, participants were screened using the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+; Canadian Society for Exercise Physiology, 2011) to determine if they met the four eligibility criterion listed above (see Appendix C). The PAR-Q+ is an evidence-based screening tool which assesses a person for contraindications to physical

activity (Bredin, Gledhill, Jamnik, & Warburton, 2013). Participants were eligible to participate if they answered "No" to all the preliminary questions, or, in cases where they answered "Yes" to the preliminary questions, they were eligible if they answered "No" to all the follow-up questions.

A total of 141 adults inquired about the study. After screening, 55 were not eligible because they answered "Yes" to one or more follow-up questions on the PAR-Q+: arthritis, osteoporosis, or back problems (n = 8), cancer (n = 1), cardiovascular disease (n = 2), metabolic conditions (n = 13), respiratory disease (n = 1), spinal cord injury (n = 5), stroke (n = 3), a chronic condition not listed or currently living with two chronic conditions (n = 22). Another four adults were not eligible since they did not meet the age criteria.

The remaining 82 eligible participants were each scheduled for a visit at the BMRU laboratory at the University of Ottawa. Upon their arrival, participants were asked to read and sign an informed consent form (see Appendix D). During their visit, they engaged in several activities in the following order: (1) completed questionnaires assessing baseline sociodemographics (see Appendix E) and physical activity behavior, (2) had their weight and height assessed using a digital scale and stadiometer, respectively, (3) engaged in the Naughton treadmill protocol (Naughton, Shanbour, Armstrong, McCoy, & Lategola, 1966) and completed questionnaires assessing affective responses and ratings of perceived exertion (RPE) during this time, and (4) completed questionnaires assessing self-efficacy beliefs and self-determined motivation for physical activity after completing the Naughton treadmill protocol.

For the Naughton treadmill protocol, participants walked at a speed of 2 miles per hour (mph) at a 0% inclination, followed by 3.5% increases in incline every 3 minutes. Once participants achieved their moderate-intensity heart rate max (HR_{max}) [206.9 - (0.67 × age)],

which corresponds to at least 64% of their HR_{max} (American College of Sports Medicine, 2009), they continued at this intensity for 30 minutes. The Naughton treadmill protocol was selected in the current study because it is recommended for use in older adults and it has smaller increases in intensity per stage when compared to other protocols, resulting in more uniform changes to physiological responses (American College of Sports Medicine, 2009). A wireless heart rate monitor (e.g., Polar RS300X Heart Rate Monitor) was used to assess heart rate during the Naughton treadmill protocol to ensure that participants achieved at least a moderate-intensity heart rate.

Measures

Physical Activity. Physical activity behavior was assessed at baseline and at the follow-up 1 month later using the 7-Day Physical Activity Recall (PAR; see Appendix F; Sallis et al., 1985). The PAR is an interviewer-administered measure that assesses the amount of time a person allocates towards physical activity, strength, and flexibility activities during the past 7 days. The amount of time spent sleeping [1 metabolic equivalent (MET)], performing moderate (4 METs; e.g., brisk walking), hard (6 METs; e.g., between running and brisk walking), and very hard (10 METs; e.g., running) activities were assessed. A total score was computed reflecting the number of days per week where ≥ 60 minutes of at least moderate-intensity physical activity was achieved. Research has confirmed the validity and reliability of the PAR, namely scores on the PAR have demonstrated acceptable validity for total energy expenditure and good test-retest reliability (Bonnefoy et al., 2001; Dubbert, Vander Weg, Kirchner, & Shaw, 2004). In the current study, the test-retest reliability [Intraclass Correlation Coefficient (ICC)] for scores on the PAR was .59.

Affective Responses. Participants' affective responses to physical activity were assessed six times using the Exercise Induced-Feeling Inventory (EFI; Gauvin & Rejeski, 1993). The six time points were: 5 minutes prior to, immediately before, 10-minutes during, 20-minutes during, 30-minutes during, and 5 minutes after the MVPA bout. The EFI assesses four distinct affective responses to physical activity (i.e., positive engagement, revitalization, tranquility, and physical exhaustion). The EFI is a 12-item scale rated on a 5-point Likert scale, ranging from 0 = *do not feel* to 4 = *feel very strongly* (see appendix G). The EFI is scored by averaging the values within each subscale [i.e., positive engagement (items 4, 7, and 12), revitalization (items 1, 6, and 9), tranquility (items 2, 5, and 10), and physical exhaustion (items 3, 8, and 11)]. Scores on the EFI have demonstrated good convergent, divergent, and construct validity (Gauvin & Rejeski, 1993), and acceptable internal consistency ($\alpha = > .70$) when assessing affective responses to physical activity in an older adult population (Barnett, 2012; Focht et al., 2007). Further, the EFI has been used in numerous physical activity studies (Focht, 2013; Focht et al., 2007; Hagger et al., 2002; Treasure & Newbery, 1998), and its distinct feeling states have been linked to correlates of physical activity behavior (Focht, 2013; Focht et al., 2007). In the current study, scores on the EFI demonstrated acceptable internal consistency at each of the assessments for positive engagement (α values = .79 to .90), revitalization (α values = .64 to .83), tranquility (α values = .86 to .92), and physical exhaustion (α values = .82 to .92). For the current analyses, changes in affective responses were computed by first averaging the scores before (i.e., 5 minutes prior to and immediately before) and during the bout (i.e., 10-, 20-, and 30-minutes during). Next, the mean scores before the bout were then subtracted from the mean scores during the bout.

Self-Efficacy Beliefs. Following recommendations (Bandura, 1997), a single-item questionnaire was constructed to assess self-efficacy beliefs for meeting physical activity

guidelines in the future (see appendix H). Participants were asked to respond to this questionnaire 10 minutes after they had completed their MVPA bout. This questionnaire was rated on a 100-point percentage scale, ranging from 0% = *not at all confident* to 100% = *completely confident*. Participants were asked to record their personal self-efficacy beliefs when asked if they could accumulate 150 minutes of moderate-to-vigorous intensity aerobic physical activity per week in bouts of 10 minutes or more during the next month. Previous research has used similar measurement approaches to assessing self-efficacy beliefs (Kwan & Bryan, 2010; Magnan, Nilsson, Marcus, Ciccolo, & Bryan, 2013b).

Self-Determined Motivation. Self-determined motivation for physical activity was assessed 10 minutes after participants completed their MVPA bout using the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, 2004). The BREQ-2 is a 19-item questionnaire that is rated on a 5-point Likert scale, ranging from 0 = *not true for me* to 4 = *very true for me* (see Appendix I). The BREQ-2 includes five subscales which assess five distinct motivations: amotivation (4-items; e.g., "I can't see why I should bother exercising"), external regulation (4-items; e.g., "I exercise because others will not be pleased with me if I don't"), introjected regulation (3-items; e.g., "I feel ashamed when I miss an exercise session"), identified regulation (4-items; e.g., "It's important to me to exercise regularly"), and intrinsic motivation (4-items; e.g., "I enjoy my exercise sessions"). To maintain statistical power, the Relative Autonomy Index (RAI; Ryan & Connell, 1989), a unidimensional index reflecting the overall degree of self-determination, was computed. This was done by weighting each subscale [i.e., amotivation × (-3), external regulation × (-2), introjected regulation × (-1), identified regulation × (+2), intrinsic regulation × (+3)], followed by the addition of the weighted scores. Scores on the BREQ-2 have demonstrated good internal consistency (α = > .75) and factorial

validity (Markland & Tobin, 2004; Wilson, Rodgers, Murray, Fraser, & McIntyre, 2004). In the current study, scores on the BREQ-2 demonstrated acceptable internal consistency for external regulation ($\alpha = .75$) and intrinsic regulation ($\alpha = .80$). Despite lower Cronbach's alpha values than recommended (i.e., > .70) for amotivation ($\alpha = .67$), introjected regulation ($\alpha = .68$), and identified regulation ($\alpha = .48$), these subscales were retained since researchers suggest that over reliance on Cronbach's alpha values should be avoided (Agbo, 2010).

Potential Covariates

Ratings of Perceived Exertion. Perceived exertion was assessed six times using Borg's RPE scale (Borg, 1998) and investigated as a potential covariate in the current study since ratings of perceived exertion (RPE) have been linked with affective responses to physical activity (Barnett, 2012; Williams et al., 2008), self-determined motivation and self-efficacy beliefs (Latimer & Ginis, 2005; Magnan et al., 2013b), and future physical activity behavior (Williams et al., 2008). The six time points were: 5 minutes prior to, immediately before, 10-minutes during, 20-minutes during, 30-minutes during, and 5 minutes after the MVPA bout. The RPE scale consists of a single-item that is rated on 15-point bipolar scale, ranging from 6 to 20 (see appendix J). The scale has verbal anchors that range from 7 = *very, very light* to 19 = *very, very hard*. Scores on the RPE scale have demonstrated acceptable criterion-related validity and it is a reliable measure of perceived exertion during walking tasks (Chen, Fan, & Moe, 2002).

Data Analyses

Initially, data were screened for missing data and univariate and multivariate outliers. Missing data were less than 5% for any one of the main study variables. Multiple imputation (n = 5) was performed to estimate missing data (Tabachnick & Fidell, 2007). Based on z-scores in excess of ± 3.00 and Mahalonobis distances ≥ 18.47 among the independent variables and ≥

13.82 among the mediators, two univariate and two multivariate outliers were identified and removed from the data set. Next, Cronbach's alpha values (Cronbach, 1951) were computed for each multi-item questionnaire and tests for violations of assumptions were performed to assess the necessary assumptions for multivariate analyses. The data did not violate the assumptions of normality, linearity, homoscedasticity, and multicollinearity. Descriptive statistics were computed for each study variable and bivariate correlations between main study variables, as well as between main study variables and potential covariates [i.e., age, sex, education, income, body mass index (BMI), MVPA assessed at baseline, and RPE], were estimated. Spearman's rank-order correlation coefficients (r_s) were computed when one or both variables were ordinal (e.g., self-efficacy beliefs) and Pearson product-moment correlation coefficients (r_p) were computed when both variables were continuous and normally distributed (Pallant, 2010; Tabachnick & Fidell, 2007). Potential covariates were included in the main analyses if they were significantly associated with the independent (i.e., affective responses during physical activity), mediating (i.e., self-efficacy beliefs, RAI), or dependent (i.e., physical activity behavior) variables.

For the main analyses, a multiple mediation macro (Preacher & Hayes, 2008) for SPSS with bias-corrected bootstrap estimation was used to assess the: (1) direct associations between changes in positive engagement, revitalization, tranquility, and physical exhaustion during MVPA and self-efficacy beliefs and self-determined motivation assessed immediately post-MVPA and MVPA assessed 1 month later, (2) indirect associations between changes in positive engagement, revitalization, tranquility, and physical exhaustion during MVPA and MVPA assessed 1 month later as mediated by self-efficacy beliefs and self-determined motivation assessed immediately post-MVPA, and (3) direct associations between self-efficacy beliefs and

self-determined motivation assessed immediately post-MVPA and MVPA assessed 1 month later in older adults. Bootstrap estimation for multiple mediation effects has been advocated when analyses involve multiple mediators (MacKinnon, Fairchild, & Fritz, 2007) and is preferable to the causal steps strategy proposed by Baron and Kenny (1986) when testing single mediation models (Preacher & Hayes, 2008). A 95% confidence interval (95% CI) was computed for the direct effects by multiplying the standard error by 1.96 followed by the addition and subtraction of the estimated effect size for the upper and lower bounds of the 95% CI, respectively (Preacher & Hayes, 2008). Based on recommendations by Preacher and Hayes (2008), the bootstrap estimations conducted in the current study were based on 5000 bootstrap samples and the direct and indirect (mediation) effects were deemed significant if the 95% bias-corrected confidence interval of the indirect effects (95% BcCI) did not include zero.

