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Reflecting on physical activity across 2 years of the COVID-19 pandemic: Predictors of intention-behavior profiles

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Reflecting on Physical Activity across two years of the COVID-19 Pandemic:
Predictors of Intention-Behavior Profiles

Abstract

The COVID-19 pandemic has affected how many people engage in regular moderate-to-vigorous intensity physical activity (MVPA). The purpose of this study was to predict current and dynamic (across two years of the pandemic) intention and MVPA profiles using the multi-process action control (M-PAC) framework. A representative sample of 977 English-speaking Canadians (18+ years) completed measures of reflective (instrumental attitude, affective attitude, perceived capability and opportunity), regulatory (planning and self-monitoring), and reflexive (habit, identity) processes and MVPA. These measures included current assessments and reflections prior to the COVID-19 restrictions. Three current intention-behavior profiles (non-intenders, unsuccessful intenders, successful intenders) and five dynamic intention-MVPA by pre-pandemic MVPA profiles (consistent non-intenders, relapsed non-intenders, consistent unsuccessful intenders, relapsed unsuccessful intenders, consistent successful intenders) emerged from these data, showing few increased MVPA across the pandemic. The current and dynamic profiles were subsequently predicted by changes in specific reflective, regulatory, and reflexive processes across the pandemic; however, only change in identity was the critical predictor of successful MVPA engagement in the dynamic two-year MVPA profiles. Collectively, the findings support the joint promotion of reflective, regulatory, and reflexive processes in the choice of behavior change techniques to promote post-pandemic MVPA intention and behavior.

Key Words: Identity, Perceived Capability, Behavioral Regulation, Adults, Exercise, Opportunity

The health benefits of regular physical activity (PA) are well-established (Rhodes et al., 2017; U.S. Department of Health and Human Services, 2018). Specifically, moderate-to-vigorous intensity PA (MVPA), performed 150 minutes or more per week, is linked to the reduced odds of over 25 chronic health conditions, with relative risk reduction between 20 and 40 percent (Arem et al., 2015; Rhodes et al., 2017). Despite these benefits, many adults do not engage in this recommended level of MVPA. Physical inactivity is most prevalent in high-income Western and South Asian countries, where nearly 50% of adults did not meet the recommended guidelines for health in 2016 (Guthold et al., 2018). Unfortunately, since the worldwide COVID-19 pandemic was declared on March 11, 2020 (World Health Organization, 2020), the prevalence of physical inactivity has risen further. While stay at home orders and the closing of recreation facilities were undertaken to reduce the spread of the respiratory virus, it drastically affected how people engaged in recreation (Sport for Life, 2020), and the relative composition of daily PA behaviours. A systematic review of PA during the first year of the pandemic showed that 44 of 45 published studies reported decreases in PA from population samples across the world (Stockwell et al., 2021). More concerning, half of these studies showed PA decreases of >50%, substantiating massive behavioral changes during the accommodation of pandemic restrictions. These findings were mirrored by the corresponding declines in mental health indicators (depressive and anxiety symptoms, perceived stress, negative affect, life satisfaction) associated with decreases in PA and increases in sedentary behavior (de Brito et al., 2021; Gierc et al., 2021; Giuntella et al., 2021).

Given the alarming rates of physical inactivity, explorations of the correlates of PA during the early phases of the pandemic allowed for interesting and helpful findings about who stayed active compared to those who decreased PA. A recent review of 64 studies on this topic

showed that individual (autonomous motivation), social (presence of children in the home, owning a dog, having a partner to exercise with), and environmental (having exercise options outside of recreation facilities, embracing online exercise options, home equipment) factors were all associated with maintaining PA (Knight et al., 2021). A clear finding that emerged during these early COVID-19 pandemic restrictions was that physical opportunity to engage in PA was associated with behavior (Kaushal et al., 2020; Rhodes et al., 2020; Spence et al., 2021; Teran-Escobar et al., 2021), which makes logical sense in the landscape of recreation centre, sports activities, and gym closures.

Interestingly, there was also a stream of evidence that showed identified motivation (acceptance that PA serves an important role in life) or PA identity (self-categorization as someone who engages in PA) was a prominent predictor of PA during the early phase of the pandemic (Petersen et al., 2021; Rhodes & Lithopoulos, 2022; Rhodes et al., 2020; Volz et al., 2021). For example, Rhodes et al. (2020) found that identity was the most powerful independent predictor of PA adherence during the early phase of the pandemic when controlling for demographic, social, environmental, personality, and other motivational variables. Identity theory suggests that behavioral discordance with an identity standard (e.g., someone who views themselves as an exerciser, but is not performing exercise) will initiate motivation to ultimately re-set behavior with that identity standard (Burke, 2006; Burke & Stets, 2009). Thus, the challenging circumstances of pandemic living may have necessitated PA identity as a critical factor for the continuance of PA.

