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**Understanding Action Control of Resistance Training among Adults**

### Abstract

**Background:** Regular muscle and bone strengthening activities through resistance training (RT) have been associated with numerous health benefits, particularly as adults age, yet participation is low. Effective promotion is likely founded on an understanding of theory-based correlates, yet almost all RT research has focused on college-aged convenience samples and employed social cognition models, which do not consider the intention-behavior gap. The purpose of this study was to explore RT from the perspective of the multi-process action control framework in a large Canadian adult sample. **Method:** Canadian adults (N = 1338) completed M-PAC measures of reflective (instrumental attitude, affective attitude, perceived capability and opportunity), regulatory (planning and self-monitoring), and reflexive (habit, identity) processes as well as intention to engage in RT at baseline and RT behavior two-weeks later. **Results:** Three intention-behavior profiles emerged: a) non-intenders who were not active (41.4%), b) unsuccessful intenders who failed to enact their positive intentions (32.9%), and c) successful intenders who engaged in RT (23.5%). A discriminant function analysis ( $p < .01$ ) showed that instrumental and affective attitude, perceived opportunity and planning/self-monitoring distinguished between all three intention-behavior profiles, while perceived capability predicted the intention-RT profiles of females but not males ( $p < .01$ ). By comparison, identity was particularly important to younger/middle-aged adults than older females ( $p < .01$ ), while habit was associated with the intention-RT profiles of older adults but not younger/middle-aged adults ( $p < .01$ ). **Conclusions:** The findings support the importance of considering both intention formation and translation in RT. Behavior change techniques aimed at reflective, regulatory, and reflexive processes appear necessary. Additional considerations of targeting specific constructs by age and sex may maximize the potential effectiveness of RT interventions.

Physical inactivity is among the leading contributors to mortality worldwide and associated with over 25 chronic health conditions (Rhodes, Bredin, et al., 2017; Warburton & Bredin, 2017). Approximately one third of the world's population are not meeting the current recommendations of at least 150 minutes of aerobic activity of moderate-intensity (or 75 minutes of vigorous activity) throughout the week (Guthold et al., 2018; Hallal et al., 2012), supporting the importance of continued physical activity promotion.

Although originally limited to the promotion of aerobic exercise and cardio-respiratory fitness, physical activity recommendations have evolved to reflect the importance of activity to improve muscular fitness (i.e., resistance training) (Blair et al., 2004). There are unique musculoskeletal (e.g., improvements in posture, mobility and balance) (Orr et al., 2008) and metabolic health benefits (e.g., reductions in blood sugar levels and increases in lean muscle mass) (Ashton et al., 2020) of improving muscular fitness from participation in resistance training (RT). Regular RT is subsequently associated with decreased overall mortality (Kraschnewski et al., 2016). As a result, international and national guidelines now recommend that adults participate in RT activities involving major muscle groups on two or more days a week (Ross et al., 2020; U.S. Department of Health and Human Services, 2018; World Health Organization, 2020).

RT (also known as strength training) is typically defined as a specialized method of conditioning that involves the progressive use of a wide range of resistive loads to enhance health, fitness and performance (Faigenbaum et al., 2009). RT can involve a variety of training modalities, such as free weights, weight machines, medicine balls, elastic tubing devices and an individual's body weight. While RT can benefit the health of all adults (World Health Organization, 2010), the activity may be particularly important to healthy aging given its impact

on reducing sarcopenia, maintaining bone density, and maintaining cognitive health (Falck et al., 2019; Fragala et al., 2019). Unfortunately, while the benefits of RT are now well established, the prevalence of RT in nationally representative samples is low. A meta-analysis of physical activities performed worldwide showed that as few as 6% of adults may engage in weight training (Hulteen et al., 2017), although broader definitions of RT suggest that 20-33% of the population may meet international guidelines (Bennie et al., 2016; Loustalot et al., 2013; ParticipACTION, in press). There is also emerging evidence that RT may have been further compromised during the COVID-19 pandemic (Steele et al., 2021). Regardless, it is clear that the promotion of RT is needed to reap these established health benefits (Steele et al., 2017).

Successful RT promotion is founded on a clear understanding of its correlates (Burton et al., 2017). A review of 51 studies exploring RT correlates showed that demographic, behavioral and health factors such as age (-), education (+), perceived health status (+), quality of life (+), and total physical activity performed (+) were all associated with RT (Rhodes, Lubans, et al., 2017). However, understanding RT through a theoretical frame is most likely to guide effective interventions (Rothman, 2004). To this end, research focused on understanding RT has been largely guided by a small number of studies that have applied social cognitive approaches (see Rhodes, Lubans, et al., 2017), such as theory of planned behavior (Ajzen, 1991), and social cognitive theory (Bandura, 1998). For example, the five studies that have applied theory of planned behavior to understand RT showed that intention predicted RT in the small to large effect size range among college students (Branscum & Fairchild, 2019; Bryan & Rocheleau, 2002; Rhodes et al., 2007), older adults (Dean et al., 2006), and type 2 diabetes patients (Plotnikoff et al., 2008). Intention was subsequently predicted by subjective norm, and attitude (Branscum & Fairchild, 2019; Bryan & Rocheleau, 2002; Plotnikoff et al., 2008; Rhodes et al.,

2007) and/or perceived behavioral control (Branscum & Fairchild, 2019; Dean et al., 2006; Rhodes et al., 2007).

