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Predicting the physical activity of new parents who participated in a physical activity intervention

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Predicting the Physical Activity of New Parents who Participated in a Physical Activity

Intervention

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Abstract

Rationale: The demands of early parenthood may limit the pursuit of moderate-to-vigorous intensity physical activity (MVPA); thus, understanding the predictors of MVPA among this population could help build targeted intervention programs. **Objective:** The purpose of this study was to examine the correlates of MVPA, in the form of constructs subsumed within the theory of planned behavior (TPB) and multi-process action control (M-PAC) framework, among new parents participating in a couple-based PA promotion randomized trial across a six-month period in the first year after birth. **Method:** 264 participants (132 couples) at the two-month point of parenting their first child were enrolled in the trial through advertisements. MVPA, TPB, and M-PAC constructs were assessed via self-report at baseline, and six-week, three-month, and six-month after baseline time-periods. **Results:** Dyadic path modeling of the TPB showed that intention only predicted MVPA for mothers and PBC did not predict MVPA. Most of the sample had intentions to be physically active, although the extent to which intentions predicted subsequent MVPA was dependent on the extent to which mothers and fathers reported planning, habits, and exercise identity (M-PAC variables). Intention was subsequently predicted by affective attitude and PBC for mothers and fathers. **Conclusions:** Interventions targeting affective attitude and perceived behavioral control may assist in improving MVPA intentions of new parents; yet, additional intervention strategies to increase planning, habit, and especially exercise identity seems warranted for many parents to close the gap between intention and PA. The findings highlight the complementary approach of intention formation and intention translation theories among new parents.

Registered Trial: [clinicaltrials.gov # NCT02290808](https://clinicaltrials.gov/ct2/show/study/NCT02290808)

Key Words: Theory of planned behavior; multi-process action control; intention, exercise; habit; identity

Regular moderate-to-vigorous intensity physical activity (MVPA) is associated with numerous health benefits and a reduced risk of over 25 chronic health conditions (Rhodes et al., 2017). Despite these extensive benefits, many adults do not meet the recommended international health guidelines of 150 minutes of MVPA accumulated over the course of a week (Guthold et al., 2018). MVPA prevalence, however, is not uniform across the adult population (Clarke et al., 2019); some groups of adults are more at risk of physical inactivity than others. Parents, particularly those with children under five years of age, typically report less MVPA than adults of a comparable age without children (Abbasi & van den Akker, 2015; Bellows-Riecken & Rhodes, 2008; Rhodes & Quinlan, 2015). While most of this evidence has focused on early motherhood, there has been some evidence that fathers experience similar (Berge et al., 2011) or even greater (Hull et al., 2010) declines in PA compared to mothers. Clearly, parents represent an important demographic group for targeted promotion of MVPA.

The demands of early parenthood likely influence lifestyle changes, which in turn, may compromise the pursuit of MVPA (Bellows-Riecken & Rhodes, 2008). This assumption has been supported in research underpinned by social cognitive theory (Bandura, 1998) and the theory of planned behavior (Ajzen, 1991). Specifically, declines in MVPA among parents is often predicted by intention, which in turn, is associated with lower perceived behavioral control (PBC; Cowie et al., 2018; McIntyre & Rhodes, 2009; Rhodes et al., 2014c) or self-efficacy (Dlugonski & Motl, 2014; Mailey & McAuley, 2013). Reduced opportunity for MVPA due to caregiving commitments has been reported as the critical barrier that depletes MVPA intentions among new parents, followed by fatigue, and low social support (Bellows-Riecken & Rhodes, 2008). Further, the predictors of MVPA intention do not appear to differ markedly by parent gender in observational studies (Hamilton et al., 2012), although there is some evidence that mothers' MVPA may be

associated with subjective norms more than for fathers (Hamilton & White, 2011; Rhodes et al., 2014b).

Research to date has helped to identify key constructs, most notably intention and self-efficacy/PBC, to target in interventions, but this literature still contains noteworthy limitations. First, most research focused on predicting the MVPA of parents features observational designs that include parents at all activity levels. This provides sound estimates of the correlates of MVPA generally, but the findings may not generalize to those parents who enter into MVPA programs to improve their MVPA. It would therefore be prudent to explore correlates of MVPA among parents who participate in PA interventions.

Second, current theory-driven PA research has focused almost exclusively on theories where intention is considered the proximal determinant of behavioral action. Theories focused on the translation of intention into behavior (Brown et al., 2020; Rhodes & Yao, 2015; Sheeran & Webb, 2016), also known as action control (Kuhl, 1984), may help yield additional information because nearly half of those with good intentions fail to follow through (Rhodes & de Bruijn, 2013). Specifically, Grant and colleagues (in press) revealed that while most mothers reported strong intentions to be regularly active very few engaged in regular MVPA. Further, the small number of studies to apply action control constructs like planning (Cowie et al., 2018; Dlugonski & Motl, 2014) and identity and habit (Grant et al., in press) have shown these constructs are able to explain unique variance in MVPA beyond social cognitive constructs. The use of action control theories has potential to shed important light on factors that convert intentions into behavioral actions among those who participate in PA interventions. Those who volunteer to participate in PA interventions will, by virtue of enrolling in such initiatives, typically display strong intentions (Rhodes & Rebar, 2017), and yet many fail to become (and stay) regularly active by the time of intervention

completion. Action control theories have, to date, received scant attention within PA intervention research.