Results

A total of 82 older adults were recruited and completed initial and follow-up assessments. After removing the identified four outliers from the data set, the sample consisted of 78 adults between 60 and 76 years (64.1% female; mean age = 68.33 years; *SD* = 4.09). The sample was predominately Caucasian (96.2%), well-educated (84.6% completed university), and had a mean BMI of 25.89 kg/m^2 (*SD* = 3.54).

Descriptive statistics for sociodemographic variables are presented in Table 1. Descriptive statistics for positive engagement, revitalization, tranquility, and physical exhaustion at 5 minutes prior to, immediately before, 10-minutes during, 20-minutes during, 30-minutes during, and 5 minutes after the MVPA bout are presented in Table 2. Prior to engaging in the MVPA bout, mean positive engagement, revitalization, and tranquility scores were relatively high, whereas physical exhaustion scores were very low based on the possible range of scores.

Mean positive engagement, revitalization, tranquility, and physical exhaustion scores were slightly higher 5 minutes after the bout when compared to scores before the bout, suggesting that, on average, participants experienced minor increases in favorable affective responses and physical exhaustion after the bout. Descriptive statistics and correlational analyses among main study variables are presented in Table 3. During the MVPA bout, mean changes in positive engagement, revitalization, and tranquility scores were moderate, whereas physical exhaustion scores were low, suggesting that, on average, participants experienced minor decreases in favorable affective responses and minor increases in physical exhaustion during the bout. Mean self-efficacy beliefs and RAI scores were high based on the possible range of scores for self-efficacy beliefs and RAI, suggesting that the sample had a high level of self-efficacy beliefs and self-determined motivation for physical activity. MVPA levels at baseline and at 1-month were moderate based on the possible range of scores, suggesting that the sample was fairly active.

In terms of the associations between main study variables and potential covariates, significant correlations were observed between (1) MVPA assessed at baseline with self-efficacy beliefs (r_s = .31, p < .01), (2) sex (0 = male, 1 = female) with changes in tranquility and physical exhaustion during MVPA (r_s = .31, r_s = -.29, respectively, p < .01), (3) BMI with MVPA assessed 1 month later (r_p = -.24, p < .05), (4) income with changes in revitalization during MVPA (r_s = .23, p < .05), (5) changes in RPE during MVPA with changes in positive engagement, tranquility, and physical exhaustion (r_p = -.31, r_p = -.31, and r_p = .31, respectively, p < .01) and changes in revitalization during MVPA (r_p = -.23, p < .05). As such, changes in RPE during MVPA, income, MVPA assessed at baseline, sex, and BMI were included as covariates in the main analyses. Of note, a model controlling for changes in RPE during MVPA and

participants' income was tested. Results did not significantly change. Thus, to maintain power, only MVPA assessed at baseline, sex, and BMI were controlled during the main analyses.

In terms of the associations between the main study variables (see Table 3), greater decreases in positive engagement during MVPA were correlated with greater decreases in revitalization during MVPA (r_p = .59, p < .01), and correlated with greater MVPA assessed 1 month later (r_p = -.23, p < .05). Greater increases in tranquility during MVPA were correlated with greater increases in positive engagement and revitalization during MVPA (r_p = .48 and r_p = .44, respectively, p < .01). Greater increases in physical exhaustion during MVPA were correlated with less revitalization and tranquility during MVPA (r_p = -.41 and r_p = -.37, respectively, p < .01). Self-efficacy beliefs were positively associated with RAI (r_s = .28, p < .05). Changes in positive engagement during MVPA were not significantly associated with changes in physical exhaustion during MVPA (p > .05). Changes in positive engagement, revitalization, tranquility, and physical exhaustion during MVPA were not significantly associated with self-efficacy beliefs and RAI (p-values > .05). Further, changes in revitalization, tranquility, and physical exhaustion during MVPA were not significantly associated with MVPA assessed at 1-month (p-values > .05). Last, self-efficacy beliefs and RAI were not significantly associated with MVPA assessed at 1-month (p-values > .05).

Direct effects from the multiple mediation analyses are presented in Tables 4 and 5. Changes in affective responses during MVPA explained 19.6% and 8.4% of the variance in self-efficacy beliefs and self-determined motivation, respectively. Changes in affective responses during MVPA, self-efficacy beliefs, and self-determined motivation collectively explained 26.8% of the variance in MVPA assessed at 1-month. Of this percentage, 6.7% was attributed to the indirect effects of changes in affective responses during MVPA on MVPA assessed at 1-

month. After controlling for MVPA assessed at baseline, sex, and BMI, no direct associations were observed between changes in positive engagement, revitalization, tranquility, and physical exhaustion during MVPA and self-efficacy beliefs (β = 1.06, β = -2.85, β = 1.01, and β = -2.60, respectively). Further, no direct associations were observed between changes in positive engagement, revitalization, tranquility, and physical exhaustion during MVPA and RAI (β = 0.40, β = -0.72, β = 1.26, and β = -0.07, respectively).

In contrast, several direct associations were observed between changes in positive engagement, tranquility, and revitalization during MVPA and MVPA assessed at 1-month. Specifically, greater decreases in positive engagement and tranquility during MVPA were associated with more MVPA assessed at 1-month (β = -1.73 and β = -1.04, respectively). In contrast, greater increases in revitalization during MVPA were associated with more MVPA assessed at 1-month (β = 1.00). In addition, RAI was positively correlated with MVPA assessed at 1-month (β = 0.20). However, changes in physical exhaustion during MVPA and self-efficacy beliefs were not significantly correlated with MVPA assessed at 1-month (β = -0.10 and β = -0.05, respectively).

Indirect effects from the multiple mediation analyses are presented in Table 6. After controlling for MVPA assessed at baseline, sex, and BMI the only one indirect significant association was between changes in tranquility during MVPA and MVPA assessed at 1-month through RAI (β = 0.25), whereby greater increases in tranquility during MVPA were associated with more self-determined motivation, and in turn higher levels of MVPA assessed at 1-month. Changes in positive engagement, revitalization, and physical exhaustion during MVPA were not significantly correlated with MVPA assessed at 1-month through the RAI (β = 0.08, β = -0.14, and β = -0.01, respectively). Further, changes in positive engagement, revitalization, tranquility,

and physical exhaustion during MVPA were not significantly correlated with MVPA assessed at 1-month through self-efficacy beliefs (β = -0.05, β = 0.14, β = -0.05, and β = 0.13, respectively).

Discussion

Worldwide, few older adults are meeting recommended physical activity guidelines (Colley et al., 2011; Spinney & Millward, 2014; Sun et al., 2013). This is concerning since many older adults are affected by chronic conditions and experience age-related declines in health (Diehr et al., 2013; Statistics Canada, 2014; World Health Organization, 2011), which can be prevented or managed by engaging in regular physical activity (Acree et al., 2006; Rockwood & Middleton, 2007; Warburton et al., 2010). Recognizing that physical activity is vital to promote well-being and reduce disease and disability in older adults, we focused our efforts on investigating modifiable factors that can act as targets in future physical activity behavior change interventions. Drawing from a number of theories, namely hedonic theories (Cofer, 1981; Emmons & Diener, 1986), SCT (Bandura, 1977), SDT (Deci & Ryan, 1985), TPB (Ajzen, 1991), as well as existing empirical research (Kwan & Bryan, 2010; Schneider & Kwan, 2013; Williams et al., 2008), we examined how older adults' affective responses during MVPA are related to their future MVPA.

Overall, our findings suggest that greater increases in revitalization and greater decreases in positive engagement and tranquility during MVPA were directly associated with greater future MVPA behavior. Further, older adults' self-determined motivation was positively correlated with future MVPA behavior. These findings suggest that it may be important to encourage older adults to engage in physical activities that promote revitalization and decrease positive engagement and tranquility during MVPA. Further, older adults' self-determined motivation should be fostered in order to facilitate participation in future MVPA behavior. In addition,

whereas greater increases in tranquility were directly associated with less future MVPA behavior, they were indirectly associated with greater future MVPA behavior. This finding further re-iterates the importance of fostering self-determined motivation to buffer the negative impact that changing tranquility feelings may have on future MVPA behavior.

Direct Links Between Affective Responses During Physical Activity and Self-Efficacy Beliefs and Self-Determined Motivation

Contrary to our hypothesis, previous research (Kwan & Bryan, 2010; Magnan et al., 2013a; Treasure & Newbery, 1998), and SCT (Bandura, 1977), no significant direct associations were observed between changes in positive engagement, revitalization, tranquility, and physical exhaustion during MVPA and self-efficacy beliefs. One reason for these non-significant findings may relate to the sources of self-efficacy beliefs. Researchers have suggested that affective states may be the least important determinant of self-efficacy beliefs (Britner & Pajares, 2006). As such, this may be why older adults' affective responses during MVPA were not related to self-efficacy beliefs in the current study. Another possible explanation for these non-significant findings may relate to the intensity level that the participants achieved during the MVPA bout. In our study, participants achieved at least a moderate-intensity according to their age-predicted heart rate maximum (mean age-predicted moderate-intensity heart rate = 103.11, *SD* = 1.75). However, there is evidence that affective responses during physical activity and self-efficacy beliefs are more consistently linked during vigorous-intensity physical activity (McAuley & Courneya, 1992; Treasure & Newbery, 1998). Therefore, it is possible that a non-significant link was observed between changes in affective responses during MVPA and self-efficacy beliefs because participants did not achieve a sufficient intensity during the bout of MVPA [mean RPE during the bout = 11.0 (fairly light), *SD* = 1.78]. This suggests that the physical activity intensity

may moderate the link between self-efficacy beliefs and MVPA behavior. In light of this, it may be important to replicate this study with two groups of older adults performing different intensities of physical activity (e.g., moderate- vs. vigorous-intensity physical activity).

In contrast to hedonic theories of motivation (Cofer, 1981; Emmons & Diener, 1986), our finding suggested that older adults' affective responses during MVPA were not directly associated with their self-determined motivation for physical activity. A first possible explanation for this non-significant finding may related to the physical activity status of our sample. Given that our sample was fairly active (mean number of days physical activity guidelines were met at baseline = 2.79, *SD* = 2.27), it is possible that affective responses during MVPA are significantly linked to self-determined motivation in sedentary older adults. As a result, it may be important to investigate if physical activity status acts as a moderator of the link between affective responses during MVPA and self-determined motivation among older adults. A second plausible explanation for this non-significant finding may be due to our small sample size and the small variability reflected in the main study variables. The latter may have resulted in lower power during the statistical analyses (Tabachnick & Fidell, 2007), and consequently reduced the chance of observing a true effect (Button et al., 2013). One reason for the small variance in self-determined motivation may be due to our highly motivated sample (mean RAI scores = 14.02, *SD* = 3.27, possible scale range is -24 to 20). Consequently, it is possible that there was insufficient variance in self-determined motivation to be explained by affective responses during MVPA. A possible reason for the small variance in affective responses during MVPA may be due to the prescribed intensity during the MVPA bout. For instance, researchers have shown that lower levels of positive affective responses are observed when the intensity during physical activity is prescribed, whereas higher levels of positive affective responses occur

during self-selected intensities (Hamlyn-Williams, Freeman, & Parfitt, 2014). Although it was necessary to prescribe intensity in our study to control for physical activity status, it is possible that our sample experienced smaller increases in positive affective responses during MVPA, and consequently reduced variance in affective responses during MVPA. It may be important to replicate this study with a larger, more sedentary sample and allow participants to self-select their intensity during physical activity to increase the variability in our main study variables. This will help determine if the non-significant associations between affective response during MVPA, self-efficacy beliefs, and self-determined motivation for physical activity are replicable.