While this research provides helpful information for setting specific mechanism of action targets for RT promotion, there are some potential shortcomings to our current understanding of RT. First, current theory-driven RT research has focused almost exclusively on social cognitive approaches, where intention is considered the proximal determinant of behavioral action (Rhodes, Lubans, et al., 2017). Theories focused on the translation of intention into behavior (Rhodes & Yao, 2015; Sheeran & Webb, 2016; Zhang et al., 2019), also known as action control (Kuhl, 1984), may help yield additional information. This is because nearly half of those with good intentions fail to follow through (Rhodes & de Bruijn, 2013). Indeed, the only study to explore action control in RT, to our knowledge, found the gap between RT intentions and behavior was 49% in a sample of hematologic cancer survivors (Vallerand et al., 2016). Further, the study showed that action control constructs like degree of planning and RT identity were predictors of this intention –behavior correspondence independent of traditional social cognitive constructs like attitudes and perceived behavioral control. Thus, the application of action control theories has potential to shed important light on factors that convert intentions into behavioral actions but requires more sustained study.

Second, most theoretical research focused on predicting RT involves either convenience samples of college students or clinical samples. Clearly the merits of RT extend to everybody, yet research focused on understanding RT would benefit from more representative population samples with subsequent comparisons between key demographic groups to better understand whether RT promotion requires targeting. Of particular interest to RT promoters may be differences in age and sex when understanding RT. This is partly due to the increased value of

RT on reversing sarcopenia, increasing bone density, and improving cognitive health among aging adults (Falck et al., 2019; Fragala et al., 2019), but also based on misperceptions among some older adults, particularly older females, who believe RT is an activity more suitable for young males due to its association with muscularity (Burton et al., 2017).

With these aims in mind, the purpose of this study was to explore action control of RT behavior in a large representative sample of adult Canadians. Specifically, we sought to 1) examine the magnitude of the RT intention-behavior gap, 2) identify theoretical predictors of this gap, and 3) discern whether RT predictors differ between older and younger adults and by sex.

We used the multi-process action control (M-PAC; Rhodes, 2017, 2021) framework to predict RT action control, which has shown predictive capability when explaining PA generally (Rhodes et al., 2021). Briefly, M-PAC conceives intention as a decisional construct (Rhodes & Rebar, 2017) (i.e., intend/do not intend) and has antecedent constructs of intention similar to the theory of planned behavior (called *reflective processes*) that include affective (expected pleasure) and instrumental (expected utility) attitudes, and perceived capability (ability to perform a behavior) and opportunity (social/environmental access to perform a behavior). In the M-PAC framework, however, reflective processes of perceived opportunity and affective attitude are also posited to predict the translation of an intention into behavior, to the extent that they represent a proxy for the affective and logistical factors that challenge one's competing daily decisions. By contrast, instrumental attitude and perceived capability are not considered antecedents of the translation of an intention because they are expected to vary little from day to day and situation to situation (Rhodes et al., 2021). The translation of intention into behavior is instead marked by the enactment of *regulatory processes* (e.g., planning, self-monitoring), as people begin to use volitional behavioral regulation tactics to help translate positive intentions into action. Finally,

continuance of action control is thought to rely upon *reflexive processes* such as habit formation (i.e., behavior performed from stimulus-response bonds) and identity (i.e., self-categorization in a role) as one begins to perform the behavior more regularly.

Based on prior research (Vallerand et al., 2016), we expected that RT intention would be predicted by reflective processes similar to prior theory of planned behavior research with RT. By contrast, we expected the differences between unsuccessful and successful intenders in meeting RT guidelines would be predicted by the regulatory (planning), and reflexive processes (identity, habit) in addition to regulatory processes. Overall, we expected reflective, regulatory, and reflexive processes to contribute unique variance to the prediction models of the intention-RT profiles. We considered our analyses of findings by age and sex as exploratory.

## **Method**

### **Sample and Design**

This study was conducted on SurveyMonkey and used an online survey design with a two-week follow-up assessment of RT behavior. The study ran from August 17-20, 2020 (participants invited on August 17). The Time 2 survey was completed September 3-8, 2020 (participants were invited on September 3). The recruitment was run by a third-party market research firm that has an online consumer database of >120,000 Canadian panelists. Panelists are recruited via online and offline methods and receive small cash incentives (\$0.50 to \$3.00 CDN) for completing surveys. The panel is comparable to the Canadian census in terms of age, gender, region, income, employment, and language spoken (Statistics Canada, 2019). At the time of survey launch, COVID-19 pandemic lockdown measures in Canada that would have previously limited physical activity (e.g., gym closures) had been temporarily lifted. Therefore, the opportunity to engage in RT behavior at traditional venues was available. All participants were

adults (18+ years of age) who were living in Canada. Each participant also provided informed consent and the study was approved by the authors' University research ethics board.