As pandemic restrictions have lessened in most countries and recreation facilities have mainly returned to normal operations, PA rates have fortunately seen a rise from early pandemic values (Bu et al., 2021; Herbec et al., 2021). However, this research still shows that population

MVPA is still considerably below pre-pandemic values, which were already a major public health concern. Clearly, there is a need to promote MVPA in this post-pandemic landscape. Further, the determination of MVPA from factors such as physical opportunities and strong PA identities may have lessened and other key factors to explain participation may now also be prominent. An understanding of how people have changed in their motivation and PA behavior now, over two years after the pandemic, is necessary in order to direct contemporary intervention approaches.

With this in mind, the purpose of this retrospective study was to explore current and dynamic (retrospective reflection across two years of the COVID 19 pandemic) motivation (intention) and behavioral (MVPA) profiles in a sample of adult Canadians. We also sought to explore how changes in PA antecedents, using the constructs of the multi-process action control (M-PAC; Rhodes, 2017, 2021) framework predicted these current and dynamic intention-MVPA profiles.

Briefly, M-PAC conceives PA as a primarily intentional behavior and intention as a decisional construct (Rhodes & Rebar, 2017) (i.e., intend/do not intend). The antecedents of intention include affective (expected pleasure) and instrumental (expected utility) attitudes, and perceived capability (physical ability to perform a behavior) and opportunity (social and environmental context available to perform a behavior), called *reflective processes*. In the M-PAC framework, reflective processes (particularly affective attitude and perceived opportunity) are also posited to predict the translation of an intention into behavior, to the extent that they represent a proxy for the factors that challenge one's competing daily decisions. Yet the translation of intention into behavior, is marked primarily by the enactment of *regulation 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 PA is thought to also 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 with M-PAC (Rhodes, 2021), we expected that post-pandemic intention-PA profiles would be predicted by pre- to post-pandemic changes in reflective (affective attitude, perceived opportunity), regulation (behavioral self-regulation), and reflexive (habit, identity) processes. We also hypothesized that changes in pre-PA to post-pandemic intention-PA profiles would be predicted by these M-PAC constructs, with particular evidence for the role of PA identity, based on early pandemic PA research (Petersen et al., 2021; Rhodes & Lithopoulos, 2022; Rhodes et al., 2020).

Methods

Sample and Design

This retrospective study was conducted on SurveyMonkey and used an online survey design. The study ran from March 12 to March 16, 2022. Recruitment for the study 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. Overall, the panel is comparable to the Canadian census in terms of age, gender, ethnicity, region, income, employment, and language spoken (Statistics Canada, 2019). At the time of survey launch, COVID-19 pandemic lockdown measures in Canada had been lifted (Canadian Institutes of Health Research, 2022). Therefore, the opportunity to engage in PA at traditional recreation 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: Moderate-to-Vigorous Physical Activity Duration

Minutes of MVPA was measured by self-report using a modified Godin Leisure-Time Questionnaire (GLTEQ; Godin et al., 1986; Godin & Shephard, 1985). Specifically, the fixed 15 minute duration of the GLTEQ was modified with an open-ended assessment so weekly frequency and duration of PA could be computed as a multiplicative (frequency x duration) sum of moderate- and vigorous-intensity minutes to estimate weekly MVPA (Courneya et al., 2004). While the outcome of interest was MVPA, the light-intensity category was also included in the measure, so that participants would be less likely to misclassify their light-intensity PA into the moderate-intensity category within their response options (Courneya et al., 2004). The instrument asked 1) about MVPA in a typical week before the COVID-19 pandemic (March, 2020) and 2) MVPA over the last seven days. Descriptors of each type of intensity physical activity were included in the definition of PA, similar to the standard GLTEQ.

Predictor Measures

The instrumentation used to assess the constructs of the M-PAC framework were framed 1) about MVPA in the context of a typical week before the COVID-19 pandemic (March, 2020) and 2) about performing MVPA over the last seven days. *Attitude* was measured on seven-point bipolar scales with two *affective* (enjoyable, pleasant), and two *instrumental* attitude (beneficial, useful) semantic items (affective attitude pre-COVID $\alpha = .96$; Current $\alpha = .96$; instrumental attitude pre-COVID $\alpha = .91$; Current $\alpha = .90$). *Perceived capability* (i.e., physical ability to engage in....; enough skill to do the activities needed for me to engage in..., confident in my