Direct Links Between Affective Responses During Physical Activity, Self-Efficacy Beliefs, Self-Determined Motivation, and Future Physical Activity Behavior

Consistent with our hypothesis and with previous research (Teixeira et al., 2012), the degree of self-determined motivation (as assessed by the RAI) was positively and directly linked with MVPA assessed at 1-month. This suggests that self-determined motivation for physical activity may be an important predictor of future MVPA behavior among older adults. In contrast to our hypothesis and with previous research (Ayotte et al., 2010; Bauman et al., 2002; McAuley et al., 2007), a non-significant direct link was observed between self-efficacy beliefs and MVPA assessed at 1-month. A possible explanation for this non-significant finding may relate to the degree of challenge of the task. For instance, researchers have shown that self-efficacy beliefs are more predictive during challenging tasks as opposed to habitual demands (Bandura, 1997; McAuley, Lox, & Duncan, 1993). Therefore, it is possible that our sample, consisting primarily of fairly active older adults (mean number of days physical activity guidelines were met at baseline = 2.79, *SD* = 2.27), did not perceive the task of meeting physical activity guidelines in the future as a sufficiently challenging task to observe a significant interaction. Accordingly, it

will be important to test the potential moderating role of physical activity status on the link between self-efficacy beliefs and future MVPA behavior by replicating this study with a sedentary and active sample. In addition, given that there are a number of self-efficacy beliefs which are linked to physical activity behavior (e.g., barrier and adherence self-efficacy; McAuley, Jerome, Elavsky, Marquez, & Ramsey, 2003; Sweet et al., 2009), it may be important for researchers to investigate other types of self-efficacy beliefs (e.g., scheduling self-efficacy) when investigating correlates of future MVPA behavior among older adults.

Consistent with our hypothesis and previous research (Annesi, 2005; Williams et al., 2008; Williams, Dunsiger, Jennings, & Marcus, 2012), greater increases in revitalization during MVPA were associated with more MVPA assessed at 1-month. These findings suggest that older adults should engage in physical activities that promote feelings of rejuvenation and energy during the bout to facilitate participation in future physical activity behavior. Given that revitalization is partly related to the level of activation/arousal and pleasure that a person experiences during physical activity (Rejeski, Reboussin, Dunn, King, & Sallis, 1999), it may be important for older adults to engage in physical activities at a sufficiently challenging intensity. This may help to foster their feelings of rejuvenation and energy during the bout, and in turn help to facilitate engagement in future physical activity behavior. In addition, researchers have suggested that the social setting and the fitness leader have an important role in facilitating positive affective responses during physical activity (Gauvin & Rejeski, 1993; McAuley, Blissmer, Katula, & Duncan, 2000; Raedeke, Focht, & Scales, 2007). For instance, researchers have revealed that engaging in physical activity within a social setting (e.g., walking groups) is linked to more favorable affective responses due to the additional emotional support found within social networks (McAuley et al., 2000). Last, participating in fitness classes led by health-

promoting fitness leaders leads to higher levels of positive affective responses due to their role in shaping the objectives of the fitness class (e.g., fun, health, appearance; Raedeke et al., 2007).

In contrast to previous research (Williams et al., 2008; Williams et al., 2012), greater decreases in positive engagement and tranquility during MVPA were associated with more MVPA assessed at 1-month. While counter-intuitive, one reason for these findings may be due to our highly-motivated sample and the degree of difficulty of the task. For instance, Annesi (2002) investigated the links between changes in affective responses after a moderate-intensity bicycling bout and attendance during a physical activity program in two groups, one with high levels of self-motivation (i.e., one's inherent tendency to persevere; Dishman, Ickes, & Morgan, 1980) and another with low levels of self-motivation. Consistent with our findings, Annesi (2002) reported that greater decreases in positive engagement and tranquility were associated with more physical activity attendance in the group with high levels of self-motivation, whereas greater increases in positive engagement and tranquility were associated with more physical activity attendance in the group with lower levels of self-motivation. A possible explanation for these findings may be because highly motivation people strive to be productive during physical activity (Annesi, 2002), and thus may perceive low levels of positive affective responses during physical activity as an indicator that they were being sufficiently productivity during the bout. In turn, they may be encouraged to engage in the physical activity in the future (Annesi, 2002). This proposition is consistent with SDT which stipulates that a person must be challenged during a behavior in order to experience feelings of competence (i.e., a person's inherent desire to effectively interact with the environment and to experience mastery; Deci & Vansteenkiste, 2004). In addition, fulfilling the psychological need for competence can help to facilitate more

self-determined motivation (Deci & Ryan, 2000), and in turn help to increase future physical activity behavior (Bauman et al., 2002; Teixeira et al., 2012).

Consistent with Annesi (2002), it may be it may be important to encourage older adults with low levels of self-determined motivation to engage in physical activities that promote positive affective responses. In contrast, it may be important to encourage highly-motivated, active, and healthy older adults to engage in physical activities that are reasonably challenging so that they experience some negative feelings during the bout, and in turn translate into higher levels of future physical activity behavior.

Indirect Links Between Affective Responses During Physical Activity and Future Physical Activity Behavior Via Self-Efficacy Beliefs and Self-Determined Motivation

In regards to the indirect link between changes in affective responses during MVPA and future MVPA behavior, the only indirect association was observed between changes in tranquility and future MVPA behavior via the RAI. Consistent with hedonic theories of motivation and SDT (Cofer, 1981; Deci & Ryan, 1985; Emmons & Diener, 1986), greater increases in tranquility during MVPA were positively associated with self-determined motivation, which in turn was correlated with future MVPA behavior. These findings are different from our direct associations (discussed above) which suggest that greater decreases in tranquility are directly correlated with more future MVPA behavior. Our significant indirect findings suggest that it may be important to include self-determined motivation for physical activity when exploring the association between changes in tranquility during MVPA and future MVPA behavior among older adults. Contrary to our hypothesis and theory (i.e., hedonic theories of motivation and SDT; Cofer, 1981; Deci & Ryan, 1985; Emmons & Diener, 1986), the RAI did not significantly mediate the links between changes in positive engagement,

revitalization, and physical exhaustion during MVPA and MVPA assessed at 1-month. One reason for these non-significant findings may be due to use of the self-determined motivation index (i.e., the RAI). Given that affective responses to physical activity have been linked to individual motivational regulations for physical activity (e.g., introjected, identified, and intrinsic regulations; Guerin & Fortier, 2012a), which in turn influence future physical activity behavior (Teixeira et al., 2012), it may be promising to explore individual motivational regulations instead of the RAI when investigating the link between affective responses during MVPA and future MVPA. Another possible reason for these non-significant findings may be that the setting where the affective responses were assessed were not congruent with the type of physical activities that the participants were contemplating when responding to questions about their self-determined motivation for physical activity (Schneider & Kwan, 2013). Since participants' affective responses during MVPA were assessed in a controlled, laboratory environment in the current study, it is possible that there was a disconnect between their affective responses during MVPA and their self-determined motivation for physical activity, and consequently resulted in non-significant findings. Together, these findings suggest that researchers should consider investigating individual motivational regulations as potential mediators and the physical activity environment when exploring the link between affective responses during MVPA and future MVPA among older adults.

Further, in contrast to our hypothesis and SCT (Bandura, 1977), self-efficacy beliefs did not significantly mediate the associations between changes in positive engagement, revitalization, tranquility, and physical exhaustion during MVPA and MVPA assessed at 1-month. Similar to above, a plausible explanation for these non-significant findings may relate to the intensity that the participants achieved during the MVPA bout and the physical activity status

of our sample. For instance, affective responses to MVPA are more consistently linked to self-efficacy beliefs during vigorous-intensity physical activity (McAuley & Courneya, 1992; Treasure & Newbery, 1998), and self-efficacy beliefs are less predictive of behavior during habitual circumstances (McAuley et al., 1993). Thus, it may be that our sample did not achieve a sufficient intensity during MVPA (mean RPE during the bout = 11.0 (fairly light), *SD* = 1.78] and that our samples' self-efficacy beliefs were not threatened due to their high level of baseline MVPA (mean number of days physical activity guidelines were met at baseline = 2.79, *SD* = 2.27), thus leading to a non-significant interaction between affective responses during MVPA and future MVPA behavior via self-efficacy beliefs. Collectively, these findings suggest that it may be important to replicate this study in a more representative sample of older adults.

Limitations

There are a number of limitations which should be considered when interpreting the results in this study. First, although we assessed affective responses during MVPA in a controlled, laboratory setting to control for potential environmental influences, we may have influenced older adults' affective responses during MVPA. Specifically, researchers have shown that engaging in physical activity within controlled, laboratory environments are associated with smaller increases in positive affective responses (Gauvin & Rejeski, 1993; McAuley et al., 2000). Second, our sample was primarily Caucasian, well-educated, and active thus our findings may not be generalizable to the broader population. Third, potential bias may have been introduced by collecting physical activity data via self-report. Fourth, our statistical analyses may have suffered from low power due to our small sample size (Tabachnick & Fidell, 2007). Last, although using the RAI helped to maintain statistical power in the current study, it prevented us

from investigating if individual motivational regulations act as mediators in the associations between affective responses during MVPA and future MVPA behavior among older adults.

Strengths and Implications

Despite these limitations, there are a number of strengths of this study. Specifically, we were able to investigate predictors of older adults' MVPA behavior – the recommended intensity for health benefits (Canadian Society for Exercise Physiology, 2014). In addition, little attention has been given to the links between affective responses during MVPA and future MVPA behavior in the past, however our research provides evidence suggesting that older adults' affective responses during MVPA may be important correlates of their future MVPA behavior. Further, our short-term prospective design allowed us to develop valuable insight into factors related to future MVPA behavior among older adults.

In regards to the study implications, our study makes a number of contributions to theory, methodology, and practice. In regards to theory, our non-significant findings between older adults' affective responses during MVPA and self-efficacy beliefs and self-determined motivation for physical activity were not consistent with SCT and hedonic theories of motivation (Bandura, 1977; Cofer, 1981; Emmons & Diener, 1986). However, it is necessary to replicate this study while considering the potential moderating effects of the physical activity environment and the intensity during physical activity before any conclusions can be made. Our findings also suggest that self-determined motivation may be an important predictor of future MVPA behavior among older adults as would be suggested by SDT and empirical research (Deci & Ryan, 1985; Teixeira et al., 2012). Further, our non-significant findings between self-efficacy beliefs and future MVPA behavior are not consistent with SCT (Bandura, 1977). However, given that self-

efficacy beliefs are task-specific, it is necessary to replicate this study in an uncontrolled environment before conclusions can be made.