## Measures

### Primary Outcome: Weekly Frequency of RT

RT frequency at time 2 was measured with a modified Godin Leisure-Time Questionnaire (Godin et al., 1986; Godin & Shephard, 1985) format used in prior RT studies (Rhodes et al., 2007; Vallerand et al., 2016). The adaptation included using a single RT category response instead of the traditional three categories of strenuous, moderate, and mild aerobic exercise. Specifically, participants were asked to recall their average weekly muscle- and bone-strengthening exercise over the past two weeks. Duration of at least 15 min was chosen as the anchor for participants to respond with their frequency, identical to the original Godin questionnaire. This is arbitrary because RT public health guidelines do not specify a duration (only a frequency), but it aligned with the design of the original instrument and likely represents a fair appraisal of the minimum time to complete strength repetitions of major muscle groups, defined in RT guidelines (Ross et al., 2020).

### Predictor Measures

The instrumentation used to assess the constructs of the M-PAC framework were framed in terms of achieving muscle- and bone-strengthening activities that use major muscle groups, at least 2 days per week and measured at T1. *Attitude* was measured on seven-point scales with three *affective* (unenjoyable-enjoyable, unpleasant-pleasant, boring-fun), and three *instrumental* attitude (useless-useful, harmful-beneficial, foolish-wise) semantic differential items (McEachan et al., 2016) framed for over the next two weeks. *Perceived capability* (i.e., I have the physical and mental capability to...; I have enough skill to do..., I can handle the physical and mental

demands of doing...) was assessed with three items on a seven-point scale and *perceived opportunity* (i.e., I will have the opportunity to do...; I could find a way to fit it in my schedule so that I do..., I would experience barriers beyond my control preventing me from doing...[reverse scored]) was assessed with three items on a seven-point scale adapted from Rhodes et al. (2006) and framed as expectations over the next two weeks. To reduce the potential confound in assessments of control and motivation (Williams & Rhodes, 2014), items were preceded by the statement “Only think about your [capability/opportunity] and ignore your motivation (i.e., how much you want to something) to do regular muscle- and bone-strengthening exercise over the next two weeks.” *Decisional intention* was measured with the item created by Courneya (1994): “intend to do regular muscle- and bone-strengthening exercise over the next two weeks.,” scored as disagree or agree. The items of *behavioral regulation* were adapted from other sources (Sniehotta et al., 2006; Umstattd et al., 2009) and included four items, answered on a seven-point scale from “strongly disagree” to “strongly agree”. Exemplar items included “I kept track of ...”, “I made regular plans concerning when, where, how and what kind of ...”, “I evaluated my ... goals to see if they are appropriate for me...” and “I made plans regarding what to do if something interfered with ....” where muscle- and bone-strengthening exercise was the referent in each question. Assessment of *habit* used the self-reported automaticity index (e.g., muscle and bone strengthening exercise is something I do automatically; Gardner et al., 2012) and assessment of *identity* used the role identity subscale (e.g., when I describe myself to others, I usually include my involvement in...; Wilson & Muon, 2008) from the exercise identity scale (Anderson & Cychosz, 1994). Response options for both measures were on a seven-point Likert scale from (1) strongly disagree to (7) strongly agree. Measures of affective attitude ( $\alpha = .93$ ;  $\omega = .93$ ), instrumental attitude ( $\alpha = .93$ ;  $\omega = .93$ ), perceived capability ( $\alpha = .92$ ;  $\omega = .92$ ), perceived

opportunity ( $\alpha = .69$ ;  $\omega = .74$ ), planning ( $\alpha = .92$ ;  $\omega = .92$ ), habit ( $\alpha = .96$ ;  $\omega = .96$ ), and identity ( $\alpha = .90$ ;  $\omega = .91$ ) showed adequate reliability.

In addition to the M-PAC measures, the questionnaire also included self-reports of age, sex, ethnicity, education, marital status, income, employment status, and presence of chronic disease.