physical ability to engage in...) was assessed with three items on a seven-point bipolar scale and *perceived opportunity* (i.e., opportunity to engage in...; could find a way to fit physical activity into my schedule..., had the chance to engage in...) was assessed with three items on a seven-point bipolar scale (Lithopoulos et al., in press). To attempt to reduce the potential confound in assessments of control and motivation (Williams & Rhodes, 2014), items included “if I wanted to” at the end of each item (perceived capability pre-COVID $\alpha = .94$; Current $\alpha = .95$; perceived opportunity pre-COVID $\alpha = .93$; Current $\alpha = .95$). *Decisional intention* was measured with the item created by Courneya (1994): “I intend to engage in moderate-vigorous physical activity for at least 150 minutes per week,” scored as disagree or agree and only phrased as currently (i.e., not retrospective before COVID-19). The items of *behavioral regulation* were adapted from other sources (Sniehotta et al., 2006; Umstatted et al., 2009) and included five items, answered on a four-point scale from “not at all” to “all of the time”. Exemplar items included “I kept track of ...”, “I set short-term goals...” “I made regular plans concerning when, where, how and what kind of ...”, and “I made plans regarding what to do if something interfered with” where MVPA was the referent in each question (pre-COVID $\alpha = .87$; Current $\alpha = .89$). Assessment of *habit* used the self-reported automaticity index (e.g., MVPA 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 five-point Likert scale from (1) strongly disagree to (7) strongly agree (habit pre-COVID $\alpha = .94$; Current $\alpha = .96$; identity pre-COVID $\alpha = .91$; Current $\alpha = .91$).

In addition to the M-PAC measures, the questionnaire also included self-report of age, sex, gender, ethnicity, education, living with dependents, income, employment status, COVID-

19 vaccination status, and regular mask wearing behavior. We also included measures of current perceived COVID-19 severity (i.e., I believe that COVID-19 is severe; I believe that COVID-19 is serious) and susceptibility (i.e., believe that I am at risk for getting COVID-19; I believe it is possible that I could contract COVID-19) on seven point Likert-type scales (Lithopoulos et al., 2021) as covariates (severity $\alpha = .93$; susceptibility $\alpha = .78$).

Analysis Plan

For the creation of the intention-behavior profiles, we first coded intenders as those who scored “agree” to the decisional intention item compared to non-intenders, who scored “disagree”. 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). Current MVPA was coded as unsuccessful (<150 min per week) and successful (≥ 150 min per week) in accordance with Canadian guidelines (Ross et al., 2020) and the scale correspondence with all M-PAC measures. This categorization of current intention-MVPA provides four possible quadrants of: 1) non-intenders (low intention, low MVPA), 2) non-intenders who were active (low intention, high MVPA), 3) unsuccessful intenders (high intention, low MVPA), and 4) successful intenders (high intention, high MVPA). Our second coding expanded upon these four profiles by adding whether participants reported meeting MVPA guidelines pre-COVID-19 pandemic. This categorization of dynamic intention-MVPA profiles provides eight possible quadrants of: 1) consistent non-intenders (low MVPA pre-pandemic, low intention, low MVPA), 2) relapsed non-intenders (high MVPA pre-pandemic, low intention, low MVPA), 3) non-intending adopters (low pre-pandemic MVPA, low intention, high MVPA) 4) consistent active non-intenders (high MVPA pre-pandemic, low intention, high MVPA) 5) consistent unsuccessful intenders (low MVPA pre-pandemic, high intention, low

MVPA), 6) relapsed unsuccessful intenders (high MVPA pre-pandemic, high intention, low MVPA), 7) successful adopters (low MVPA pre-pandemic, high intention, high MVPA) and 8) consistent successful intenders (MVPA pre-pandemic, high intention, high MVPA).

Data were analysed in SPSS 26 (SPSS Inc., Chicago, IL, USA). For the prediction analyses, univariate (skewness < 1.0 and kurtosis < 2.0 ; outliers $Z < 3.1$) and multivariate (Mahalanobis distance $p < .01$) normality of all M-PAC variables was checked to determine whether any transformations or removal of participants were required (Tabachnick & Fidell, 2012). Changes in M-PAC variables were computed using the unstandardized residuals (Tennant et al., 2021) of current perceptions regressed on the reflected pre-pandemic perceptions. Descriptives of all variables were computed.