In regards to methodology, we used a novel physical activity protocol which can be used to safely assess older adults' affective responses during MVPA, thus helping to improve our understanding of the correlates of MVPA. In addition, we used a prospective design which helped us to develop insight on predictors of older adults' future MVPA behavior. Our study is also one of the first to investigate if self-efficacy beliefs and self-determined motivation – two consistent correlates of physical activity behavior (Bauman et al., 2002; Teixeira et al., 2012), significantly mediate the link between affective responses during MVPA and future MVPA among older adults. Our study contributes insight to this link, providing evidence that self-determined motivation for physical activity, but not self-efficacy beliefs, significantly mediates the link between changes in tranquility during MVPA and future MVPA behavior. These findings suggest that it may be important to include self-determined motivation for physical activity when exploring the links between changes in affective response during MVPA and future MVPA among older adults.

In regards to practice, our findings suggest that it may be important for health professionals to encourage active older adults to participate in physical activities that promote higher levels of revitalization during a bout to promote future MVPA behavior. In addition, active older adults should engage in challenging physical activities so that they experience lower levels of positive engagement during the bout, and in turn facilitate participation in future MVPA behavior. It may also be important for health practitioners to facilitate older adults' self-determined motivation for physical activity, and in turn foster engagement in future MVPA behavior. Finally, it will be important to replicate this study in a more representative sample to

provide clarity to the mixed findings between changes in tranquility during MVPA and future MVPA before conclusions are made.

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Chapter 4: General Discussion

Regular physical activity can promote older adults' physical and psychosocial health and reduce their risk of developing diseases and disability (Acree et al., 2006; Buchman et al., 2012; Warburton et al., 2011). Given the low number of older adults meeting recommended physical activity guidelines around the world (Colley et al., 2011; Spinney & Millward, 2014; Sun et al., 2013), we focused on investigating modifiable factors that can be targeted in physical activity behavior change interventions. Drawing from existing empirical research (Kwan & Bryan, 2010; Schneider & Kwan, 2013; Williams et al., 2008), as well as a number of theories, namely SCT (Bandura, 1977), SDT (Deci & Ryan, 1985), TPB (Ajzen, 1991)], and hedonic theories (Cofer, 1981; Emmons & Diener, 1986), we employed a prospective design to examine the direct and indirect associations between changes in older adults' affective responses during MVPA and future MVPA behavior via self-efficacy beliefs and self-determined motivation. We hypothesized that more favorable affective responses (i.e., greater increases in positive engagement, revitalization, and tranquility) and lower physical exhaustion during MVPA would directly predict higher levels of self-efficacy beliefs, self-determined motivation, and MVPA 1 month later. In addition, it was hypothesized that self-efficacy beliefs and self-determined motivation would partially mediate the associations between affective responses during MVPA and MVPA levels 1 month later. It was also hypothesized that higher levels of self-efficacy beliefs and self-determined motivation would directly predict higher levels of MVPA 1 month later.

Taken together, greater increases in revitalization during MVPA and greater decreases in positive engagement were directly correlated with greater future MVPA behavior. These findings suggest that it may be important to find strategies to foster feelings of revitalization and reduce

positive engagement during MVPA. Further, higher levels of self-determined motivation following the MVPA bout were directly correlated with future MVPA behavior, suggesting it may be important for health professionals to employ motivational change strategies to promote higher levels of self-determined motivation. Finally, whereas greater increases in tranquility during MVPA were directly linked to less future MVPA behavior, they were indirectly linked to greater future MVPA behavior, suggesting self-determined motivation may act as a buffer.

Direct Links Between Affective Responses During Physical Activity and Self-Efficacy Beliefs and Self-Determined Motivation

Contrary to previous research (Kwan & Bryan, 2010; Magnan et al., 2013a; Treasure & Newbery, 1998) and our hypothesis, changes in positive engagement, revitalization, tranquility, and physical exhaustion during MVPA were not significantly correlated with self-efficacy beliefs. Further, these findings were not consistent with SCT which suggest that self-efficacy beliefs are partly influenced by one's affective states (Bandura, 1977). These non-significant findings may relate to the intensity level of the MVPA bout that participants engaged in. Researchers have shown that the intensity during physical activity may influence the link between affective responses during physical activity and self-efficacy beliefs, with more consistent links observed during vigorous-intensity physical activity (McAuley & Courneya, 1992; Treasure & Newbery, 1998). Given that our sample engaged in MVPA in our study, it is possible that participants' affective responses during MVPA were not significantly associated with their self-efficacy beliefs because they did not attain an adequate intensity during MVPA [mean RPE during the bout = 11.0 (fairly light), *SD* = 1.78]. In light of this, it may be important to replicate this study with one group performing moderate-intensity physical activity and another performing vigorous-intensity physical activity to investigate the potential moderating

effect of physical activity intensity on the link between affective responses during MVPA and self-efficacy beliefs among older adults. In addition, other researchers have suggested that affective states are the least important determinant of self-efficacy beliefs (Britner & Pajares, 2006), which may be why they were not related to older adults' perceptions of their ability to meet physical activity guidelines in the future. This suggests that future research should consider investigating other modifiable factors associated with older adults' MVPA behavior.

In addition, our findings that older adults' affective responses during MVPA were not related to their self-determined motivation were not consistent with hedonic theories of motivation (Cofer, 1981; Emmons & Diener, 1986), which suggest that a person's affective responses to physical activity may influence his/her motivation in general to be physically active. A first possible explanation for the non-significant association between affective responses during MVPA and self-determined motivation may be that potential confounders were not controlled for during statistical analyses. Arousal and perceived pain have been shown to significantly influence affective responses during physical activity and self-determined motivation for physical activity (Magnan et al., 2013b). However, data on these potential confounders were not collected and therefore could not be controlled for during the analyses. It is possible that affective responses during MVPA relates to self-determined motivation among older adults who are more sedentary. This should be investigated to examine if physical activity status moderates the link between affective responses during MVPA and self-determined motivation. Another possible explanation for this non-significant finding may be due to our small sample size and small variance both in changes in affective responses during MVPA and self-determined motivation, which reduced power during statistical analyses (Tabachnick & Fidell, 2007), thus hindering the detection of true effects (Button et al., 2013). A possible reason for the

small variance in affective responses during MVPA may be due to the limited autonomy given to participants when selecting an intensity during MVPA. Researchers have shown that higher levels of positive affective responses are observed during self-selected intensities (Hamlyn-Williams et al., 2014). Given that we prescribed intensity in our study to control for physical activity status, it is possible that the sample experienced smaller increases in positive affective responses during MVPA, and thus smaller variance in affective responses during MVPA. A plausible explanation for the small variance in self-determined motivation may relate to the physical activity status of the sample. Our sample was fairly active (mean number of days physical activity guidelines were met at baseline = 2.79, *SD* = 2.27), likely because they had a high level of self-determined motivation for physical activity (mean RAI scores = 14.02, *SD* = 3.27, possible scale range is -24 to 20). Thus, it is possible that there was not enough variance in self-determined motivation to be explained by affective responses during MVPA. This suggests that it may be important to replicate these findings with a larger, more representative sample so that more variability is reflected in the main study variables. A fourth reason for this may relate to a disconnect between the environment where the affective responses were assessed and the type of physical activities that the participants were considering when reporting their self-determined motivation for physical activity (Schneider & Kwan, 2013). For instance, when responding to questions about their self-determined motivation for physical activity, participants may have considered a specific type of physical activity within a particular environment. Consequently, assessing their affective responses during MVPA within a controlled, laboratory environment may have led to a non-significant link between their affective responses during MVPA and self-determined motivation for physical activity. Together, these findings suggest that it will be important to consider a number of factors when investigating the link between

affective responses during MVPA, self-efficacy beliefs, and self-determined motivation for physical activity among older adults.

Direct Links Between Affective Responses During Physical Activity, Self-Efficacy Beliefs, Self-Determined Motivation, and Future Physical Activity Behavior

In support of our hypothesis and in agreement with previous research (Teixeira et al., 2012), the degree of self-determined motivation (as assessed by the RAI) was positively correlated with MVPA assessed at 1-month. These findings provide evidence suggesting that self-determined motivation may be an important predictor of future MVPA behavior among older adults. However, in contrast to our hypothesis and with previous research (Ayotte et al., 2010; Bauman et al., 2002; McAuley et al., 2007), self-efficacy beliefs were not significantly correlated with MVPA assessed at 1-month. This may be because self-efficacy beliefs are less predictive of behavior during habitual demands when compared to challenging tasks (Bandura, 1997; McAuley et al., 1993). Given that most of our sample were fairly active (mean number of days physical activity guidelines were met at baseline = 2.79, *SD* = 2.27), it is possible that they did not perceive the task as challenging enough to threaten their self-efficacy beliefs, thus reducing the potential of observing a statistically significant effect. This suggests that physical activity status may moderate the link between self-efficacy beliefs and future MVPA behavior. Accordingly, it may be important replicate this study with active and inactive participants to test this possibility. Another possible explanation for this non-significant finding may relate to the type of self-efficacy beliefs we assessed. There are a number of different types of self-efficacy beliefs which have been identified as correlates of physical activity behavior (e.g., barrier and adherence self-efficacy; McAuley et al., 2003; Sweet et al., 2009). For instance, adherence and barrier self-efficacy beliefs have been shown to be important predictors of physical activity in

older adults (McAuley et al., 2003). This suggests that it may be important to investigate other types of self-efficacy beliefs when investigating correlates of future MVPA behavior among older adults.

In agreement with our hypothesis and previous research (Annesi, 2005; Williams et al., 2008; Williams et al., 2012), greater increases in revitalization during MVPA were associated with greater MVPA assessed at 1-month. This suggests that it may be important to encourage older adults to participate in physical activities that promote feelings of rejuvenation and energy so that they will engage in higher levels of future physical activity behavior. Researchers have argued that revitalization is related both to the degree of activation/arousal and pleasure that a person experiences during physical activity (Rejeski et al., 1999). Thus, it may be important to encourage older adults to engage in physical activities that are sufficiently challenging so that they experience increases in revitalization, and in turn foster participation in future physical activity behavior. Further, it may be important to encourage older adults to engage in physical activities within social settings (e.g., walking groups) and in fitness classes led by health-promoting fitness leaders since these are associated with high levels of positive affective responses during physical activity (Gauvin & Rejeski, 1993; McAuley et al., 2000; Raedeke et al., 2007). In regards to the physical activity environment, McAuley et al. (2000) has suggested that the heightened support provided within a social network may provide emotional support, and subsequently translate into higher levels of positive affective responses during physical activity. Further, a fitness instructors' leadership qualities may influence affective responses during physical activity due to their role in shaping the objectives of the fitness class (e.g., fun, health, appearance; Raedeke et al., 2007).