Third, our knowledge of MVPA correlates among new parents has focused primarily on mothers (Abbasi & van den Akker, 2015), with little consideration of parenting dyads or MVPA correlates among fathers. There is a need to examine what predicts MVPA for new mothers and fathers in dyadic analyses because past longitudinal research has shown that MVPA changes following parenthood are linked among parents (Rhodes et al., 2014a). From a family systems perspective (Cox & Paley, 2003), targeted intervention that focus on interactions between the mother and father as a dyad may allow parents to engage in workload negotiation, social support, and collective MVPA goals to be managed together. By contrast, if correlates are not linked in dyadic analyses, the results would support a more targeted gender-based approach to improving the MVPA of new mothers and fathers.

With these limitations in mind, the purpose of this study was to examine the psychological predictors of MVPA across time, using dyadic modeling, among a sample of new parents (2 months postpartum) who participated in a randomized trial aiming to promote their MVPA via a combination of education and planning techniques. The original trial outcomes, reported elsewhere (Rhodes et al., in press), showed that the couple-based education plus planning intervention did not have a differential effect on MVPA behavior in comparison to an education-only comparison condition; however, mothers (across both conditions) responded with improvements in MVPA over time while fathers did not change their MVPA behavior over the six month study period.

We used the theory of planned behavior (TPB; Ajzen, 1991) and the multi-process action control (M-PAC; Rhodes, 2017) framework to predict MVPA. Both approaches have shown predictive capability when explaining PA (McEachan et al., 2011; Rhodes et al., 2021). Briefly, TPB suggests that intentions are the primary cause of behavioral action but intention is

subsequently determined by affective (expected pleasure) and instrumental (expected utility) attitudes, subjective norm (perceived social pressure) and perceived behavioral control over enacting the behavior (PBC; ease or difficulty of behavioral performance). PBC may also directly determine behavior, to the extent that it represents an accurate proxy of actual control (Ajzen, 1991). M-PAC conceives intention as a decisional construct (Rhodes & Rebar, 2017) (i.e., intend/do not intend) and has antecedent constructs similar to the TPB (called *reflective processes*). In the M-PAC framework, however, reflective processes of perceived opportunity (time and access to perform the behavior) 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. The translation of intention into behavior, however, is marked 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 action control 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 (McEachan et al., 2016; Rhodes & Grant, 2018), we expected that MVPA may be predicted by intention and PBC using the TPB formulation, while the differences between unsuccessful and successful intenders in meeting MVPA guidelines would be predicted primarily by the regulatory (planning), and reflexive processes (identity, habit).

Methods

Design

A two-arm parallel design, randomized trial was conducted. Participants were randomized using an online program (Urbaniak & Plous, 2015) that allowed for 1:1 allocation of participants to either the couple planning + information/education group or the PA information/education only

group (Quinlan et al., 2017). The primary outcome for the trial corresponded to an assessment of differences in MVPA between the trial conditions, the results of which are reported elsewhere (Rhodes et al., in press). For the purpose of this follow-up paper, the groups were collapsed because there were no significant differences in MVPA between conditions. Couples were assessed at baseline and subsequently assessed at six-weeks, 12-weeks, and six-months. Rolling recruitment began in November 2014 and completed in July 2017, with final follow-up in January 2018.

Participants

Participants were recruited through several clinical, community, and online avenues. Advertisements were distributed through doctor's offices, health centers, midwifery services, recreation centers, maternity and baby stores, and any other community organizations offering prenatal classes for first-time parents. In-person recruitment initiatives took place at community fairs such as baby fairs, health shows, and community markets. Participants also received a \$25 CAN grocery store gift card if they referred another couple who enrolled in the study.

Inclusion criteria. Participants were common law or married couples who were two months post-birth of their first child at study commencement. Participants were screened for PA readiness via the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) (Warburton et al., 2011). Those individuals who were not ready or able to participate in MVPA were excluded.

Measures

Primary Outcome: Minutes of MVPA

The primary outcome of the study was minutes of MVPA measured by accelerometer and self-report. Despite using multiple strategies to wear accelerometers, such as providing reminder e-mails, incentives and monitoring logs (Troost et al., 2005) compliance to wearing the PA monitors was low (average of missing data across the trial = 87%), wear time was correlated across time ($r = 0.23$ to $r = 0.48$), and wear time was correlated with MVPA ($r = 0.26$ to $r = 0.39$). Based on the

high proportions of missing data and that the data were missing not at random, conducting imputation for the missing data is not recommended (Sterne et al., 2009) and thus, no further analyses were conducted with the accelerometry data.