Prediction of the intention-MVPA 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-behavior profiles, while controlling for any demographic and health condition variables associated with profile membership. To explore the relative contribution of reflective (affective and instrumental attitudes, perceived capability and opportunity), regulatory (planning), and reflexive processes (habit, identity) we used hierarchical blocks of predictors in the discriminant function analysis. Considering a small-medium effect size ($f = .18$) from prior research using M-PAC (Rhodes et al., 2021), an alpha of .01, and a power of .80, 65 participants were needed in a particular intention-behavior profile to be included in the analyses (Faul et al., 2007). Due to the large sample size and number of statistical tests, alpha was set at a slightly more conservative $p < .01$ 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

Nine hundred and seventy-seven participants responded to the survey invitation and their demographics and health profile is reported in Table 1. Participants reported a mean age of 46.79 years ($SD = 15.23$), with 51.2% women, 48.2% men and 0.1% transgender, and 0.8% gender non-conforming representation. Participants had diverse ethnicity, with 41% reporting European origins, 38.3% reporting North American origins, 12.7% reporting Asian origins, and 6.0% reporting other origins (North American Aboriginal = 2%; Caribbean = 1.6%; Central and South American = 1%; African = 0.5%; Oceania = 0.9%). The sample had variability in education (49.9% university), employment (67% full and part time), and income (57.7% at or above the median for Canadians). Participants also reported a COVID-19 vaccination rate of 92.1%, and 48.4% reported currently meeting PA guidelines.

Preliminary Analyses

The current intention-behavior profiles were: 1) non-intenders (29.9%; $n = 290$); 2) non-intenders who did PA (6.6%; $n = 64$); 3) unsuccessful intenders (21.8%; $n = 212$); and 4) successful intenders (41.7%; $n = 405$). This breakdown shows the intention-behavior gap was 34% (number of unsuccessful intenders divided by the total number of intenders). Due to the small and disproportionate sample size of non-intenders who resulted in PA and our a priori power analysis criteria, this cell was eliminated from all further analyses.

Our second coding, adding whether participants reported meeting MVPA guidelines pre-COVID-19 pandemic, provided the following dynamic intention-behavior profiles: 1) consistent non-intenders (22.6%; $n = 219$); 2) relapsed non-intenders (7.2%; $n = 70$); 3) non-intending adopters (1.2%; $n = 12$); 4) consistent active non-intenders (5.4%; $n = 52$); 5) consistent unsuccessful intenders (11.9%; $n = 115$); 6) relapsed unsuccessful intenders (10%; $n = 97$); 7) successful adopters (4.3%; $n = 42$); and 8) consistent successful intenders (37.4%; $n = 363$). Due to the small and disproportionate sample sizes of the non-intending adopters, consistent active non-intenders, and successful adopters groups, and our a priori power analysis criteria, these cells were eliminated from all further analyses.

M-PAC variables and their residual change scores showed evidence of normality (e.g., skewness < 1.0 and kurtosis < 2.0), but 18 univariate outliers ($Z > 3.0$) were identified and adjusted to the next lowest score (Tabachnick & Fidell, 2012) which produced Z score results within the acceptable range. Descriptive statistics and bivariate correlations for the M-PAC variables are presented in Supplementary Table 1 and baseline scores of all variables can be found in Supplementary Table 2. All variables were significantly ($p < .01$) inter-correlated, ranging from small to large effect sizes. For the main analyses, the Mahalanobis distance test showed that 13 participants were multivariate outliers ($p < .01$); these were removed from further analyses (see Table 2 and Table 3 for adjusted intention-PA group sample sizes).

Main Analyses

An examination of these intention-behavior profiles by demographics and COVID-19 related variables was performed to determine whether any of these variables should be entered into the multivariate analyses as covariates (Supplementary Table 3 and Table 4). Sex (males more likely to be successful intenders; females more likely to be non-intenders), employment

status (employed more likely to be successful intenders; not employed more likely to be non-intenders), education (higher formal education more likely to be successful intenders; lower formal education more likely to be non-intenders), and family income (higher income more likely to be successful intenders; lower income more likely to be non-intenders) were associated with the profiles ($p < .01$; $\eta^2 = .02$). These variables were subsequently included in the analyses of the current intention-MVPA profiles as covariates.

For our coding of dynamic intention-MVPA profiles (i.e., intention-MVPA profiles, also divided by pre-pandemic MVPA), sex (males more likely to be consistent successful intenders; females more likely to be consistent non-intenders), employment status (employed more likely to be consistent successful intenders; not employed more likely to be consistent non-intenders and relapsed non-intenders), and education (higher formal education more likely to be consistent successful intenders; lower formal education more likely to be consistent non-intenders) were associated with the profiles ($p < .01$; $\eta^2 = .02$). These variables were subsequently included in the analyses of the second coding as covariates.