However, in contrast with previous research (Williams et al., 2008; Williams et al., 2012), greater decreases in positive engagement and tranquility during MVPA were associated with more MVPA assessed at 1-month. Although counter-intuitive, a plausible explanation for these findings may relate to their enduring high levels of self-determined motivation for physical activity. For instance, Annesi (2002) revealed that greater decreases in positive engagement, tranquility, and revitalization after a moderate-intensity bicycle bout were correlated with less attendance during a 14-week physical activity program in a group with low levels of self-motivation (i.e., his/her innate tendency to persist; Dishman et al., 1980). In contrast, greater decreases in positive engagement and tranquility after the bicycle bout were associated with greater attendance in a group with high levels of self-motivation. This may be because highly motivated people are inclined to engage in future physical activity behavior if they perceive that they are achieving a sufficient level of productivity during physical activity (Annesi, 2002). It is possible that motivated and already active older adults may perceive low levels of positive engagement and tranquility during physical activity as indicators that they were being sufficiently productive during the bout, and in turn encourage them to engage in future physical activity. This proposition is supported by a review which reports that greater decreases in positive affective responses occur in people who experience higher levels of exertion during physical activity (Ekkekakis, Hall, & Petruzzello, 2008). Further, this proposition is consistent with SDT which suggests that experiencing an optimal level of challenge during physical activity allows a person to experience greater feelings of competence (Deci & Ryan, 2000), and consequently helps to foster self-determined motivation (Deci & Ryan, 2000). In turn, self-determined motivation for physical activity may help to facilitate engagement in future physical activity behavior (Bauman et al., 2002; Teixeira et al., 2012). Our findings are consistent with

this proposition since our sample reported high levels of self-determined motivation. In light of this, it may be important to investigate the direct link between affective responses during MVPA and future MVPA behavior among older adults with low self-determined motivation. Collectively, these findings suggest that it may be important to encourage active and healthy older adults to participate in physical activities that are sufficiently challenging so that they experience decreases in some of their favorable affective responses during the bout (e.g., lower levels of positive engagement), in turn to promote participation in future physical activity behavior. On the other hand, consistent with Annesi (2002), it may be important for sedentary older adults to participate in physical activities that foster higher feelings of revitalization and positive engagement to promote future physical activity behavior.

Indirect Links Between Affective Responses During Physical Activity and Future Physical Activity Behavior Via Self-Efficacy Beliefs and Self-Determined Motivation

In regards to the indirect associations between affective responses during MVPA and future MVPA behavior, the only indirect association was observed between changes in tranquility and future MVPA behavior via self-determined motivation, whereby greater increases in tranquility during MVPA were positively correlated with self-determined motivation, which in turn was positively associated with future MVPA behavior. This is consistent with hedonic theories of motivation and SDT (Cofer, 1981; Deci & Ryan, 1985; Emmons & Diener, 1986) which suggest that affective responses during physical activity influences one's motivation to engage in future physical activity behavior and that self-determined motivation is an important correlate of physical activity behavior, respectively. Thus, it may be important to consider older adults' self-determined motivation for physical activity when investigating the link between changes in tranquility during MVPA and future MVPA behavior among older adults. However in

contrast to hedonic theories of motivation and SDT (Cofer, 1981; Deci & Ryan, 1985; Emmons & Diener, 1986), the RAI did not significantly mediate the associations between changes in positive engagement, revitalization, and physical exhaustion during MVPA and MVPA assessed at 1-month. Similar to above, a possible explanation for these non-significant findings may be that the environment where the affective responses were assessed were not congruent with the type of physical activity and setting that the participants were considering when answering questions about their self-determined motivation for physical activity (Schneider & Kwan, 2013). Consequently, it is possible that this may have led to a non-significant link between positive engagement, revitalization, and physical exhaustion during MVPA and future MVPA behavior via self-determined motivation for physical activity.

Another possible explanation for these non-significant findings may relate to use of the RAI. Although we used the RAI to maintain statistical power during statistical analyses, researchers have shown that affective responses during physical activity are linked to a number of motivational regulations for physical activity (e.g., intrinsic, identified, and introjected regulations; Guerin & Fortier, 2012a), which are also correlates of future physical activity behavior (Teixeira et al., 2012). Given this evidence, it may be important to investigate individual motivational regulations as opposed to the RAI when examining the link between affective responses during MVPA and future MVPA. Together, these findings suggest that it may be necessary to consider the physical activity setting, the type of physical activity, and the individual motivational regulations when exploring the link between affective responses during MVPA and future MVPA among older adults.

In addition, contrary to our hypothesis and SCT (Bandura, 1977), the associations between changes in positive engagement, revitalization, tranquility, and physical exhaustion

during MVPA and MVPA assessed at 1-month were not significantly mediated by self-efficacy beliefs. Similar to above, affective responses to physical activity and self-efficacy beliefs are more consistently linked during vigorous-intensity physical activity (McAuley & Courneya, 1992; Treasure & Newbery, 1998), and self-efficacy beliefs are less predictive of behavior during habitual circumstances (McAuley et al., 1993), like in the walking task for this study. Therefore, it is possible that our sample did not achieve a sufficiently challenging intensity during the MVPA bout [mean RPE during the bout = 11.0 (fairly light), *SD* = 1.78], thus reducing the chance of observing a significant link between affective responses during MVPA and future MVPA via self-efficacy beliefs. Collectively, these findings suggest that it may be important to investigate if physical activity intensity is a potential moderator of the indirect link between affective response during MVPA and future MVPA behavior via self-efficacy beliefs.

Limitations

The results of this study should be interpreted within the context of its limitations. First, our findings may not be generalizable to the broader population since our sample was primarily active, well-educated, and Caucasian. Thus, it may be important for future studies to replicate these findings in a more representative sample of the population. Second, affective response to physical activity may vary based on the physical activity environment, with socially isolating environments and laboratory settings resulting in lower levels of positive affective responses (Gauvin & Rejeski, 1993; McAuley et al., 2000). As a result, given that a laboratory setting was used in the current study to control for the potential environmental influences, we may have influenced older adults' affective response during MVPA. Third, although the RAI was useful in the current study since it helped to maintain statistical power, it hindered our ability to examine if individual motivational regulations significantly mediate the link between affective responses

during MVPA and future MVPA behavior. Fourth, physical activity data were collected via self-report, which may have led to the introduction of potential biases. Last, given our small sample size, our statistical analyses may have been underpowered (Tabachnick & Fidell, 2007).

Implications

Despite the limitations in our study, there are a number of strengths. Specifically, the links between affective responses during physical activity and future physical activity behavior among older adults have received little attention in the past. The prospective design used in this study allowed us to investigate older adults' affective responses during MVPA as a predictor of future MVPA behavior. Further, no studies have investigated self-efficacy beliefs and self-determined motivation as potential mediators of the link between affective responses during MVPA and future MVPA behavior. In the current study, our findings provide evidence suggesting that older adults' self-determined motivation for physical activity, but not self-efficacy beliefs, significantly mediates the link between changes in tranquility during MVPA and their future MVPA behavior, thus underscoring the need to include self-determined motivation for physical activity when investigating the links between changes in affective responses during MVPA and future MVPA behavior among older adults.

This study makes contributions to theory, methodology, and practice. In relation to theory, our findings provide evidence suggesting that older adults' affective responses during MVPA may not be associated with self-efficacy beliefs and self-determined motivation for physical activity as would be suggested in SCT and hedonic theories of motivation (Bandura, 1977; Cofer, 1981; Emmons & Diener, 1986). However, given that the intensity during physical activity may moderate the link between affective responses during physical activity and self-efficacy beliefs (McAuley & Courneya, 1992; Treasure & Newbery, 1998), it will be important

to replicate this study with moderate- and vigorous-intensity physical activity to investigate this possibility before conclusions can be made. In addition, consistent with SDT (Deci & Ryan, 1985) and a wealth of empirical research (see Teixeira et al., 2012 for review), our findings suggest that self-determined motivation may be an important predictor of future MVPA behavior among older adults. However, in contrast to SCT (Bandura, 1977), our findings suggest that task self-efficacy beliefs may not be associated with future MVPA behavior among older adults. Since Bandura (1977) stipulates that self-efficacy beliefs are specific to the task that is performed, it will be important to investigate if the environment and the type of physical activity moderate the link between self-efficacy beliefs and future MVPA behavior.

In relation to methodology, we used a novel physical activity protocol (Naughton et al., 1966) that can be safely used to assess affective responses during MVPA among older adults. This is important because this will help to improve our understanding of the correlates of MVPA – the recommended intensity for health benefits (Canadian Society for Exercise Physiology, 2014). Further, our prospective design extends previous cross-sectional research and allowed us to gain valuable insight on the predictors of future MVPA behavior in older adults. Finally, consistent with previous research (Schneider, Dunn, & Cooper, 2009; Williams et al., 2008), our findings provide evidence suggesting that changes in certain affective responses during MVPA, namely revitalization, positive engagement, and tranquility, may be important correlates of future MVPA behavior among older adults.

In relation to practice, our findings suggest that it may be important for health professionals to incorporate motivational change strategies into physical activity interventions to help promote self-determined motivation for physical activity, and in turn facilitate participation in future MVPA behavior. It may also be important for health professionals to encourage active

older adults to participate in physical activities that are sufficiently challenging so that they experience greater increases in revitalization and greater decreases in positive engagement during the bout, and consequently translate into higher levels of future MVPA behavior. In addition, given that our direct findings suggest that greater increases in tranquility during MVPA were linked with less future MVPA behavior and that our indirect findings suggest that greater increases in tranquility during MVPA were linked with greater MVPA behavior, it will be important to replicate this study in a more representative sample before conclusions are made for tranquility during MVPA.

Chapter 5: Conclusion

The current investigation provides valuable insight for a mechanism through which affective responses during MVPA predict future MVPA behavior among older adults. Specifically, our findings extend previous research by revealing that older adults' self-determined motivation for physical activity, but not self-efficacy beliefs, significantly mediates the link between changes in tranquility during MVPA and their future MVPA behavior. Accordingly, it will be important to include self-determined motivation for physical activity when investigating the links between changes in affective responses during MVPA and future MVPA behavior among older adults. Our findings also suggest that revitalization, positive engagement, and tranquility may be important correlates of future MVPA behavior among older adults.

In relation to theory, our findings suggest that older adults' affective responses during MVPA may not be associated with their self-efficacy beliefs and self-determined motivation for physical activity. Although not consistent with SCT and hedonic theories of motivation (Bandura, 1977; Cofer, 1981; Emmons & Diener, 1986), it will be necessary to investigate if the intensity during physical activity moderates the link between affective responses during MVPA and self-efficacy beliefs and if the physical activity environment moderates the link between affective responses during MVPA and self-determined motivation before conclusions are made. Our findings also suggest that task self-efficacy beliefs may not be associated with future MVPA behavior among older adults. Although this non-significant finding is not consistent with SCT (Bandura, 1977), it will be important to investigate if the type of physical activity moderates the link between self-efficacy beliefs and future MVPA behavior before conclusion are made. Finally, our findings suggest that self-determined motivation may be an important predictor of

future MVPA behavior among older adults. These findings were consistent with theory (i.e., SDT; Deci & Ryan, 1985) and empirical research (Teixeira et al., 2012).

Taken together, our study provides evidence suggesting that certain affective responses during MVPA, namely revitalization, tranquility, and positive engagement may be important predictors of future MVPA behavior among older adults. Our findings suggest that health professionals should encourage active older adults to engage in challenging physical activity to decrease positive engagement during the bout, and in turn foster participation in future MVPA behavior. In addition, older adults should engage in physical activities that increase feelings of revitalization during physical activity and health practitioners should foster older adults' self-determined motivation for physical activity to facilitate engagement in future MVPA behavior. Given our mixed direct and indirect findings for tranquility, it will be important to replicate this study in a more representative sample before conclusions can be made regarding tranquility during MVPA.