### Analysis Plan

Data were analysed in SPSS 25 (SPSS Inc., Chicago, IL, USA). For the prediction analyses, missingness of the variables was inspected to determine the appropriate imputation procedures (Allison, 2002) and normality of all variables was checked to determine whether any transformations were required. Descriptives of all variables were computed. For the creation of the action control framework (i.e., intention-behavior profiles), we coded intenders as those who scored “agree” to the decisional intention item compared to non-intenders, who scored “disagree” at time 1. The approach adheres to the binary decisional intention construct used in M-PAC, as intention is not meant to represent the intensity of commitment but rather the mere direction of intended action (Rhodes & Rebar, 2017). Subsequent RT, was coded as unsuccessful (<2 times per week) and successful (>1 time per week) in accordance with RT guidelines (Ross et al., 2020) and the scale correspondence with all M-PAC measures. This categorization provides four possible quadrants of: 1) nonintenders (low intention, low RT), 2) nonintenders who were active (low intention, RT), 3) unsuccessful intenders (high intention, low RT), and 4) successful intenders (high intention, RT).

Prediction of the intention-RT profile category membership was achieved using discriminant function analyses and follow-up univariate analysis of variance tests to identify where there were differences among the M-PAC predictors across the intention-RT profiles,

while controlling for any demographic and health condition variables associated with profile membership. To explore the relative contribution of reflective (affective and instrumental attitude, perceived capability and opportunity), regulatory (planning), and reflexive processes (habit, identity) we used hierarchical blocks of predictors in the discriminant function analysis.

Our sub-analyses included the same discriminant function analyses tests for age groups (50+), sex, and the action control x sex and age interaction. We acknowledge that any chronological age cut-off is arbitrary, and chose this break-down because muscle and bone loss tends accelerate around this age due to sarcopenia and the beginning of menopause among females (Ferrucci et al., 2012; McKinlay et al., 1972).

Considering a small-medium effect size ( $f = .20$ ) from prior research using M-PAC (Rhodes et al., 2021), an alpha of .01, and a power of .80, 75 participants were needed in a particular intention-behavior profile to be included in the analyses (Faul et al., 2007). Alpha was set at  $p < .01$  and effect sizes were estimated to aid in the interpretation of the inferential statistics results. Specifically, for the associations with the discriminant function, we used  $r = .15$  as the minimum recommended effect size based on past research (Rhodes et al., 2021). Similarly, for supplementing Bonferroni post-hoc mean differences, we used  $d = .30$  as the minimum recommended effect size based on comparable past research with M-PAC (Rhodes et al., 2021).

## Results

### Baseline Characteristics of Respondents

Thirteen hundred and 38 participants responded to the survey invitation and their demographics and health profile is reported in Table 1. Participants reported a mean age of 46.85 years ( $SD = 15.95$ ), with 51.7% female, 48% male and 0.03% transgender representation. Participants were primarily (79.5%) white; however, the sample had variability in education

(53% university), employment (61%), and income (60% at or above the median for Canadians). Participants also reported variability in the presence of chronic diseases such as cancer (9%), heart disease (11%) and type 2 diabetes (11%). In terms of physical activity, 28.8% reported meeting RT guidelines and 40.3% reported meeting aerobic physical activity guidelines.

### Preliminary Analyses

M-PAC variables showed evidence of univariate (e.g., skewness and kurtosis <1.0) and multivariate normality (Mahalanobis distance = 7.00;  $p > .05$ ). Descriptive statistics and bivariate correlations for the M-PAC variables are presented in Supplementary Table 1. All variables were significantly ( $p < .05$ ) inter-correlated, ranging from small to large effect sizes. The two-week follow-up of RT ( $M = 16.96$  days;  $SD = 1.26$ ) was completed by 1113 participants (83.2% retention). Little's MCAR test was not significant ( $\chi^2_{49} = 63.93$   $p > .05$ ) and a more specific analysis of a dummy coded missing variable did not show any correlations between baseline RT or demographics. Thus, a missing at random estimation of these data is accurate and an imputation approach for time 2 RT was conducted using the expectation-maximization algorithm (Allison, 2002, 2012).

The intention-behavior profiles of the action control framework yielded the following distributions for RT: 1) nonintenders (41.4%;  $n = 554$ ); 2) nonintenders who did RT (2.2%;  $n = 29$ ); 3) unsuccessful intenders (32.9%;  $n = 440$ ); and, 4) successful intenders (23.5%;  $n = 315$ ). This breakdown shows the RT intention-behavior gap was 58% (number of unsuccessful intenders divided by the total number of intenders). Due to the extremely small sample size of nonintenders who resulted in meeting RT guidelines, this cell was eliminated from all further analyses. Also, due to the small number of transgender participants, our sub-analyses included only participants who reported being male or female.