The main results of the discriminant analyses and follow-up tests for the intention-MVPA profiles are presented in Table 2. The discriminant analysis identified a significant discriminant function that distinguished among the three groups [Wilks' $\lambda = .72$; canonical $r = .52$, $\chi^2(22) = 249.80$, $p < .01$] and correctly classified 57.3% of cases. Changes in affective attitude ($r = .18$), perceived capability ($r = .16$), behavioral regulation ($r = .33$), and identity ($r = .41$) had meaningful correlations with the discriminant function, controlling for the demographic covariates. Post-test follow-up analyses showed that all variables significant in the association with the discriminant function predicted both non-intenders from unsuccessful intenders and subsequent unsuccessful intenders from successful intenders with consecutively larger values in

each predictor variable. Supplementary Table 4 highlights the ascending contributions of the reflective ($\Delta R^2 = .18$), regulatory ($\Delta R^2 = .07$) and reflexive ($\Delta R^2 = .03$) constructs as they contributed significant variance to the discriminant function equation ($p < .01$).

The main results of the discriminant analyses and follow-up tests for the second coding of intention-MVPA profiles by pre-pandemic MVPA are presented in Table 3. The discriminant analysis identified a significant discriminant function that distinguished among the three groups [Wilks' $\lambda = .65$; canonical $r = .56$, $\chi^2 = (40) = 354.82$, $p < .01$] and correctly classified 44.2% of cases. Changes in perceived capability ($r = .16$), behavioral regulation ($r = .32$), habit ($r = .15$) and identity ($r = .49$) had meaningful correlations with the discriminant function, controlling for the demographic covariates. Post-test follow-up analyses showed that negative changes in identity, behavioral regulation and perceived opportunity distinguished relapsed non-intenders as lower than all other profiles. Relapsed non-intenders, relapsed unsuccessful intenders, and consistent non-intenders were lower than consistent non-intender and consistent successful intenders across all changes in M-PAC variables. Only positive changes in identity, however, distinguished consistent successful intenders from all other profiles. Finally, Supplementary Table 5 highlights the ascending contributions of the reflective ($\Delta R^2 = .22$), regulatory ($\Delta R^2 = .07$) and reflexive ($\Delta R^2 = .06$) constructs as they each contributed significant variance to the discriminant function equation ($p < .01$).

Discussion

Understanding MVPA in the post-pandemic restrictions landscape is important in order to determine effective intervention targets. The purpose of this retrospective study was to predict current and dynamic (retrospective reflection across two years of the COVID-19 pandemic) intention and MVPA profiles using the M-PAC framework (Rhodes, 2017, 2021). The study

yielded important insights into the motivational and behavioral profiles of Canadians and represents one of a handful of comprehensive theory-based applications to understand MVPA during the pandemic (Knight et al., 2021).

Collectively, our results showed that 48% of our sample reported meeting PA guidelines, which was perceived by respondents to be down from 60% before the pandemic began. This decrease is correspondent with prior research pertaining to MVPA during COVID-19 pandemic restrictions (Stockwell et al., 2021). Our intention-MVPA profiles, however, provided more information about the motivational and behavioral foundation of MVPA in the post-pandemic landscape. Specifically, 30% of our sample reported being inactive and having no intention to engage in MVPA at guideline levels, but of the 64% of respondents with intention to engage in MVPA, only 66% were successful. This intention-MVPA gap is slightly lower than average (Rhodes & de Bruijn, 2013), but still considerably marked, with 34% of participants who intend to engage in MVPA but are not yet realizing those intentions.

More interesting, however, was our dynamic profile of intention-MVPA when subdivided by the MVPA profile of participants before the pandemic began. In this profile, over 2/3rds of our sample were consistent in a pattern of not meeting guidelines at both time-points with no intention to engage in MVPA, not meeting guidelines at both time-points with an intention to engage in MVPA, or meeting guidelines at both time-points with an intention to engage in MVPA. The group (about 1/3rd) who was not meeting guidelines at both time-points yet had an intention to engage in MVPA, represents an interesting profile of individuals who appear to consistently fall-short on their positive intentions. In contrast to these consistent patterns, two changes in behavioral profiles also emerged from our findings. Unfortunately, both of these change profiles were relapses in meeting MVPA guidelines when comparing pre-pandemic

values. Specifically, one group reported no longer meeting PA guidelines with no intention to engage in MVPA while the other group reported no longer meeting guidelines with an intention to engage in MVPA. The group who reported no intention to engage in MVPA represents a particularly concerning outcome, as this is a dramatic change in their behavioral and motivational profile. Overall, the findings support the promotion of both intention formation and action control (i.e., translating intention into behavior) in efforts to increase MVPA post-pandemic. The dynamic intention-MVPA profiles in our sample also suggest that inactive people may be coming from a different experience from the pandemic (i.e., consistently inactive with low motivation, newly inactive with motivation to change, newly inactive with no motivation to change) that may need to be considered during intervention.