As the self-report indicator of MVPA, we used a modified Godin Leisure-Time Questionnaire (GLTEQ; Godin et al., 1986; Godin & Shephard, 1985). Specifically, weekly frequency and duration of PA were provided with an open-ended assessment identical to the International Physical Activity Questionnaire (Craig et al., 2003) and the multiplicative (frequency x duration) sum of moderate and vigorous intensity minutes were used as the estimate of 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 did not “bump up” their light-intensity exercise into the moderate intensity category within their response options (Courneya et al., 2004). The instrument asked about a typical week within the epoch of the assessment frame (e.g., over the last six weeks). Descriptors of each type of intensity physical activity were included within the measure, identical to the standard GLTEQ.

Predictor Measures

The instrumentation used to assess the constructs of the TPB included common items for assessment of this theory (Ajzen, 2002; Conner & Norman, 2015). Questions were framed in terms of expectations of achieving 150 minutes of MVPA per week. Baseline and six weeks assessment asked for expectations of getting MVPA over the next six weeks and 12 weeks assessment asked for expectations of MVPA over the next 3 months in order to correspond with the assessment times of the trial. Assessments of the additional constructs featured in the M-PAC model (Rhodes, 2017) included *perceived capability and perceived opportunity* (Rhodes et al., 2006), *decisional intention* (Courneya, 1994), *behavioral regulation* (Sniehotta et al., 2006; Umstatted et al., 2009), self-

reported *habit* (Gardner et al., 2012), and *role identity* (Wilson & Muon, 2008) (see Table S1 for the measurement properties).

Procedures

The study followed procedures established in a prior family-based PA pilot study (Rhodes et al., 2010) as a guide for recruitment, study protocol, and assessment (Quinlan et al., 2015). The lead trial coordinator conducted study protocol quality control training and cross-checks with all research assistants to ensure standardization. After interested couples contacted the researcher and were determined to be initially eligible to participate in the study, the trial coordinator scheduled a baseline assessment at the laboratory corresponding with the approximate date for contact two months after the birth of their child.

After baseline assessment, participants were randomized to one of the two conditions. At six and 12 weeks, a member of the research team met with parents to conduct subsequent assessments with the measures. As an incentive for couples to complete all assessments, an honorarium was provided upon pick-up of the accelerometers starting at \$25 at baseline and increasing by \$5 at each time point.

Statistical Analyses

Descriptive statistics were calculated for the TPB and M-PAC variables across time, after which the normality of the variables was examined and transformed if necessary. To examine the TPB relationships over time for mothers and fathers, correlations were examined among the TPB variables. Next, a series of dyadic path analyses (Atkins, 2005; Cook & Kenny, 2005; Fitzpatrick et al., 2016; Muthén & Muthén, 2017) using maximum likelihood estimation with robust standard errors were conducted in MPlus (version 8.1). Specifically, the analyses used the (a) baseline TPB variables to predict 6-week PA, (b) 6-week TPB variables to predict 12-week PA, and (c) 12-week TPB variables to predict six-month PA (see supplemental Figure 1 for a conceptual diagram; Cook

& Kenny, 2005; Fitzpatrick et al., 2016). Next, to determine if the TPB variables significantly predicted PA change over time, residualized change scores for PA were created separately for husbands and wives from baseline to 6 weeks, 6 weeks to 12 weeks, and 12 weeks to six months. Then, dyadic path analyses were conducted for each time interval (e.g., the first set of path analyses used the baseline TPB variables to predict the PA change score from baseline to 6 weeks). It has been suggested that path analyses include a minimum of 5 participants per parameter estimated (Bentler & Chou, 1987) or 10 cases per variable (Wolf et al., 2013). These dyadic path analyses estimated 20 parameters for each analysis (i.e., required a minimum sample size of 120 couples), and each analysis included 8 predictor variables (i.e., required a minimum of 80 couples per analysis), suggesting adequate testing power for the sample. R^2 and the standardized root mean square residual (i.e., a good fit is $< .08$: Hu & Bentler, 1999) were examined for model fit.

For analyses using an M-PAC formulation, intention-behavior profiles were formatted to include intenders, 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). Subsequent MVPA, was coded as unsuccessful (<150 min MVPA) and successful (>149 min MVPA) in accordance with Canadian guidelines (Tremblay et al., 2011) and the scale correspondence with all M-PAC measures. The categorization provides four possible quadrants of: 1) nonintenders (low intention, inactive), 2) nonintenders who were active (low intention, active), 3) unsuccessful intenders (high intention, inactive), and 4) successful intenders (high intention, active). This profile was created for baseline to six weeks, six weeks to 12 weeks, and 12 weeks to six months epochs, similar to the TPB analyses. Prediction of the category membership used separate discriminant function analyses and follow-up univariate F -tests for the intention-PA profile (action control), gender, and the action

control x gender interaction with SPSS (version 25). We estimated that a subsample of 105 participants were needed in each equation to detect a small-medium effect size ($f^2 = .13$) with the five M-PAC predictors, using an alpha of .05, and a power of .80. For the associations with the discriminant function, we used Ferguson's (2009) $r = .20$ recommendations as a criterion of association.