### Main Analyses

An examination of the intention-behavior profiles by demographics and health conditions was performed to determine whether any of these variables should be entered into the multivariate analyses as covariates (Supplementary Table 2). Employment status (those who were employed were more likely to follow-up on RT intentions) was associated with the profiles ( $p < .01$ ;  $\eta^2 = .02$ ). No other demographic variable was associated with the intention-RT profiles in the small effect size (or greater) range (Cohen, 1992), so we proceeded in the analyses with employment status as a covariate. The main results of the discriminant analyses and follow-up tests are presented in Table 2 and the hierarchical analyses of predictors by reflective, regulatory, and reflexive constructs are presented in Table 3. The discriminant analysis identified one significant discriminant function that distinguished among the three groups [Wilks'  $\lambda = .45$ ; canonical  $r = .73$ ,  $\chi^2 = (16) = 1022.13$ ,  $p < .01$ ] and correctly classified 66.4% of cases. Affective attitude ( $r = .20$ ), instrumental attitude ( $r = .20$ ), perceived opportunity ( $r = .21$ ), behavioral regulation ( $r = .43$ ), habit ( $r = .16$ ) and identity ( $r = .23$ ) had meaningful correlations with the discriminant function. Furthermore, the addition of regulatory ( $\Delta R^2 = .09$ ) and reflexive ( $\Delta R^2 = .03$ ) constructs contributed significant variance to the discriminant function equation ( $p < .01$ ). Post-test follow-up analyses showed that all variables significant in the association with the discriminant function predicted both nonintenders from unsuccessful intenders and subsequent unsuccessful intenders from successful intenders with consecutively larger values in each predictor variable.

### Sub-Analyses by Age and Sex

Our sub-analyses by age and sex showed similar findings to our main analyses, with a significant discriminant function for each group and subsequent significant contributions with

the entry of regulatory/reflexive variables (see Table 3). The full results of these analyses are presented in Supplementary Table 3 and Supplementary Table 4. Overall, there was a significant difference in the relationship between sex and the intention-behavior profiles ( $\chi^2(2) = 18.36; p < .01$ ), but no age, or age x sex interaction. Specifically, more nonintenders were male (47%) than female (38%), yet more females (39%) reported being unsuccessful intenders compared to males (28%). In terms of M-PAC constructs, the results of the formal statistical tests between age and sex are presented in Table 4. The correlation with the multivariate discriminant function was significantly different for perceived capability, habit, and identity ( $p < .01$ ). Specifically, perceived capability was associated with prediction of the intention-RT profiles for older females more than any other demographic group. Perceived capability was also associated with the intention-RT profiles of young males more than young females. Habit was associated with the intention-RT profiles for older adults more than younger adults. Finally, older females had a significantly lower association between identity and the intention-RT profiles compared to all other groups.

### **Discussion**

Regular RT has been associated with numerous health benefits, particularly as adults age (Fragala et al., 2019), yet participation is low and promotion efforts are scant in comparison to aerobic physical activity (Steele et al., 2017). Effective promotion is likely founded on a solid understanding of behavioral correlates, particularly with the use of an organizing theoretical framework (Bauman et al., 2012; Rhodes et al., 2019). At present, most theoretical research focused on RT has included convenience samples or clinical samples, which may not generalize to the larger adult population; furthermore, almost all RT research has employed social cognition models which suggest that intention is the critical determinant of behavior and does not consider

the infamous intention-behavior gap (Rhodes & de Bruijn, 2013; Sheeran & Webb, 2016). The purpose of this study was to explore RT from the perspective of the M-PAC framework in a large Canadian adult sample to 1) examine the magnitude of the RT intention-behavior gap, 2) identify predictors of this gap, and 3) discern any differences by age and sex.

Our results showed that less than a third (28%) of our sample reported meeting RT public health guidelines, which is commensurate with prevalence estimates from Canadian national statistics (ParticipACTION, in press) and also similar to Australia (Bennie et al., 2016), and the United States (Loustalot et al., 2013). This is about half the prevalence of self-reported aerobic physical activity guidelines (Guthold et al., 2018; ParticipACTION, in press), confirming the need to place more promotion effort on RT (Steele et al., 2017). Dividing the sample, however, into intention-RT profiles helped produce a more fine-grained assessment of population readiness of RT. Specifically, we showed that 41% of the inactive sample were nonintenders, while 33% of inactive participants had the intention to engage in RT but did not reach this intention. By contrast, nearly all of the sample participating in RT were those with a positive intention (24%), making the intention-behavior gap 58%. These proportions were similar across age, but differed by sex with more male nonintenders (47%) than female (38%), yet more females (39%) reported being unsuccessful intenders compared to males (28%).

There are several findings in this breakdown of RT and intention profiles that may be helpful to shape intervention efforts. First, the proportion of nonintenders is roughly double that of aerobic physical activity (ParticipACTION, 2019; Rhodes & de Bruijn, 2013). From this evidence, complemented by a recent multi-country study that showed intention to perform RT was declining due to the pandemic (Steele et al., 2021), we suggest that many people, potentially even more males specifically, may benefit from promotion aimed at raising RT intentions.

However, among those intending to engage in RT, the intention-RT gap is also sizeable. In fact, the results show that the intention-RT gap is larger than aerobic physical activity (ParticipACTION, 2019; Rhodes & de Bruijn, 2013), and disproportionately larger for females than males. It is also important to note that few participants (2% of the sample) were classified as nonintenders who subsequently engaged in RT. This asymmetry in the intention-behavior relationship supports theorizing in action control theories (Rhodes & Yao, 2015), such as M-PAC, where intention is conceived as a necessary, yet intermediary construct in regular behavioral enactment. Taken together, the results support the importance of understanding the factors that may determine intention formation and intention translation in order to implement targeted intervention.