In line with this assumption, the main purpose of this study was to explore whether changes in M-PAC constructs could explain these intention-MVPA profiles. Based on prior research with M-PAC (Rhodes, 2021), we expected that post-pandemic intention-PA profiles would be predicted by pre- to post-pandemic changes in reflective (affective attitude, perceived opportunity), regulation (behavioral self-regulation), and reflexive (habit, identity) processes. This hypothesis was generally supported. Specifically, changes in affective attitude, perceived capability, behavioral regulation, and identity all explained differences in the current intention-MVPA profiles, with higher values across the non-intender, unsuccessful intender, and successful groups. Hierarchical analyses also showed that the addition of each process layer (reflective, regulatory, reflexive) added significant explained variance to predicting group membership, akin with the tenets of M-PAC (Rhodes, 2021). Thus, intention formation and subsequent action control can be explained by a multivariate application of these three processes, and interventions should promote affective attitudes (Rhodes et al., 2019), perceived capability

(Beauchamp et al., 2019), behavioral regulation (Knittle et al., 2018), and identity (Caldwell et al., 2018; Husband et al., 2019).

There were two key discrepancies from our hypotheses in our results, however, that warrant mention. First, we expected that change in perceived opportunity would explain the intention-MVPA profiles both based on M-PAC theory (i.e., that perceived opportunity is a proxy for the time and access barriers that may disrupt action control) and the importance of opportunity to perform MVPA reported throughout the pandemic (Kaushal et al., 2020; Rhodes et al., 2020; Spence et al., 2021; Teran-Escobar et al., 2021); thus, its limited performance in the model was surprising. One possibility for this finding may be that recreation facilities and gyms were open during this survey, so current MVPA may no longer be as dependent on opportunity compared to past assessments, because there is now less variation than during the lockdowns. It may also be that many active people have now moved to online and home exercise options (Parker et al., 2021), thus reducing the impact of opportunity. Another possibility is that the ability to navigate changes in opportunity has now affected MVPA identity, and thus opportunity is a more indirect predictor of the intention-MVPA relationship (via identity). Specifically, change in perceived opportunity did explain the intention-MVPA profiles in the first and second hierarchical models (see Supplemental Table 4), but was no longer significant after the entry of identity in the third hierarchical model. It seems conceivable that two years of successful or unsuccessful engagement in MVPA during the locked-down landscape of recreation facilities would manifest in either the strengthening or weakening of an MVPA identity (Burke, 2006).

Relatedly, identity but not habit, emerged as the key reflexive predictor of the intention-MVPA profiles. Identity and related constructs have been among the strongest associations with MVPA during the pandemic and these results mirror previous findings (Petersen et al., 2021;

Rhodes & Lithopoulos, 2022; Rhodes et al., 2020; Volz et al., 2021). The tumultuous experiences of pandemic living may explain why identity is a stronger predictor than habit in these findings. 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 Canadians has been difficult, and many have had to juggle multiple roles and restrictions with a break in predictable routines (Garre-Olmo et al., 2021; Glowacz & Schmits, 2020). It may be that this unpredictability had lessened the effects of habit on health behaviors, such as MVPA (Rhodes et al., 2020). By contrast, identity is theorized to motivate behavioral activation reflexively in the face of cues that suggest someone is behaving differently than said identity in order to minimize dissonance (Burke & Stets, 2009). This may also relate to the findings in this study and help explain the differences between identity and habit.

While an understanding of current intention-MVPA profiles is important for promotion, the most novel aspect of this study involved the prediction of the dynamic intention-MVPA profiles. We hypothesized that changes in pre-PA to post-pandemic intention-PA profiles would be predicted by M-PAC constructs, with particular evidence for the role of PA identity, based on early pandemic PA research (Petersen et al., 2021; Rhodes & Lithopoulos, 2022; Rhodes et al., 2020). The results supported our hypothesis. Specifically, changes in perceived capability, behavioral regulation, habit and identity all explained differences in the intention-MVPA profiles by pre-pandemic MVPA. Furthermore, hierarchical analyses also showed that the addition of each process layer (reflective, regulatory, reflexive) added significant explained variance to predicting group membership.

It was interesting to note that, among the reflective processes, the attitudinal variables, particularly instrumental attitude, had no predictive utility toward group membership. Instead,

the different profiles of participants were predicted by perceived capability. This makes sense within the context of the pandemic, where MVPA restrictions were limiting on control of performance (Sport for Life, 2020), but not on the appraisal of MVPA (e.g., benefits, enjoyment). A similar profile of changes in MVPA from control based factors and not attitudinal factors is observed during the transition to parenthood, where time and access to engage in MVPA change rapidly (Hamilton & White, 2011; Rhodes et al., 2014). From a pragmatic perspective, our results collectively speak to the importance of rebuilding a personal sense of agency over MVPA post-pandemic through the behavior change techniques to promote self-efficacy (French et al., 2014; Williams & French, 2011).