List of Tables

Table 1. *Frequencies, Means, and Standard Deviations (SD) of Participant Demographics*

Variables	Mean (*SD*) or Frequency (%)
Age, years, mean (*SD*)	68.33 (4.09)
Female (%)	64.1
Ethnicity (% Caucasian)	96.2
Education completed to date (%)	
High school	2.6
Some university/college	12.8
University/college	44.9
Some graduate school	5.1
Graduate school	34.6
Annual income (CAN$, %)	
20-39,999	7.2
40-59,999	22.8
60-79,999	16.9
80-99,999	20.8
>100,000	32.3
Smoking status (%)	
Never smoked	48.7
Ex-smoker	47.4
Current smoker	3.8
Disability, injury, or health condition limits ability to be physically active (%)	
No, not at all	76.4
A little	19.2
Somewhat	4.3
Affected by the following chronic condition (%):	
Angina	0.0
High blood pressure	14.1
Diabetes	6.4
High cholesterol	32.1
Baseline MVPA, mean (*SD*)	2.79 (2.27)
BMI (kg/m^2), mean (*SD*)	25.89 (3.54)
Age-predicted heart rate maximum [206.9 - (0.67 x age)], mean (*SD*)	161.13 (2.74)
Moderate-intensity heart rate maximum (i.e., 64% of age-predicted heart rate maximum), mean (*SD*)	103.11 (1.75)

Note. BMI = Body Mass Index; MVPA = Number of physical activity sessions ≥ 60 minutes of at least a moderate-intensity per week.

Table 2. *Means (M) and Standard Deviations (SD) Among Affective Responses at 5 Minutes Prior to, Immediately Before, 10-Minutes During, 20-Minutes During, 30-Minutes During, and 5 Minutes After the Physical Activity Bout*

Variable, M (*SD*)	5 minutes prior	Immediately before	10-minutes during	20-minutes during	30-minutes during	5 minutes after
PEN	2.88 (.72)	2.88 (.81)	2.69 (.80)	2.70 (.86)	2.75 (.76)	2.97 (.72)
REV	1.97 (.80)	2.06 (.84)	1.84 (.81)	1.76 (.81)	1.76 (.83)	2.29 (.80)
TRA	2.68 (.87)	2.74 (.93)	2.59 (.82)	2.63 (.78)	2.74 (.72)	3.04 (.71)
PEX	.40 (.60)	.38 (.60)	.80 (.71)	1.18 (.75)	1.19 (.74)	.90 (.78)

Note. PEN = Positive engagement; REV = Revitalization; TRA = Tranquility; PEX = Physical exhaustion.

Table 3. *Ranges, Means (M), Standard Deviations (SD), and Correlations Among Main Study Variables*

Variable	Score Range	M	*SD*	Correlations					
				(Δ) PEN	(Δ) REV	(Δ) TRA	(Δ) PEX	SE	RAI
(Δ) PEN	-1.39 - 1.33	-.15	.47	–	–	–	–	–	–
(Δ) REV	-2.47 - 2.04	-.21	.76	.59**	–	–	–	–	–
(Δ) TRA	-1.44 - 1.96	-.06	.61	.48**	.44**	–	–	–	–
(Δ) PEX	-.44 - 2.11	.66	.60	-.20	-.41**	-.37**	–	–	–
SE beliefs	70.00 - 100.00	96.03	8.11	-.05	-.11	-.09	-.06	–	–
RAI	5.75 - 19.50	14.02	3.27	.06	-.04	.18	-.03	.28*	–
1-month MVPA	0.00 - 7.00	3.27	2.35	-.23*	.06	-.17	-.04	-.08	.12

Note. SE beliefs = Self-efficacy beliefs; RAI = Relative autonomy index; Δ = Change from average during score to average baseline score; PEN = Positive engagement; REV = Revitalization; TRA = Tranquility; PEX = Physical exhaustion; MVPA = Number of physical activity sessions ≥ 60 minutes of at least a moderate-intensity per week.
*$p < .05$, **$p < .01$

Table 4. *Bootstrapped Direct Effects of Changes in Positive Engagement, Revitalization, Tranquility, and Physic Exhaustion During Physical Activity on Self-Efficacy Beliefs and Self-Determined Motivation*

Variable	beta	*SE*	*T*-value	95% CI for beta	R^2
Direct effects on SE beliefs					0.20*
(Δ) PEN	1.06	2.43	.44	-3.70; 5.82	
(Δ) REV	-2.85	1.62	-1.75	-6.03; 0.33	
(Δ) TRA	1.01	1.78	.57	-2.48; 4.50	
(Δ) PEX	-2.61	1.73	-1.50	-6.00; 0.79	
Direct effects on RAI					0.08
(Δ) PEN	.40	1.04	.38	-1.65; 2.44	
(Δ) REV	-.72	.70	-1.03	-2.08; 0.65	
(Δ) TRA	1.26	.77	1.64	-0.24; 2.76	
(Δ) PEX	-.07	.75	-.09	-1.53; 1.39	

Note. SE beliefs = Self-efficacy beliefs; RAI = Relative autonomy index; Δ = Change from average during score to average baseline score; PEN = Positive engagement; REV = Revitalization; TRA = Tranquility; PEX = Physical exhaustion; beta = Unstandardized beta; *SE* = Standard error; 95% CI = 95 percent confidence interval (significant if the confidence interval does not cross zero).
*$p < .05$, **$p < .01$

Table 5. *Bootstrapped Direct Effects of Changes in Positive Engagement, Revitalization, Tranquility, and Physical Exhaustion During Physical Activity, and Self-efficacy Beliefs and Self-Determined Motivation, on Physical Activity Assessed at 1-Month*

Variable	beta	*SE*	*T*-value	95% CI for beta
Direct effects				
(Δ) PEN	-1.73	.68	-2.54	-3.07; -0.40
(Δ) REV	1.00	.47	2.16	0.09; 1.92
(Δ) TRA	-1.04	.51	-2.04	-2.03; -0.04
(Δ) PEX	-.20	.49	-.19	-1.07; 0.87
SE beliefs	-.05	.04	-1.43	-0.12; 0.02
RAI	.20	.08	2.39	0.04; 0.36

Note. SE beliefs = Self-efficacy beliefs; RAI = Relative autonomy index; Δ = Change from average during score to average baseline score; PEN = Positive engagement; REV = Revitalization; TRA = Tranquility; PEX = Physical exhaustion; beta = Unstandardized beta; *SE* = Standard error; 95% CI = 95 percent confidence interval (significant if the confidence interval does not include zero).

Table 6. *Bootstrapped Indirect Effects of Changes in Positive Engagement, Revitalization, Tranquility, and Physical Exhaustion During Physical Activity on Physical Activity Assessed at 1-Month Via Self-Efficacy Beliefs and Self-Determined Motivation*

Variable	beta	*SE*	BC 95% CI
Indirect effects via SE beliefs			
(Δ) PEN	-0.05	0.16	-0.53; 0.16
(Δ) REV	0.14	0.13	-0.02; 0.55
(Δ) TRA	-0.05	0.10	-0.40; 0.07
(Δ) PEX	.13	.12	-0.03; 0.50
Indirect effects via RAI			
(Δ) PEN	0.08	0.23	-0.37; 0.58
(Δ) REV	-0.14	0.14	-0.57; 0.05
(Δ) TRA	0.25	0.16	0.03; 0.74
(Δ) PEX	-0.01	0.15	-0.42; 0.22

Note. SE beliefs = Self-efficacy beliefs; RAI = Relative autonomy index; Δ = Change from average during score to average baseline score; PEN = Positive engagement; REV = Revitalization; TRA = Tranquility; PEX = Physical exhaustion; beta = Unstandardized beta; *SE* = Standard error; BC 95% CI = Bias-corrected 95 percent confidence interval (significant if the confidence interval does not include zero).

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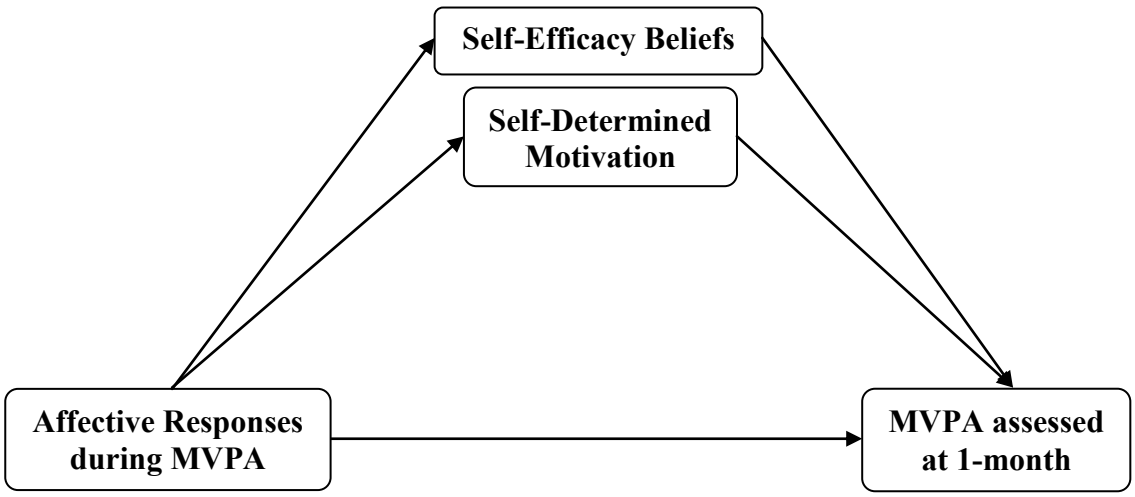

Figure 1. Proposed conceptual framework linking affective responses during physical activity, self-determined motivation and self-efficacy beliefs for physical activity, and future physical activity behavior.

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List of Appendices

Appendix A – Ethics Approval

File Number: H10-14-05 **Date (mm/dd/yyyy):** 11/14/2014

Université d'Ottawa University of Ottawa
Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

Ethics Approval Notice

Health Sciences and Science REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

First Name	Last Name	Affiliation	Role
Jennifer	Brunet	Health Sciences / Human Kinetics	Supervisor
Nicolas	Speranzini	Health Sciences / Human Kinetics	Student Researcher

File Number: H10-14-05

Type of Project: Master's Thesis

Title: Do psychological responses to an acute bout of physical activity predict physical activity behaviour 3 months later in older adults?

Approval Date (mm/dd/yyyy)	Expiry Date (mm/dd/yyyy)	Approval Type
11/14/2014	11/13/2015	Ia

(Ia: Approval, Ib: Approval for initial stage only)

Special Conditions / Comments:
N/A

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File Number: H10-14-05 **Date (mm/dd/yyyy):** 11/14/2014

Université d'Ottawa University of Ottawa
Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

This is to confirm that the University of Ottawa Research Ethics Board identified above, which operates in accordance with the Tri-Council Policy Statement (2010) and other applicable laws and regulations in Ontario, has examined and approved the ethics application for the above named research project. Ethics approval is valid for the period indicated above and subject to the conditions listed in the section entitled "Special Conditions / Comments".

During the course of the project, the protocol may not be modified without prior written approval from the REB except when necessary to remove participants from immediate endangerment or when the modification(s) pertain to only administrative or logistical components of the project (e.g., change of telephone number). Investigators must also promptly alert the REB of any changes which increase the risk to participant(s), any changes which considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project and safety of the participant(s). Modifications to the project, including consent and recruitment documentation, should be submitted to the Ethics Office for approval using the "Modification to research project" form available at: http://www.research.uottawa.ca/ethics/forms.html.

Please submit an annual report to the Ethics Office four weeks before the above-referenced expiry date to request a renewal of this ethics approval. To close the file, a final report must be submitted. These documents can be found at: http://www.research.uottawa.ca/ethics/forms.html.

If you have any questions, please do not hesitate to contact the Ethics Office at extension 5387 or by e-mail at: ethics@uOttawa.ca.