Results

Participant Flow

One hundred and eighty couples contacted the research team about participating in the study and 151 couples were assessed for eligibility (29 couples were excluded due to not being able to get in further contact/too busy). Of these, 18 couples were uninterested or could not be reached again and one couple was not eligible due to not being cleared to start becoming more physically active. The 132 couples who met the inclusion criteria and completed baseline assessments were randomly assigned to one of two conditions ($n = 74$ couples in the planning condition and 58 couples in the education condition). Of these, 96% ($N = 254$) of the sample completed the study to the six-month end-point. Reasons listed for dropping out included moving cities ($n=2$), too busy ($n=1$) and unable to contact ($n=2$). No participants cited harms associated with the study.

Baseline Characteristics of Respondents

Couples reported a mean age of 31.94 years ($SD = 4.90$), with 50% male/female representation. Participants were primarily (>80%) white, university educated (>75%), employed (>68%), and above the median income for Canadian adults (>66%). On average, parents had a BMI in the overweight category ($M = 26.35$; $SD = 4.50$), yet reported minimal health conditions (< 4%). For health behaviors, participants reported an average of 6.42 hours of sleep, were non-smokers (>98%), and 50% reported meeting MVPA recommendations.

Preliminary Analyses

Descriptive statistics for MVPA and the TPB and M-PAC variables are presented in Table S2 and S3 respectively. MVPA was skewed (Kim, 2013) at all time points. Therefore, a square root transformation was performed that resulted in acceptable values. Instrumental attitude, affective attitude, capability and intention were significantly skewed (> 1) and/or kurtotic (> 3) at various time points (Mishra et al., 2019). For affective attitude and intention, outliers (z-scores > 3.29) were fixed to the next highest value in the distribution (Barbeau et al., 2019), which normalized the variables. However, various transformations (square root, log) did not normalize the instrumental attitude or capability variables. Therefore, they were conceptually dichotomized into negative / neutral (i.e., scores < 4 on a given scale) and positive (scores ≥ 4) scores. Examination of the frequencies in Table S4 showed that both scales had significant ceiling effects across time. Therefore, neither variable was included in subsequent analyses.

Path Analyses for the TPB

Predicting min of MVPA. The correlations in Table S5 showed that min MVPA were significantly correlated between fathers and mothers over time in addition to various TPB variables. Results from the dyadic path analyses are presented in Table 1. The first path analysis had a good model fit (SRMR = .08) and showed that baseline intention significantly predicted 6-week min MVPA for fathers and mothers. Intention was significantly predicted by affective attitude and PBC for fathers and only PBC for mothers. Finally, the indirect effects of affective attitude, subjective norm and PBC via intention on MVPA were examined. For mothers and fathers, a significant indirect effect was found for PBC (mothers $\beta = .12$, $p = .01$; fathers $\beta = .12$, $p = .02$), but not affective attitude or subjective norm ($p = >.05$).

When predicting 12-week min MVPA, the model showed a good fit (SRMR = .06). Min MVPA was only significantly predicted by intention for mothers; however, intention was significantly predicted by affective attitude and PBC for fathers and mothers. In terms of the

indirect effects, affective attitude, subjective norm, and PBC were non-significant for fathers ($p > .05$). For mothers, affective attitude ($\beta = .08, p = .04$) and PBC ($\beta = .13, p = .001$) were significant, whereas subjective norm was non-significant.

Finally, the 6 month min MVPA model also showed a good fit (SRMR = .06). Here, min MVPA were significantly predicted by intention for mothers, but not fathers. Intention was significantly predicted by affective attitude, subjective norm and PBC for fathers, whereas affective attitude and PBC were significant predictors for the mothers. Regarding the indirect effects, affective attitude, subjective norm, and PBC were non-significant for fathers ($p > .05$). For mothers, affective attitude ($\beta = .09, p = .04$) and PBC ($\beta = .11, p = .002$) had significant indirect effects, whereas the indirect effect was non-significant for subjective norm.

Predicting change in min MVPA. Table 2 includes the results for predicting change in min MVPA across the three epochs. The first model had a good fit (SRMR = .07) and showed that the change in min MVPA from baseline to 6 weeks was significantly predicted by baseline intention for fathers and mothers. There was a significant indirect effect for PBC in fathers ($\beta = .10, p = .04$) and mothers ($\beta = .09, p = .04$), but not for affective attitude or subjective norm ($p > .05$). For the 6-week to 12-week change in min MVPA model (SRMR = .06), neither intention nor PBC were significant predictors for fathers or mothers. Further, all of the indirect effects were non-significant. Finally, the 12-week to six-month change in min MVPA (SRMR = .04) was significantly predicted by intention for mothers, but not fathers. All of the indirect effects were non-significant for fathers. For mothers, a significant effect was found for PBC ($\beta = .08, p = .03$), whereas the effects were non-significant for affective attitude and subjective norm ($p > .05$).