Our results also highlighted that the group we labeled “relapsed non-intenders” received the lowest scores among nearly all M-PAC variables. This group is marked by being active before the pandemic but has subsequently declined in both behavior and intention. With such low scores on all M-PAC processes, the group had a higher risk profile than even consistent non-intenders (before the pandemic and current) and may need considerable attention for promotion. More qualitative work to explore the lived experiences of this group is warranted, as they represent what may be a very concerning profile for health conditions based on such a decline in their motivational and behavioral profiles over the pandemic.

Finally, as hypothesized, the largest predictor of group membership in these dynamic intention-MVPA by pre-pandemic MVPA profiles was identity. Indeed, it was the only variable to predict consistently successful intenders across the pandemic from all other profiles. As noted previously, identity and its related constructs, such as identified regulation in self-determination theory, have been among the largest correlates of MVPA during the pandemic (Petersen et al., 2021; Rhodes & Lithopoulos, 2022; Rhodes et al., 2020; Volz et al., 2021). 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). How to promote identity change effectively in health behaviors is still an emerging focus of research (Caldwell et al., 2018; Rhodes et al., 2016), yet some success has been achieved through prioritization of values, visual displays that reinforce the identity, rules for participation and self-regulation, and self-talk, among others (Husband et al., 2019; Lim et al., 2021; Liu et al., in press; Strachan et al., 2017; Vallerand et al., 2018).

Despite the large national sample, the theoretical and applied strengths of this paper, and the innovative research questions, there are limitations to this research. First, the MVPA measure was self-report and thus subject to biases that are not entirely predictable but likely inflate estimates (Prince et al., 2008). Second, because our instruments were accessible only in English, our sampling may not have full representation among francophones, or new Canadians who do not read English. Third, this study represents a retrospective design, with a response frame of a “typical week before the COVID-19 pandemic” and thus recall of past experiences may be biased. While perceptual reflections (biased or not) are still important to how a participant reflects upon their current experiences, the accuracy of these perceptions from pre-pandemic may vary from what could be obtained during a two-year prospective design with exact measurement times. Fourth, at the time of our survey, pandemic restrictions were not in place to prohibit MVPA participation at recreation centres and gyms, but gym protocols (e.g., mask requirements, social distancing; capacity limitations) may have influenced perceptions of opportunity and capability. Finally, 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), so instruments with this broader focus may yield different outcomes (Rhodes et al., 2021).

Conclusions

The COVID-19 pandemic has affected how many people engage in regular MVPA over the last two years. While some adults have increased MVPA or managed to stay consistently active, there has clearly been a downward shift in MVPA for many. This study showed that profiles of current intention and MVPA were predicted by changes in specific reflective (affective attitude, perceived capability), regulatory (planning, self-monitoring), and reflexive (identity) processes across the pandemic, highlighting the importance of targeting these factors in intervention. Dynamic patterns of these intention-MVPA profiles by pre-pandemic MVPA showed the presence of two at risk groups (relapsed non-intenders, relapsed unsuccessful intenders) who have relapsed in MVPA. Changes in reflective (perceived capability), regulatory (planning, self-monitoring), and reflexive (habit, identity) processes across the pandemic explained differences in these dynamic intention-MVPA profiles, yet identity was the critical predictor of successful MVPA enactment. Collectively, the findings support the importance of considering intention formation and action control and the joint promotion of reflective, regulatory, and reflexive processes in the choice of behavior change techniques.

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Table 1 *Sample Demographics*

Baseline Characteristics (N = 977)	
<u>Demographic Profile</u>	
Age in Years (SD)	46.79 (15.23)
Biological Sex	
% Female	51.2
% Male	48.8
Gender	
% Woman	50.9
% Man	48.2
% Transgendered Woman	0.1
% Gender Nonconforming	0.8
Ethnicity	
% North American Aboriginal origins	2.0
% Other North American origins	38.3
% European origins	41.8
% Caribbean origins	1.6
% Latin, Central, and South American origins	1.0
% African origins	0.5
% Asian origins	12.7
% Oceania origins (Australia, New Zealand, Pacific Islands)	0.9
% Living with a dependent	23.4
% Bachelor's Degree and above	49.9
% Income \$80k CDN and above	57.7
Provinces and Territories	
% Alberta	13.1
% British Columbia	15.4
% Manitoba	4.4
% New Brunswick	2.0
% Newfoundland & Labrador	1.8
% Nova Scotia	3.6
% Nunavut	0.1
% Ontario	48.0
% Prince Edward Island	0.6
% Quebec	7.0
% Saskatchewan	4.0
% Full-time Employed	55.0
% Part-time Employed	12.5
% COVID-19 Vaccinated	92.1
% who wear masks per required	96.5

Table 2.