Kim Thompson
Protocol Officer for Ethics in Research
For Daniel Lagarec, Chair of the Health Sciences and Sciences REB

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Appendix B – Study Advertisement

Does the way you feel during physical activity predict your future behavior? A study focused on men and women 60 to 79 years of age.

Research participants needed

Principal investigator: Nicolas Speranzini, Master's Student, BPHE, University of Ottawa
Thesis supervisor: Dr. Jennifer Brunet, Assistant Professor, University of Ottawa

Purposes of the study: We want to understand if older adults' feelings during physical activity influence their motivation and perceived ability to participate in physical activity in the future, as well as their actual behavior.

Study procedure: If you agree to participate in this study, you will be asked to visit our research laboratory at the University of Ottawa and 1 month later you will be contacted by phone and asked a few questions about your physical activity behavior. For the first assessment, you will spend approximately 1 hour at our research laboratory located at the University of Ottawa. During this time, you will be asked to complete the following tasks:

(1) Read and sign a consent form;
(2) Have your heart rate, body temperature, height, and weight taken;
(3) Complete questionnaires;
(4) Complete 30-minutes of walking on a treadmill. Every 3 minutes, the treadmill inclination will increase progressively until your heart rate indicates that you are walking at a moderate intensity. At this point, your breathing will quicken and you may develop a light sweat. However, you will be able to stop at any time.

Then, 1 month later we will call you and ask you to answer a few questions over the phone about your physical activity behavior in the past 7 days.

You are eligible to participate in this study if you:

- Are 60 to 79 years of age;
- Speak and understand English;
- Can safely participate in 30-minutes of walking at a pace that leads to quickened breathing, deeper breathing and light sweating;
- Are not a highly active athlete (i.e., do not perform high intensity physical activity on a daily basis or for multiple hours a day).

If you are interested in participating in this study or want more information about the study please call Nicolas Speranzini at:

Appendix C – The Physical Activity Readiness Questionnaire for Everyone

Regular physical activity is fun and healthy, and more people should become more physically active every day of the week. Being more physically active is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

SECTION 1 - GENERAL HEALTH

	Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	YES	NO
1.	Has your doctor ever said that you have a heart condition OR high blood pressure?	☐	☐
2.	Do you feel pain in your chest at rest, during your daily activities of living, OR when you do physical activity?	☐	☐
3.	Do you lose balance because of dizziness OR have you lost consciousness in the last 12 months? Please answer NO if your dizziness was associated with over-breathing (including during vigorous exercise).	☐	☐
4.	Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)?	☐	☐
5.	Are you currently taking prescribed medications for a chronic medical condition?	☐	☐
6.	Do you have a bone or joint problem that could be made worse by becoming more physically active? Please answer NO if you had a joint problem in the past, but it does not limit your current ability to be physically active. For example, knee, ankle, shoulder or other.	☐	☐
7.	Has your doctor ever said that you should only do medically supervised physical activity?	☐	☐

If you answered NO to all of the questions above, you are cleared for physical activity.

Go to Section 3 to sign the form. You do not need to complete Section 2.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow the Canadian Physical Activity Guidelines for your age (www.csep.ca/guidelines).
- You may take part in a health and fitness appraisal.
- If you have any further questions, contact a qualified exercise professional such as a CSEP Certified Exercise Physiologist® (CSEP-CEP) or CSEP Certified Personal Trainer® (CSEP-CPT).
- If you are over the age of 45 yrs. and NOT accustomed to regular vigorous physical activity, please consult a qualified exercise professional (CSEP-CEP) before engaging in maximal effort exercise.

If you answered YES to one or more of the questions above, please GO TO SECTION 2.

Delay becoming more active if:

- You are not feeling well because of a temporary illness such as a cold or fever – wait until you feel better
- You are pregnant – talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the PARmed-X for Pregnancy before becoming more physically active OR
- Your health changes – please answer the questions on Section 2 of this document and/or talk to your doctor or qualified exercise professional (CSEP-CEP or CSEP-CPT) before continuing with any physical activity programme.

SECTION 2 - CHRONIC MEDICAL CONDITIONS

Please read the questions below carefully and answer each one honestly: check YES or NO.			YES	NO
1.	Do you have Arthritis, Osteoporosis, or Back Problems?		☐ If yes, answer questions 1a-1c	☐ If no, go to question 2
	1a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	1b.	Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/ or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)?	☐	☐
	1c.	Have you had steroid injections or taken steroid tablets regularly for more than 3 months?	☐	☐
2.	Do you have Cancer of any kind?		☐ If yes, answer questions 2a-2b	☐ If no, go to question 3
	2a.	Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and neck?	☐	☐
	2b.	Are you currently receiving cancer therapy (such as chemotherapy or radiotherapy)?	☐	☐
3.	Do you have Heart Disease or Cardiovascular Disease? This includes Coronary Artery Disease, High Blood Pressure, Heart Failure, Diagnosed Abnormality of Heart Rhythm		☐ If yes, answer questions 3a-3e	☐ If no, go to question 4
	3a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	3b.	Do you have an irregular heart beat that requires medical management? (e.g. atrial fibrillation, premature ventricular contraction)	☐	☐
	3c.	Do you have chronic heart failure?	☐	☐
	3d.	Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer YES if you do not know your resting blood pressure)	☐	☐
	3e.	Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months?	☐	☐
4.	Do you have any Metabolic Conditions? This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes		☐ If yes, answer questions 4a-4c	☐ If no, go to question 5
	4a.	Is your blood sugar often above 13.0 mmol/L? (Answer YES if you are not sure)	☐	☐
	4b.	Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, and the sensation in your toes and feet?	☐	☐
	4c.	Do you have other metabolic conditions (such as thyroid disorders, pregnancy-related diabetes, chronic kidney disease, liver problems)?	☐	☐
5.	Do you have any Mental Health Problems or Learning Difficulties? This includes Alzheimer's, Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome)		☐ If yes, answer questions 5a-5b	☐ If no, go to question 6
	5a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	5b.	Do you also have back problems affecting nerves or muscles?	☐	☐

Please read the questions below carefully and answer each one honestly: check YES or NO.			YES	NO
6.	Do you have a Respiratory Disease? This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure		☐ If yes, answer questions 6a-6d	☐ If no, go to question 7
	6a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	6b.	Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy?	☐	☐
	6c.	If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week?	☐	☐
	6d.	Has your doctor ever said you have high blood pressure in the blood vessels of your lungs?	☐	☐
7.	Do you have a Spinal Cord Injury? This includes Tetraplegia and Paraplegia		☐ If yes, answer questions 7a-7c	☐ If no, go to question 8
	7a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	7b.	Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting?	☐	☐
	7c.	Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)?	☐	☐
8.	Have you had a Stroke? This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event		☐ If yes, answer questions 8a-c	☐ If no, go to question 9
	8a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	☐	☐
	8b.	Do you have any impairment in walking or mobility?	☐	☐
	8c.	Have you experienced a stroke or impairment in nerves or muscles in the past 6 months?	☐	☐
9.	Do you have any other medical condition not listed above or do you live with two chronic conditions?		☐ If yes, answer questions 9a-c	☐ If no, read the advice on page 4
	9a.	Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months OR have you had a diagnosed concussion within the last 12 months?	☐	☐
	9b.	Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)?	☐	☐
	9c.	Do you currently live with two chronic conditions?	☐	☐

Please proceed to Page 4 for recommendations for your current medical condition and sign this document.

PAR-Q+

If you answered NO to all of the follow-up questions about your medical condition, you are ready to become more physically active:

- It is advised that you consult a qualified exercise professional (e.g., a CSEP-CEP or CSEP-CPT) to help you develop a safe and effective physical activity plan to meet your health needs.
- You are encouraged to start slowly and build up gradually – 20-60 min. of low- to moderate-intensity exercise, 3-5 days per week including aerobic and muscle strengthening exercises.
- As you progress, you should aim to accumulate 150 minutes or more of moderate-intensity physical activity per week.
- If you are over the age of 45 yrs. and NOT accustomed to regular vigorous physical activity, please consult a qualified exercise professional (CSEP-CEP) before engaging in maximal effort exercise.

If you answered YES to one or more of the follow-up questions about your medical condition:

- You should seek further information from a licensed health care professional before becoming more physically active or engaging in a fitness appraisal and/or visit a or qualified exercise professional (CSEP-CEP) for further information.

Delay becoming more active if:

- You are not feeling well because of a temporary illness such as a cold or fever – wait until you feel better
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise profesional, and/or complete the PARmed-X for Pregnancy before becoming more physically active OR
- Your health changes - please talk to your doctor or qualified exercise professional (CSEP-CEP) before continuing with any physical activity programme.

SECTION 3 - DECLARATION

- You are encouraged to photocopy the PAR-Q+. You must use the entire questionnaire and NO changes are permitted.
- The Canadian Society for Exercise Physiology, the PAR-Q+ Collaboration, and their agents assume no liability for persons who undertake physical activity. If in doubt after completing the questionnaire, consult your doctor prior to physical activity.
- If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.
- Please read and sign the declaration below:

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that a Trustee (such as my employer, community/fitness centre, health care provider, or other designate) may retain a copy of this form for their records. In these instances, the Trustee will be required to adhere to local, national, and international guidelines regarding the storage of personal health information ensuring that they maintain the privacy of the information and do not misuse or wrongfully disclose such information.

NAME _____ DATE _____

SIGNATURE _____ WITNESS _____

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER _____

For more information, please contact:
Canadian Society for Exercise Physiology
www.csep.ca

KEY REFERENCES
1. Jamnik VJ, Warburton DER, Makarski J, McKenzie DC, Shephard RJ, Stone J, and Gledhill N. Enhancing the eectiveness of clearance for physical activity participation; background and overall process. APNM 36(S1):S3-S13, 2011.
2. Warburton DER, Gledhill N, Jamnik VK, Bredin SSD, McKenzie DC, Stone J, Charlesworth S, and Shephard RJ. Evidence-based risk assessment and recommendations for physical activity clearance; Consensus Document. APNM 36(S1):S266-s298, 2011.

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Appendix D – Research Informed Consent

Does the way you feel during physical activity predict your future behavior? A study focused on men and women 60 to 79 years of age.

Principal investigator: Nicolas Speranzini, University of Ottawa, School of Human Kinetics, Faculty of Health Sciences, 125 University Private, Ottawa, ON, K1N 6N5

Supervisor: Dr. Jennifer Brunet, University of Ottawa, School of Human Kinetics, Faculty of Health Sciences, 125 University Private, Ottawa, ON, K1N 6N5

Thank you for taking the time to learn about this research study. This form will explain the study and what will happen in the study if you decide to participate. This study is being conducted as part of Nicolas Speranzini's Master's thesis, under the supervision of Dr. Jennifer Brunet. When we refer to "we" in this form, we are referring to the researchers.

Your consent (agreement) is required to participate in this study. If you would like to participate in this study, please read this sheet and sign where specified on the final page of this document.

Why are you being invited to participate in this study? Older adults are at increased risk for many chronic diseases, which can lead to a reduced quantity and quality of life. Regular physical activity may help to prevent or reduce some of these problems. However, the majority of older adults are either inactive or not active enough. This research study will help to understand why older adults are inactive in order to develop physical activity programs for this population.

Why is this study being done? The purposes of this study are to evaluate how you feel during physical activity and see if these feelings influence your motivation and self-efficacy to take part in physical activity, as well as your future participation in physical activity.

How many people will take part in this study? We are expecting to recruit 100 adults for this study.