Prediction of the translation of intention to MVPA

The intention-behavior profiles created for the M-PAC variables can be found in Table S6. Overall, distributions for the baseline intention to six-week min MVPA frame showed the majority

of participants were successful [mothers $n = 75$ (61%); fathers $n = 73$ (59%)] and unsuccessful intenders [mothers $n = 40$ (33%); fathers $n = 39$ (32%)], with only a small group of nonintenders. This was similar across the six-week to 12-week [successful intenders: mothers $n = 71$ (57%); fathers $n = 71$ (60%); unsuccessful intenders: mothers $n = 38$ (31%); fathers $n = 28$ (24%)] and 12-week to six-month epochs [successful intenders: mothers $n = 70$ (57%); fathers $n = 69$ (58%); unsuccessful intenders: mothers $n = 36$ (29%); fathers $n = 25$ (21%)]. No gender effects were found for the baseline to six-week ($\chi^2(3) = 0.53, p = 0.91$), six-week to 12-week ($\chi^2(3) = 2.13, p = 0.55$), and 12-week to six-month ($\chi^2(3) = 4.19, p = 0.24$) time periods. Based on the small sample sizes of the non-intender groupings, only the intender profiles were carried forward as the dependent variable for prediction with the M-PAC constructs.

Correlations can be found among all M-PAC constructs in Table S7. The main results of the discriminant analyses and follow-up tests are presented in Table 3. For baseline to six weeks, the discriminant analysis identified one significant discriminant function that distinguished the intender groups among both mothers [Wilks' $\lambda = .75$; canonical $r = .51, \chi^2(5) = 32.27, p < .01$] and fathers [Wilks' $\lambda = .78$; canonical $r = .47, \chi^2(5) = 26.51, p < .01$], explaining 25% and 22% of the variance, respectively. Perceived opportunity (mothers $r = .23$; fathers $r = .63$), planning (mothers $r = .43$; fathers $r = .42$), habit (mothers $r = .51$; fathers $r = .24$), and identity (mothers $r = .54$; fathers $r = .23$) had meaningful correlations with the discriminant function. Follow-up F tests showed that gender interacted with the successful translation of intention into min MVPA for perceived opportunity ($p > .05$), where fathers opportunity was linked to action control (i.e., intention translation) more than mothers. By contrast, mothers engaged in planning more than fathers during this first six weeks ($p < .01$), yet the effect did not interact with the successful translation of intention into min MVPA ($p > .05$).

For the six weeks to 12 weeks time-frame, the discriminant analysis identified one significant discriminant function that also distinguished the intender groups among both mothers [Wilks' $\lambda = .85$; canonical $r = .39$, $\chi^2 = (5) = 17.04$, $p < .01$] and fathers [Wilks' $\lambda = .85$; canonical $r = .39$, $\chi^2 = (5) = 15.82$, $p < .01$], explaining 15% of the variance in both equations. Planning (mothers $r = .34$; fathers $r = .29$), habit (mothers $r = .27$; fathers $r = .44$), and identity (mothers $r = .75$; fathers $r = .40$) had meaningful correlations with the discriminant function for both mothers and fathers, while perceived opportunity ($r = .50$) was associated with the discriminant function for fathers. Follow-up F tests showed that, while mothers engaged in planning more than fathers during this six- to 12-week time period ($p < .01$), the effect did not interact with the successful translation of intention into min MVPA ($p > .05$).

Finally, for the 12-weeks to six-month time-frame, the discriminant analysis identified one significant discriminant function that also distinguished the intender groups among both mothers [Wilks' $\lambda = .83$; canonical $r = .41$, $\chi^2 = (5) = 18.59$, $p < .01$] and fathers [Wilks' $\lambda = .85$; canonical $r = .39$, $\chi^2 = (5) = 14.76$, $p < .01$], explaining 17% and 15% of the variance, respectively. Planning (mothers $r = .60$; fathers $r = .32$), habit (mothers $r = .31$; fathers $r = .39$), and identity (mothers $r = .45$; fathers $r = .50$) had meaningful correlations with the discriminant function for both mothers and fathers, while perceived opportunity ($r = .21$) had a small correlation with the discriminant function for mothers and affective attitude ($r = .24$) was associated with the discriminant function for fathers. Follow-up F tests showed that mothers reported higher affective attitudes than fathers ($p < .01$), but the effect did not interact with the successful translation of intention into min MVPA ($p > .05$).

Discussion

Promotion of MVPA during early parenthood is important because parenting demands may compromise their ability to engage in MVPA and, in turn, facilitate longstanding inactivity lifestyle

changes (Bellows-Riecken & Rhodes, 2008). The purpose of this study was to examine the predictors of min MVPA using dyadic modeling among a sample of new parents who participated in a randomized trial parenting intervention (recruited at two months post-birth and followed for six months). We used the TPB (Ajzen, 1991) and the M-PAC (Rhodes, 2017) framework to predict MVPA.

TPB suggests that behavior is the product of intention and PBC (Ajzen, 1991; Fishbein & Ajzen, 2010). Contrary to this expectation, we found that PBC did not predict MVPA (independent from intention) across the trial, and while intention predicted MVPA, it did so with consistency for only mothers but not fathers. This was replicated for both total MVPA and change in min MVPA over time. The finding therefore provides mixed evidence, for the effectiveness of TPB when predicting min MVPA in new parents. Interestingly, intention was not correlated at the level of the dyad, yet MVPA had some association, particularly in changes across time. The findings complement past research among new parents (Rhodes et al., 2014b), suggesting there may be some MVPA coordination among couples, yet this is clearly not reflected in their respective intentions. Taken together, TPB provides some understanding of the MVPA of mothers, but another model may be needed to better explain the MVPA of fathers. The difference in these findings between mothers and fathers is difficult to understand with these data, but it may arise from a failure to address men's health needs in the family system (Garfield et al., 2008). We recommend sustained formative research on MVPA and fatherhood to explore the efficacy of targeted parenting interventions.