Prediction of Physical Activity Intention-Behavior Profiles using Change in Multi-Process Action Control Variables from Pre- to Post-Pandemic.

	Intention-Behavior Profiles			Correlation with Discriminant Function	Univariate Follow-Up F	Post Hoc
	Non-intenders (<i>n</i> = 280)	Unsuccessful Intenders (<i>n</i> = 211)	Successful Intenders (<i>n</i> = 403)			
Sex	1.58 (0.49)	1.58 (0.49)	1.46 (0.50)	-.14	NA	NA
Employment Status	1.57 (0.50)	1.66 (0.47)	1.76 (0.42)	.28	14.89*	NI<SI
Education	3.30 (1.09)	3.42 (1.01)	3.62 (1.03)	.14	NA	NA
Income	4.56 (2.70)	5.01 (2.61)	5.22 (2.54)	.06	NA	NA
ΔInstrumental Attitude	-0.17 (0.94)	-0.03 (0.96)	0.16 (0.83)	-.06	NA	NA
ΔAffective Attitude	-0.41 (1.04)	-0.01 (1.18)	0.39 (1.04)	.18	45.89*	NI<UI<SI
ΔPerceived Capability	-0.36 (1.13)	0.04 (0.88)	0.30 (0.69)	.16	45.22*	NI<UI<SI
ΔPerceived Opportunity	-0.31 (1.20)	-0.01 (1.06)	0.34 (0.75)	.07	NA	NA
ΔBehavioral Regulation	-0.26 (0.35)	-0.08 (0.56)	0.24 (0.55)	.33	86.42*	NI<UI<SI
ΔHabit	-0.32 (0.67)	-0.15 (0.84)	0.34 (0.72)	.13	NA	NA
ΔIdentity	-0.36 (0.63)	-0.15 (0.79)	0.23 (0.74)	.41	111.22*	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 $d > 0.30$. Δ represents residual scores of post-pandemic values regressed on pre-pandemic values.

Table 3
Change in Multi-Process Action Control Constructs as Predictors of Intention and Change in Behavior Profiles Pre- to Post-Pandemic.

	Correlation with discriminant function	Intention-Behavior Change Profiles					F	Post Hoc
		CNI (n= 215)	RNI (n = 65)	CUI (n = 115)	RUI (n = 95)	CSI (n = 361)		
Sex	-.10	1.61 (0.49)	1.49 (0.50)	1.61 (0.49)	1.56 (0.50)	1.44 (0.50)	NA	
Employment Status	.25	1.57 (0.50)	1.56 (0.50)	1.63 (0.48)	1.69 (0.46)	1.77 (0.42)	7.91*	CNI,RNI<CSI
Education	.10	3.26 (1.09)	3.46 (1.05)	3.43 (1.06)	3.41 (0.94)	3.60 (1.03)	NA	
ΔInstrumental Attitude	-.02	-0.14 (0.88)	-0.28 (1.10)	0.13 (0.93)	-0.22 (0.98)	0.14 (0.83)	NA	
ΔAffective Attitude	.12	-0.36 (0.94)	-0.58 (1.33)	0.22 (1.07)	-0.31 (1.24)	0.34 (1.02)	NA	
ΔPerceived Capability	.16	-0.32 (1.05)	-0.50 (1.36)	0.25 (0.67)	-0.21 (1.04)	0.26 (0.68)	23.50*	RNI,CNI<CUI,CSI RUI<CUI,CSI
ΔPerceived Opportunity	.12	-0.22 (1.11)	-0.61 (1.44)	0.23 (0.88)	-0.30 (1.18)	0.31 (0.74)	NA	
ΔBehavioral Regulation	.32	-0.21 (0.30)	-0.42 (0.45)	0.06 (0.47)	-0.23 (0.59)	0.19 (0.50)	45.42*	RNI<CNI<CUI,CSI RUI<CUI,CSI
ΔHabit	.15	-0.25 (0.58)	-0.58 (0.88)	0.06 (0.75)	-0.39 (0.82)	0.28 (0.67)	39.73*	RNI<CNI<CUI,CSI RUI<CUI,CSI
ΔIdentity	.49	-0.25 (0.50)	-0.73 (0.86)	0.08 (0.64)	-0.39 (0.84)	0.32 (0.52)	67.20*	RNI<RUI, CNI<CUI<CSI

Note: *= $p < .01$. Post hoc tests performed at $p < .01$. CNI = consistent nonintenders, RNI = relapsed non-intenders, CUI = consistent unsuccessful intenders, RUI = relapsed unsuccessful intenders, CSI = consistent successful intenders. Δ represents residual scores of post-pandemic values regressed on pre-pandemic values.