Thus, the second purpose of this study was to use the variables present in the M-PAC framework to predict intention-RT profiles. Overall, there was support for the M-PAC approach that reflective, regulatory, and reflexive variables all explain unique variance in intention-behavior concordance (Rhodes, 2017), similar to the prior findings of Vallerand et al. (2016). This builds upon most prior RT research to show that both regulatory and reflexive processes should be considered in intervention along with targeting more traditional social cognitive variables (Rhodes, Lubans, et al., 2017). Contrary to expectations, the means for M-PAC constructs increased significantly between nonintender, unsuccessful-, and successful intender groupings. This finding suggests that higher levels of M-PAC variables are generally needed to enact RT than form an intention, but there was little discrimination to show specific variables were more important to intention formation than action control. This result provides evidence against discontinuity patterns among M-PAC variables (Duan et al., 2011; Grant et al., 2021), and instead suggests that the results may reflect a continuum. Longitudinal analyses of

participants beginning RT and progressing across time, however, is likely needed to understand how M-PAC variables change across time (Kekäläinen et al., 2018). The current sample is likely heterogeneous in past RT experiences and a two-week prospective design is not sufficient to understand how M-PAC constructs predict true progression from intention formation to action control.

Despite the lack of evidence for discontinuity patterns, there were noteworthy differences in the effect sizes across M-PAC constructs, suggesting specific constructs may be most important to target in interventions. For the reflective constructs, instrumental and affective attitude were both relatively equal predictors in the small effect size range. This is similar to the only prior study that has focused on predicting RT intention-behavior profiles (Vallerand et al., 2016), yet aerobic physical activity research shows that affective attitude, but not instrumental attitude, is the critical predictor (Grant et al., 2021). We speculate the discrepancy may be occurring because knowledge about the health benefits of RT is not as prevalent as aerobic activity (Burton et al., 2017; Steele et al., 2017) and thus, even among intenders, a stronger expectation of the benefits of RT may translate to prioritizing enactment. Almost all of the adult population is aware that aerobic physical activity is beneficial to health and this has been established for some time (Martin et al., 2000; O'Donovan & Shave, 2007). In this case of RT, however, there may be an opportunity to promote its health benefits along side the affective aspects of RT (Williams et al., 2019) in order to improve intention formation and subsequent action control.

The reflective constructs of perceived capability and perceived opportunity also predicted the RT intention-behavior profiles, generally in the small effect size range. The effect of perceived opportunity on both intention formation and action control was commensurate with

our expectations. Perceived opportunity may impact both the formation of an intention and its translation to behavior to the extent that it represents a proxy for the logistical challenges faced during day-to-day behavioral enactment (Rhodes, 2017). RT activities often include equipment (e.g., weights, elastic resistance bands) and recreation centres so environmental opportunity may be even more important for promotion considerations than aerobic activity (Harada et al., 2011). In addition, while our survey was conducted between lockdowns at gyms and recreation centres in Canada, the perception of opportunity may have been compromised for some participants, as shown in other research (Spence et al., 2021). Promoting opportunities for RT seems a public health priority as the pandemic subsides. In contrast to perceived opportunity, perceived capability predicted RT intention-behavior profiles most for older females, and had little association with RT for males. This may represent gendered stereotypes around RT and masculinity, which has been particularly manifest in differences among older adults and their past exercise and sport experiences (Burton et al., 2017; Rhodes et al., 1999). The finding suggests that specific RT programs targeting females, particularly older females, may be useful to help build perceptions of capability (Beauchamp & Rhodes, 2020; Chevan, 2008; Galuska et al., 2002; Rhodes et al., 2001). This promotion aim seems especially relevant and timely, because RT has particular benefits to healthy ageing for females such as maintaining bone density and preventing muscle wastage that can dramatically improve functional quality of life and activities of daily living (Chodzko-Zajko et al., 2009; Fragala et al., 2019).

While reflective processes are key to intention formation theories, the hallmark constructs of action control theories are regulation processes that manifest as planning, self-monitoring, and other tactics that people use to translate intentions into action (Rhodes & Yao, 2015). As expected in our hypotheses and in line with this theorizing, regulation processes were

consistently the largest predictors of the intention-RT profiles, in the medium effect size range. The finding supports the overall role of planning and self-monitoring in action control theories such as M-PAC and the health action process approach (Schwarzer, 2008). The particularly standout effect sizes in this study compared to past research (Grant et al., 2021; Zhang et al., 2019), however, may relate to the additional organizational requirements of enacting RT. Like the perceived opportunity construct noted above, RT often involves more equipment and access to locations, such as gyms or recreation centers so this requires more self-regulation planning than aerobic activity. The results support the importance of promoting planning and other self-regulatory skills (Hagger et al., 2016; Rhodes, Grant, et al., 2020) alongside RT competencies and knowledge (Lubans et al., 2014; Smith et al., 2016).