One of the factors that may have led to the mixed evidence for intention as a predictor of MVPA is the high mean scores of the sample overall (86% of the sample had scores \geq agree on a five-point scale). All of the participants volunteered to engage in this PA trial and thus had, by nature of this process, an intention to be active in some capacity (Rhodes & Rebar, 2017). This

limited variance can compromise statistical prediction, but it also signals limitations in the practical utility of theories like TPB where intention is conceived as the proximal antecedent of behavior.

With the limited range of intention in the sample, a focus on understanding the translation of intention into behavior with the constructs of M-PAC (Rhodes, 2017) appeared particularly warranted. Creation of the intention-behavior profiles for this approach showed that most of the sample was comprised of intenders and thus could be separated into those who succeeded in their MVPA intentions and those who did not. The intention-behavior gap ranged from 27% to 35% (i.e., proportion of *intenders* who did not match with behavioral follow through) across the trial with no differences between mothers and fathers. These estimates are similar to prior research with mothers of dependent children (Grant et al., in press), and striking when considering that the participants in this sample were motivated volunteers.

Prediction of intention-MVPA discordance using M-PAC constructs showed consistent support for the regulatory process of planning and the reflexive processes of habit and identity. By contrast, there was mixed evidence that the reflective processes of perceived opportunity and affective attitude explained the intention-behavior gap, after accounting for the multivariate associations of these reflexive and regulatory processes. Overall, the findings align with the proposed tenets of the M-PAC framework (Rhodes, 2017). First, regulation processes (planning, self-monitoring) are generally seen as the hallmark of almost all action control theories (Rhodes & Yao, 2015), so our results are concordant with prior research (Kwasnicka et al., 2013; Rhodes et al., 2020; Zhang et al., 2019). It was interesting to note that mothers had larger effects of planning on closing the intention-MVPA gap than fathers. This may correspond with the primary trial findings where mothers were generally more responsive to the interventions (Rhodes et al., in press), thus creating and enacting more regulation tactics on the whole. It is also noteworthy that planning was a significant predictor in of the intention-MVPA gap, yet our planning intervention was unable to

significantly increase MVPA compared to an education control. One possibility for why planning predicted MVPA in the path analyses but the intervention operationalized in this study did not substantively change behavior is because planning comprises elements of both a changeable skill (Allan et al., 2013) and a stable trait (Costa & McCrae, 2009; Spinella, 2005). Thus, there may be limitations to the effects of changing planning, despite its central importance in action control. Alternatively, the potency of the intervention (i.e., one session at baseline, and two boosters) in this study, while sufficient to increase planning behavior (Rhodes et al., in press), was not powerful enough to affect changes in MVPA. More experimentation with increased potency of the planning intervention may show different findings.

From a M-PAC conceptual perspective, Rhodes (2017) suggests that action control is partly determined by reflexive factors such as habit and identity, in conjunction with regulatory processes because they improve the probability that a behavior will be repeatedly selected over other intended behaviors (also see Gardner et al., 2016). Our findings provide strong support of this proposition, similar to prior research among mothers with young children (Grant et al., in press). Habit represents behaviors enacted by cues from learned associations (Gardner et al., 2020; Rhodes & Rebar, 2018) and identity represents a self-standard, which is thought to determine behavior based on the motivation to ameliorate dissonance when that self-standard is challenged by contrarian stimuli (Burke & Stets, 2009).

Interventions to build MVPA habits are sparse at the moment but a focus on building consistency in participants' PA practice with critical cues to action that precede the behavior is recommended (Gardner & Rebar, 2019). PA identity promotion research is also in its infancy, with relatively undeveloped behavior change techniques (McEwan et al., 2019). Identity promotion may be particularly important as a reflexive process for new parents because of their disrupted routines that can arise during parenthood and challenge habit formation. Identity is expected to strengthen its

impact on behavior with disrupted routines, because the motivation to enact one's intention is based on this dissonance between this disruption experience and one's self-standard (Burke & Stets, 2009; Strachan et al., 2011). This was also supported in these data because identity had the largest associations with action control among any M-PAC variable across the trial.

While the primary aim of this study was to understand MVPA through the application of TPB and M-PAC, TPB also provides for an exploration of the antecedents of intention formation (Ajzen, 1991; Fishbein & Ajzen, 2010). Meta-analytic evidence indicates that affective attitude and PBC are the most reliable predictors (McEachan et al., 2016), and our results replicated this finding. In fact, instrumental attitude was so skewed that it could not be used as a variable in the analysis. This speaks to the importance of differentiating between affective and instrumental attitudinal constructs when operationalizing the TPB, especially with samples who volunteer for MVPA promotion programs. Our findings show that attempting to intervene with education on the instrumental benefits of MVPA participation would likely yield limited or no efficacy in forming intentions, which is perhaps not surprising, given the utility of MVPA is well understood among most of the population (Martin et al., 2000).