What will you be asked to do if you decide to participate in this study? If you agree to participate in this study, you will be asked to come to the University of Ottawa on one occasion. When you come, you will spend approximately 1 hour at the Behavioral and Metabolic Research Unit laboratory where you will be asked to complete the following tasks:

(1) Read and sign a consent form;
(2) Have your heart rate, body temperature, height, and weight taken;
(3) Complete questionnaires assessing your sociodemographics, physical activity behavior, mood, feelings, perceived exertion, self-efficacy, and motivation;
(4) Complete 30-minutes of walking on a treadmill. Every 3 minutes, the treadmill inclination will increase progressively until your heart rate indicates that you are

walking at a moderate intensity. At this point, your breathing will quicken and you may develop a light sweat. However, you will be able to stop at any time.

Then, 1 month later we will call you and ask you to answer a few questions over the phone about your physical activity behavior in the past 7 days.

What are the risks of this study? This study is considered low risk. Nonetheless, even though physical activity is safe for older adults, you may experience faster breathing and develop a light sweat. After a while your breathing may deepen and you may be sweating at a slightly higher rate. In addition, you may experience an elevated heart rate, physical tiredness, nausea, dizziness, muscle pain, and weakness which may increase the risk of a fall, muscle sprain, bone fracture, or cardiac event. However, the likelihood that you will experience any serious negative effects is minimal since you have been screened for contraindications (e.g., cardiovascular disease) that prevent you from safely engaging in physical activity using the Physical Activity Readiness Questionnaire for Everyone. It should be noted that the duration and intensity of the physical activity session follows recommendations from the Canadian Society for Exercise Physiology, but this intensity of physical activity may be a greater intensity than you experience on a daily basis and result in physical discomfort. You should know that you will be able to decrease the intensity or stop the activity at any time without consequences. Further, the principal investigator will take the necessary steps to help reduce these feelings should they occur (e.g., assist you from the treadmill onto a chair, give you water, demonstrate breathing exercises). In the event of a medical emergency, the Behavioral and Metabolic Research laboratory is equipped with an Automated External Defibrillator (AED), and the principal investigator is certified in First Aid and CPR/AED level C. In addition, Protection Services at the University of Ottawa will be contacted to ensure a quick response by third party responders.

What about your privacy? The information that is collected from you for this study will be used solely for research purposes. Only the research team (i.e., Nicolas Speranzini and Dr. Jennifer Brunet) will have access to the information. All data will be kept anonymous and will not contain any identifying information. To ensure this anonymity, we will make sure that:

(1) Your name is not included on any questionnaires;
(2) A random barcode will be used to identify your questionnaires and other collected data so that we can keep your data together;
(3) Your personal information will be removed so that you cannot be identified in the dissemination of the results (in both presentations and written papers);

How will your information be kept? All of your data will be securely stored. To ensure this security, we will make sure that:

(1) Computer files will be kept on a password-protected computer in a locked office for a five year period after data is collected. In addition, files stored on mobile/portable devices (e.g., laptops) that contain your personal information will be encrypted.
(2) Written documents will be kept in locked cabinets within Dr. Brunet's research laboratory with a locked door at the University of Ottawa for 5 years. We will also separate your identifying information (name and contact information which is needed to communicate with you during the study) from all other information that is collected from you. After this period of time, Dr. Brunet will have all documents destroyed at Transport Services at the University of Ottawa.

What are your rights as a participant? You are not obligated to participate in this study and you can choose if you would like to take part in this study. Also, you are not waiving any of your legal rights if you choose to participate in this study. You can withdraw at any time and/or skip any procedures without consequences. Further, if you would like to have your data destroyed or removed from this study at any time, you may contact Nicolas Speranzini and he will ensure that this takes place.

If you have any questions or concerns about this study you may contact Nicolas Speranzini or his supervisor Dr. Jennifer Brunet. If you have any questions or concerns about your rights as a research participant that you do not feel comfortable discussing with the research team, you may also contact the Protocol Officer for Ethics in Research at the University of Ottawa by telephone: 613-562-5387, or by email: ethics@uottawa.ca.

*****We will give you a copy of this form to keep*****

Signature: You have been given a copy of all 3 pages of this form. You have reviewed the information and agree to participate in this study conducted by Nicolas Speranzini and Dr. Jennifer Brunet.

Participant's signature: _____ Date: _____

Participant's contact number: _____

Alternative contact number: _____

Appendix E – Baseline Sociodemographic Questionnaire

This questionnaire is needed to help understand the characteristics of the people participating in the study. All information will remain confidential.

1. Age: _____

2. Sex: _____

3. Education (please check highest level attained)

Some high school _____	Completed high school _____
Some university/college_____	Completed university/college _____
Some graduate school _____	Completed graduate school _____
(e.g., master's degree or PhD)	Prefer not to answer _____

4. Annual household income:

< 20,000 _____ 20-39,999 _____ 40-59,999 _____
60-79,999 _____ 80-99,999 _____ >100,000 _____
Prefer not to answer _____

5. Which of the following best describes your current smoking status?

____ Never Smoked ____ Ex-Smoker ____ Current Smoker
Prefer not to answer _____

6. Has a doctor or nurse ever told you that you have had the following? Please check all that apply.

a. Angina____yes ____no d. High blood pressure ____yes ____no

b. Diabetes ____yes ____no e. Other _____

c. High blood cholesterol ____yes ____no

7. People living in Canada come from many different racial and cultural backgrounds. What best describes your background (check all that apply)?

____ White	____ Arab
____ Chinese	____ West Asian (e.g., Afghan, Iranian, etc.)
____ South Asian (e.g., East Indian, Pakistani, Sri Lankan, etc.)	____ Southeast Asian (e.g., Vietnamese, Cambodian, etc.)

____ Japanese ____ Black

____ Filipino ____ Aboriginal

____ Latin American ____ Korean

Other – specify _____

8. Does a disability, injury, or health condition limit your ability to be physically active?

0 no, not at all	1 a little	2 somewhat	3 quite a lot	4 completely

Appendix F – Seven-Day Physical Activity Recall

PAR#: 1 2 3 4 5 6 7 **Participant**: _____

Interviewer: _____ Today is: _____ Today's Date: _____

1. Were you employed in the last seven days? 0. No **(**Skip to **Q#4)** 1. **Yes**
2. How many days of the last seven days did you work? _____ days
3. How many total hours did you work in the last seven days?_____ hours last week
4. What two days do you consider your weekend days? _____

(mark days below with a squiggle)

DAYS								
SLEEP		1 ___	2 ___	3 ___	4 ___	5 ___	6 ___	7 ___
MORNING	Moderate							
	Hard							
	Very Hard							
AFTERNOON	Moderate							
	Hard							
	Very Hard							
EVENING	Moderate							
	Hard							

	Very Hard							
Total Min Per Day	Strength: Flexibility:	_____	_____	_____	_____	_____	_____	_____

4a. Compared to your physical activity over the past 3 months, was last week's physical activity more, less, or about the same? **1. More 2. Less 3. About the same**	6. Do you think this was a valid PAR interview? **1. Yes 0. No** If **NO**, go to the back and explain.
5. Were there any problems with the PAR interview? **0. No 1. Yes** If **YES**, go to the back and explain.	7. Were there any special circumstances concerning this PAR? **0. No 1. Yes,** If **YES**, what were they? (circle) 1. Injury all week 2. Illness all week 3. Illness part week 4. Injury part week 5. Pregnancy 6. Other:

Explain why there were problems with this PAR interview:

_____
_____
_____

If PAR interview was not valid, why was it not valid?

_____
_____
_____

Please list below any activities reported by the subject which you do not know how to classify.

_____
_____
_____

Please provide any other comments you may have.

_____
_____
_____

Appendix G – Exercise-Induced Feeling Inventory

Please use the following scale to indicate the extent to which each word below describes how you feel at this moment in time. Record your responses by ticking the appropriate box next to each number.

	Do Not Feel	Feel Slightly	Feel Moderately	Feel Strongly	Feel Very Strongly
Refreshed	0	1	2	3	4
Calm	0	1	2	3	4
Fatigued	0	1	2	3	4
Enthusiastic	0	1	2	3	4
Relaxed	0	1	2	3	4
Energetic	0	1	2	3	4
Happy	0	1	2	3	4
Tired	0	1	2	3	4
Revived	0	1	2	3	4
Peaceful	0	1	2	3	4
Worn-out	0	1	2	3	4
Upbeat	0	1	2	3	4

Appendix H – Self-Efficacy Questionnaire

The item listed below is designed to assess your **belief in your ability to accumulate 150 minutes of moderate-to-vigorous intensity aerobic physical activity per week in bouts of 10 minutes or more during the next month**. Using the scale provided below, please indicate how confident you are in your ability to perform this amount of physical activity during the next month.

For example, if you **have complete confidence** that you can accumulate 150 minutes of moderate-to-vigorous intensity aerobic physical activity per week in bouts of 10 minutes or more for the next month, you would **circle 100%**. However, if you have **no confidence** that you can accumulate 150 minutes of moderate-to-vigorous intensity aerobic physical activity per week in bouts of 10 minutes or more for the next month, you would **circle 0%**.

Please remember to answer honestly and accurately. There is no right or wrong answer.
Rate your degree of confidence by recording a number from 0 to 100 using the scale given below:

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

NOT AT ALL CONFIDENT — MODERATELY CONFIDENT — COMPLETELY CONFIDENT

---

1. I am confident that I can accumulate ***150 minutes of moderate-to-vigorous intensity aerobic physical activity PER WEEK****, in bouts of 10 minutes or more*, during ***the next MONTH.***

   0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Appendix I – The Behavioral Regulation in Exercise Questionnaire-2

We are interested in the reasons underlying peoples' decisions to engage, or not engage in physical exercise. Using the scale below, please indicate to what extent each of the following items is true for you. Please note that there are no right or wrong answers and no trick questions. We simply want to know how you personally feel about exercise. Your responses will be held in confidence and only used for our research purposes.

	Not true for me		Sometimes true for me		Very true for me
I exercise because other people say I should	0	1	2	3	4
I feel guilty when I don't exercise	0	1	2	3	4
I value the benefits of exercise	0	1	2	3	4
I exercise because it's fun	0	1	2	3	4
I don't see why I should have to exercise	0	1	2	3	4
I take part in exercise because my friends/family/partner say I should	0	1	2	3	4
I feel ashamed when I miss an exercise session	0	1	2	3	4
It's important to me to exercise regularly	0	1	2	3	4
I can't see why I should bother exercising	0	1	2	3	4
I enjoy my exercise sessions	0	1	2	3	4
I exercise because others will not be pleased with me if I don't	0	1	2	3	4
I don't see the point	0	1	2	3	4

in exercising					
I feel like a failure when I haven't exercised in a while	0	1	2	3	4
I think it is important to make the effort to exercise regularly	0	1	2	3	4
I find exercise a pleasurable activity	0	1	2	3	4
I feel under pressure from my friends/family to exercise	0	1	2	3	4
I get restless if I don't exercise regularly	0	1	2	3	4
I get pleasure and satisfaction from participating in exercise	0	1	2	3	4
I think exercising is a waste of time	0	1	2	3	4

Appendix J – Rating of Perceived Exertion Scale

While participating in exercise it is quite common to have a sense for how hard you are working. We would like you to consider the total amount of exertion you feel, taking into account all sensations of physical stress, effort and fatigue in your whole body. Scientists have developed a scale to measure this perception of exertion.

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	