M-PAC is unique from other action control theories in its addition of the reflexive constructs of habit and identity (Rhodes, 2017). These reflexive determinants are hypothesized to develop as a behavior continues and subsequently increase the efficiency of action control over time. Our results found habit was not associated with intention-RT profiles for younger/middle-aged adults, but had a small-medium effect size association with the intention-RT profiles of older adults. The differences in these findings by age requires more detailed information from participants to fully understand, but one explanation may have been the tumultuous experiences of pandemic living faced by younger compared to older adults. Specifically, habits are based on the forging of stimulus-behavior bonds from repetition within the same context over time (Gardner & Rebar, 2019; Rebar et al., 2020). The lives of working age Canadians, particularly those with young families, has been difficult, and many have had to juggle multiple roles with a break in predictable routines (Garre-Olmo et al., 2021; Glowacz & Schmits, 2020). It may be

that this unpredictability has lessened the effects of habit on health behaviors such as exercise (Rhodes, Liu, et al., 2020), particularly for younger/middle-aged adults.

By contrast, RT identity was a predictor of RT intention-behavior profiles for younger/middle-aged in the medium effect size range. Identity is the self-categorization of oneself in a particular role, and theorized to motivate behavioral activation reflexively in the face of cues that suggest someone is behaving differently than that self-categorization in order to minimize the negative affect that occurs from this dissonance (Burke & Stets, 2009). Previous research in physical activity during the COVID-19 pandemic has shown that exercise identity was the strongest predictor of continuing regular physical activity in the face of disruptions (Rhodes, Liu, et al., 2020). This may also relate to the findings in this study, and help explain the differences between identity and habit. Specifically, identity theory supports its critical role in motivating behavior during challenging situations as it promotes increased motivation and self-regulation when discrepancies in behavioral action appear (Strachan et al., 2015; Strachan et al., 2017). Habit, on the other hand, will weaken in the face of contextual instability because the stimulus-behavior associations are no longer consistent (Wood & Runger, 2016). The results, overall support behavior change strategies that foster identity for RT, although how to promote identity change effectively in health behaviors is still an emerging focus of research (Caldwell et al., 2018; Rhodes et al., 2016). Of note, our results found RT identity did not predict the intention-behavior profiles for older females. Like our findings for perceived capability, these sex x age interactions may be a reflection of past experiences with physical activity and the stereotypes around RT, which affect how older females perceive RT within their lives, and the role it plays (Whaley & Ebbeck, 2002). A more qualitative focus on identity and RT among older adults is recommended to better understand why these differences may be present.

Despite the large national sample, the innovative research questions, and the theoretical and applied strengths of this paper, there are limitations to this research. First, the RT measure was self-report and thus subject to biases. Second, because our instruments were accessible only in English, our sampling was reflective of English Canada but may not have full representation in Quebec, or new Canadians who do not read English. Third, while pandemic restrictions did not prohibit going to gyms, there were likely protocol in place at gyms (e.g., mask requirements, social distancing; capacity limitations) that may have influenced perceptions of opportunity so the results of this study need to be considered within the pandemic context. Fourth, our sub-analysis by age included a division at age 50, and while we did show interactions with this sub-analysis, other age thresholds or even a continuous age variable may be a better alternative to explore these data. Fifth, our behavioral regulation measure included content that focused primarily on planning and self-monitoring; behavioral regulation in M-PAC is conceived as a broader construct (e.g., emotion regulation, social tactics) of regulation tactics (Rhodes et al., 2021), so instruments with this broader focus and a multi-variate focus may yield different outcomes. Finally, while the design was prospective and could accurately assess action control over time, the two-week measurement period lacks the temporal range to understand the changes in RT patterns and intention. A longer time-frame with participants who are new to beginning an RT program would yield more accurate data on action control.

### **Conclusions**

The study results found that many adult Canadians in our sample were not intending to engage in RT as recommended by public health guidelines and, among those with positive intentions, well over half failed to follow-through and enact the behavior. M-PAC constructs could discriminate these intention-behavior profiles showing that reflective, regulatory, and

reflexive processes added unique variance to the prediction equation. Consecutively higher planning and self-monitoring was particularly important to discriminate these profiles, in addition to smaller contributions of attitudes (instrumental and affective), and perceived opportunity. Perceived capability was more critical to predicting the intention-RT profiles of women, particularly older females, compared to males. By comparison, identity was particularly important to younger/middle aged adults than older females, while habit was associated with the intention RT profiles of older adults but not younger/middle aged adults. Collectively, the findings support the importance of considering intention formation and action control in RT and the joint promotion of reflective, regulatory, and reflexive processes in the choice of behavior change techniques. Additional considerations of targeting specific constructs by age and sex may be needed to maximize the potential effectiveness of interventions.