By contrast, affective attitude and PBC were generally consistent predictors of intention across the trial for both mothers and fathers in the medium effect size range (Cohen, 1992), while subjective norm was not. The critical importance of PBC among parents with dependent children has been well established in prior PA research (Cowie et al., 2018; Dlugonski & Motl, 2014; Mailey & McAuley, 2013; McIntyre & Rhodes, 2009; Rhodes et al., 2014b). Thus, targeting underlying control beliefs such as lack of time, lack of energy, and lack of social support (Hamilton & White, 2011; Rhodes et al., 2014c) is likely an essential aspect of any intervention on intention with this demographic. While there is some evidence among new mothers to suggest an individual approach to PBC intervention has short-term success (Gilinsky et al., 2015), we believe that overcoming PBC

for new parents will likely require upstream environmental (e.g., facilities that accommodate child care during exercise), programmatic (e.g., group programs targeting new parents and their baby such as stroller walks), and policy (e.g., affordances for child care, flexibility in work hours to accommodate exercise time) assistance as well (McKinlay & Marceau, 2000). Less research has been conducted on promoting PA affective attitude (Rhodes et al., 2018), but a focus on the mental health benefits of MVPA to assist with the stress of the parenting experience has been identified as the critical behavioral belief to target (McIntyre & Rhodes, 2009; Rhodes et al., 2014c). We recommend future research that explores affect-regulation techniques (Pears & Sutton, 2020) and their potential impact on MVPA among new parents. Considering the TPB and M-PAC findings together, affective attitude and PBC may be the critical antecedents of building intentions; and planning, identity and habit may be the critical variables that translate these intentions into action. This is complementary to the differences between intention formation and action control theories generally (Bagozzi, 1992; Heckhausen, 2007).

Limitations

Despite the novel findings in our study and the strong methods employed, there are noteworthy limitations. First, while we made an active attempt to use accelerometry as a measure of MVPA, our results yielded disappointing missing data that were not missing at random, so we were reliant on self-reported MVPA as an outcome. Self-report measures are likely to overestimate MVPA and may suffer from errors in recollection and social desirability (Prince et al., 2008). Second, the sample of parents in this study was mainly white, middle income, and university educated. While many of these features do represent the study setting (Statistics Canada, 2017), the generalizability to people residing in other regions in Canada or worldwide is unknown.

Conclusion

In summary, in this sample of new parents participating in an intervention, we examined the correlates of MVPA in the form of TPB and M-PAC constructs. Dyadic path modeling of the TPB showed that affective attitude and PBC predicted intention across the trial, but intention only predicted MVPA for mothers and was not linked to the intentions of fathers. We also found that most of the sample had the intention to perform MVPA, yet a third of participants did not translate these intentions into action. M-PAC variables of planning, habit and identity were reliable correlates of this intention-behavior gap across the trial for mothers and fathers. The results provide evidence to justify interventions targeting affective attitude and perceived behavioral control to assist in improving MVPA intentions, yet additional intervention strategies to increase planning, habit and especially identity seem warranted for many participants with positive intentions.

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Table 1

Results from the dyadic TPB path analyses predicting min of physical activity at 6 and 12 weeks, and six-months

	Baseline to 6 weeks				6 weeks to 12 weeks				12 weeks to six-months			
	Intention		PA		Intention		PA		Intention		PA	
	Beta (SE)	β	Beta (SE)	β	Beta (SE)	β	Beta (SE)	β	Beta (SE)	β	Beta (SE)	β
Fathers												
1. AA	.37 (.10) ¹	.37			.34 (.11) ¹	.31			.44 (.09) ¹	.39		
2. SN	.17 (.10)	.13			.11 (.11)	.09			.25 (.11) ²	.17		
3. PBC	.37 (.06) ¹	.43	1.46 (.89)	.16	.32 (.08) ¹	.37	1.12 (.70)	.13	.36 (.08) ¹	.33	.84 (.84)	.10
4. Intent			2.95 (1.18) ¹	.27			1.65 (.95)	.17			1.48 (.93)	.19
5. PA												
	R ² = .39		R ² = .14		R ² = .30		R ² = .07		R ² = .44		R ² = .07	
Mothers												
6. AA	.16 (.10)	.15			.26 (.10) ¹	.24			.32 (.13) ²	.27		
7. SN	.14 (.09)	.13			.16 (.09)	.18			.18 (.10)	.17		
8. PBC	.26 (.07) ¹	.31	.22 (.54)	.03	.33 (.07) ¹	.39	.26 (.62)	.04	.31 (.07) ¹	.32	-.19 (.61)	-.03
9. Intent			3.11 (.77) ¹	.40			2.65 (.69) ¹	.34			2.52 (.70) ¹	.35
10. PA												
	R ² = .17		R ² = .17		R ² = .33		R ² = .13		R ² = .25		R ² = .12	
Residuals												
	Cov (SE)		r		Cov (SE)		r		Cov (SE)		r	
4. with 9.	-.03 (.04)		-.07		.03 (.03)		.09		.02 (.04)		.05	
5. with 10.	12.43 (4.1) ¹		.31		5.01 (3.88)		.14		6.18 (3.46)		.17	

Note. PA = min moderate to vigorous physical activity; β = standardized beta; SE = standard error; AA = affective attitude; SN = subjective norm; PBC = perceived behavioral control; Cov = covariance.