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Table 1

*Sample Demographics*Baseline Characteristics (*N* = 1338)Demographic Profile

Age in Years (SD)		46.85 (15.95)
% Female		51.7
% Male	48.0	
% Transgendered		0.3
% Visible Minority		20.5
% Black	2.6	
% Asian	9.0	
% South Asian	5.3	
% South East Asian		1.3
% Indigenous		1.3
% Other		1.0
% College Education and above	52.7	
% Married/Common-law		54.3
% Income \$75k CDN and above	60.1	
% Full-time Employed	49.5	
% Part-time Employed	11.7	

Health Profile

% Heart Disease		11.1
% Cancer		9.9
% T2 Diabetes		11.0
% High Blood Pressure	23.4	
% meeting MVPA Guidelines	40.3	
% Meeting RT Guidelines		28.8

Table 2.

*Prediction of Resistance Training Intention-Behavior Profiles using Multi-Process Action Control Variables.*

	Intention-Behavior Profiles			Correlation with Discriminant Function	Univariate Follow-Up $F_{2,1306}$	Post Hoc
	Non-intenders (n = 554)	Unsuccessful Intenders (n = 440)	Successful Intenders (n = 315)			
Employment Status	1.54 (0.50)	1.63 (0.48)	1.71 (0.45)	.04	NA	NA
Instrumental Attitude	4.76 (1.56)	5.75 (1.17)	6.35 (0.92)	.20	164.56*	NI < UI < SI
Affective Attitude	3.27 (1.40)	4.83 (1.29)	5.61 (1.19)	.20	362.11*	NI < UI < SI
Perceived Capability	4.31 (1.59)	5.50 (1.15)	6.13 (0.94)	.12	NA	NA
Perceived Opportunity	4.39 (1.63)	5.49 (1.13)	6.15 (0.96)	.21	192.06*	NI < UI < SI
Behavioral Regulation	2.33 (1.19)	4.26 (1.24)	4.80 (1.33)	.43	470.19*	NI < UI < SI
Habit	2.26 (1.31)	3.67 (1.54)	4.58 (1.54)	.16	281.21*	NI < UI < SI
Identity	2.07 (1.19)	3.66 (1.54)	4.64 (1.45)	.23	381.13*	NI < UI < SI

Note:  $*=p < .01$  and  $\eta^2 > .01$ . NI = non-intenders; UI = unsuccessful intenders; SI = successful intenders. NA = not applicable. Post hoc tests interpreted as  $p < .01$  and  $d > 0.30$ .

Table 3

*Comparison of reflective, regulatory, and reflexive processes as predictors of Resistance Training in hierarchical analyses*

Processes	Wilks' $\lambda$	Canonical Correlation	X <sup>2</sup>	$\Delta R^2$	$\Delta X^2$
<u>Overall Model</u>					
Reflective Processes	0.57	.65	720.86*	.43	720.86*
Regulatory Processes	0.48	.72	949.09*	.09	228.23*
Reflexive Processes	0.45	.73	1022.13*	.03	73.04*
<u>Males Aged 18-49</u>					
Reflective Processes	0.58	.64	179.24*	.42	179.24*
Regulatory Processes	0.47	.72	248.04*	.11	68.8*
Reflexive Processes	0.46	.73	259.58*	.01	11.54*
<u>Females Aged 18-49</u>					
Reflective Processes	0.63	.60	187.05*	.37	187.05*
Regulatory Processes	0.54	.67	250.86*	.09	63.81*
Reflexive Processes	0.51	.69	271.99*	.03	21.13*
<u>Males Aged 50+</u>					
Reflective Processes	0.52	.69	182.96*	.48	182.96*
Regulatory Processes	0.45	.74	223.98*	.07	41.02*
Reflexive Processes	0.40	.76	253.96*	.05	29.98*
<u>Females Aged 50+</u>					
Reflective Processes	0.49	.71	185.88*	.51	185.88*
Regulatory Processes	0.41	.77	231.65*	.08	45.77*
Reflexive Processes	0.37	.78	256.50*	.04	24.85*

Note: \* =  $p < .01$ .

Table 4  
*Comparison of Multi-Process Action Control Constructs discriminant function correlations by Age and Sex*

	$\chi^2$	<i>p</i> -level	Post-Hoc
Instrumental attitude	3.82	.28	NA
Affective attitude	10.08	.02	NA
Perceived capability	22.39	< .01	YM<YF,OF; OM<OF
Perceived opportunity	5.74	.13	NA
Behavioral regulation	4.65	.20	NA
Habit	29.29	<.01	YF,YM<OM,OF
Identity	23.96	<.01	OF<OM,YM,YF

Note: *p* < .01 criterion for post-hoc follow-up. YM = younger males, YF = younger females, OM = older males, OF = older females.