¹p < .01; ²p < .05.

Table 2

Results from the residual dyadic TPB path analyses predicting the change in min physical activity over time

	Baseline TPB → Δ PA (Base to 6wks)		6-week TPB → Δ PA (6 to 12 wks)		12-week TPB → Δ PA (12 to 6 mos.)	
	Beta (SE)	β	Beta (SE)	β	Beta (SE)	β
Fathers						
1. PBC	.62 (.72)	.08	-.03 (.66)	-.01	-.49 (.69)	-.07
2. Intent	2.08 (.95) ²	.22	.61 (.73)	.07	.77 (.73)	.12
3. PA	<hr/> R ² = .07		<hr/> R ² = .01		<hr/> R ² = .01	
Mothers						
4. PBC	-.09 (.58)	-.01	-.20 (.51)	-.04	-.55 (.54)	-.09
5. Intent	2.19 (.80) ¹	.30	.97 (.68)	.16	1.58 (.65) ²	.25
6. PA	<hr/> R ² = .09		<hr/> R ² = .02		<hr/> R ² = .05	
Residuals	Cov (SE)	r	Cov (SE)	r	Cov (SE)	r
3. with 6.	7.72 (3.48) ¹	.22	5.89 (2.37) ¹	.22	6.09 (3.17) ²	.21 ²

Note. Δ = change; wks = weeks; PA = min moderate to vigorous intensity physical activity; β = standardized beta; SE = standard error; PBC = perceived behavioral control; Cov = covariance.

¹p < .01; ²p < .05.

Table 3

Multi-Process Action Control Predictors of intention to min MVPA for Mothers and Fathers from baseline to six months

	Mothers			Fathers			AC	Gender	AC x Gender
	UI	SI	r _{DF}	UI	SI	r _{DF}			
<u>Baseline to Six Weeks</u>									
Affective Attitude	4.28 (0.68)	4.45 (0.65)	.04	4.08 (0.80)	4.34 (0.66)	.14	5.01*	2.63	0.29
Perceived Opportunity	3.80 (0.68)	3.97 (0.75)	.23	3.50 (0.88)	4.10 (0.62)	.63	14.40**	0.74	4.31*
Planning	2.76 (0.92)	3.20 (0.66)	.43	2.40 (0.88)	2.88 (0.90)	.42	15.88**	8.91**	0.03
Habit	2.48 (0.83)	3.27 (0.98)	.51	2.53 (0.78)	3.09 (0.95)	.24	27.84**	0.29	0.79
Identity	2.98 (1.04)	3.78 (0.83)	.54	3.09 (1.01)	3.68 (0.84)	.23	31.15**	0.00	0.74
<u>Six Weeks to 12 weeks</u>									
Affective Attitude	4.36 (0.59)	4.52 (0.55)	-.06	4.30 (0.60)	4.28 (0.62)	-.19	0.67	2.72	1.00
Perceived Opportunity	3.74 (0.85)	3.86 (0.69)	.00	3.45 (0.88)	3.88 (0.75)	.50	5.73*	1.28	1.78
Planning	2.83 (0.86)	3.11 (0.68)	.34	2.35 (0.96)	2.74 (0.93)	.29	7.05**	11.70**	0.20
Habit	2.57 (0.88)	3.11 (0.89)	.27	2.77 (0.84)	3.28 (0.88)	.44	17.01**	2.00	0.15
Identity	3.09 (1.04)	3.81 (0.83)	.75	3.23 (0.88)	3.76 (0.79)	.40	23.18**	0.11	0.54
<u>12 weeks to Six Months</u>									
Affective Attitude	4.34 (0.62)	4.48 (0.58)	-.03	4.04 (0.65)	4.40 (0.66)	.24	6.63**	3.89*	1.32
Perceived Opportunity	3.57 (0.66)	3.78 (0.79)	.21	3.71 (0.72)	3.80 (0.79)	.00	2.85	1.12	0.00
Planning	2.47 (1.03)	3.14 (0.84)	.60	2.31 (0.93)	2.78 (0.86)	.32	16.56**	3.49	0.50
Habit	2.72 (0.93)	3.27 (0.99)	.31	2.83 (0.91)	3.40 (0.89)	.39	14.90**	0.71	0.00
Identity	3.10 (0.90)	3.75 (0.96)	.45	3.23 (0.72)	3.79 (0.68)	.50	22.06**	0.41	0.11

Note: **= $p < .01$. * = $p < .05$. UI= unsuccessful intender; SI = successful intender; AC = action control; r_{DF} = correlation with multivariate discriminant function. Discriminant function analyses were performed separately for mothers and fathers. AC, Gender, and AC x Gender analyses are presented as univariate factorial analysis of variance F tests.

