How impulsivity shapes the interplay of impulsive and reflective processes involved in objective physical activity

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A B S T R A C T

Grounded on the Reflective–Impulsive Model, a recent study by Cheval, Sarrazin, Isoard-Gautheur, Radel, and Friese (2015) found support for an interactive pattern between reflective (i.e., physical activity intentions) and impulsive (i.e., impulsive approach tendencies towards sedentary behaviors; IASB) processes to prospectively predict objective moderate to vigorous physical activity (MVPA) — strong IASB hindered reflective intentions from being executed. As low self-control is presumed to be associated with the stronger influence of impulsive processes on behavior, the present article provides a secondary analysis testing whether the interactive pattern between reflective intentions and IASB may be moderated by different facets of self-control (i.e., restraint and impulsivity). Ninety-seven adults completed a questionnaire assessing the study’s variables of interest and wore an accelerometer over one week. Results revealed a moderated moderation pattern between intentions, IASB, and trait impulsivity — the previously documented interactive effect between intentions and IASB on objective MVPA was more pronounced for individuals with high as compared to low trait impulsivity. The results underline the dynamic interplay between intentions, IASB, and self-control in the determination of physical activity behavior.

1. Introduction

Promoting regular physical activity (PA) is a public health priority, given its extensive health benefits (Warburton, Charlesworth, Ivey, Nettlefold, & Bredin, 2010), yet there are low participation rates (Haskell et al., 2007; Sjöström, Oja, Hagströmer, Smith, & Bauman, 2006). Most social–cognitive theories assume an individual’s conscious intention (e.g., “I intend to walk for at least 30 minutes, four times a week”) is the most immediate and crucial predictor of behavior (see for a review Armitage & Conner, 2000). However, results of a meta-analysis of experimental evidence showed that a medium-to-large change in intention to be physically active \((d = 0.45)\) produces only a small-to-medium change in behavior \((d = 0.15; Rhodes & Dickau, 2012)\). Thus people do not always seem to behave in accordance with their conscious intention when they plan to do PA. Grounded on the Reflective–Impulsive Model (RIM; Strack & Deutsch, 2004) the purpose of this study was to examine the dynamic interplay between (a) a reflective precursor (i.e., intention to engage in PA), (b) impulsive precursors (i.e., approach-avoidance tendencies towards PA and sedentary behaviors), and (c) a dispositional moderator (i.e., self-control) on objective PA behavior.

1.1. The Reflective–Impulsive Model

The RIM has been proven useful in understanding the intrapersonal dynamics underlying health behavior (e.g., Hofmann, Friese, & Wiers, 2008). The model distinguishes two separate, but interacting systems: the impulsive and the reflective that jointly guide behavior. The reflective system is based on propositional knowledge such as personal standards, explicit attitudes, and deliberate intentions. It operates through relatively slow, controlled processes, and needs psychological resources and motivation to function efficiently. By contrast, the impulsive system draws upon an associative network, operates through fast, automatic processes, and taxes resources and motivation to a much lesser extent. For example, through the repeated experience of sedentary behaviors (SB), the mere perception of an input such as seeing someone on the sofa or in front of a computer screen can lead to an impulsive tendency to approach or avoid SB.

The RIM assumes that a behavior (e.g., PA) is enacted when a specific behavioral schemata is activated above a certain threshold by the reflective and the impulsive system. When both systems activate competing behavioral schemata – for example, when the intention to go running conflicts with an impulsive tendency to watch TV – the execution of
the behavior can be impeded (Strack & Deutsch, 2004). A recent study by Cheval, Sarrazin, Isoard-Gautheur, Radel, and Friese (2015) found support for this presumed interactive pattern between reflective and impulsive precursors of PA behavior. Participants completed a computerized reaction time task assessing impulsive approach-avoidance tendencies towards PA (IAPA) and towards sedentary behaviors (IASB; (Mogg, Bradley, Field, & De Houwer, 2003) and a measure of intentions to engage in PA during the next week. Moderate-to-vigorous PA (MVPA) was objectively assessed with an accelerometer during the following week. Results revealed that MVPA was positively predicted by PA intentions and IAPA, and negatively predicted by IASB. More centrally for present purposes, the relationship between PA intentions and MVPA was moderated by IASB: intentions positively predicted MVPA, but only among participants with low or moderate, but not high, IASB (For a more detailed description of the study and the results, see Cheval et al., 2015).

1.1. Individual differences

Another prediction of the RIM is that dispositional moderators can shift the weight towards more impulsively or more reflectively driven behavior (Friese, Hofmann, & Schmitt, 2008; Hofmann et al., 2008). Consequently, the consideration of both reflective and impulsive precursors of behavior and dispositional moderators should further elucidate the processes underlying behavior. Two dimensions of dispositional self-control, namely trait restraint and trait impulsivity, are potential dispositional moderators identified by Hofmann et al. (2008). Trait restraint is “the ability to override or change one’s inner responses, as well as to interrupt behavioral tendencies (such as impulses) and refrain from acting on them” (Tangney, Baumeister, & Boone, 2004, p. 274). Trait impulsivity refers to the same phenomenon, but from a different perspective. Whereas trait restraint focuses on control and overriding, trait impulsivity highlights different aspects of a lack of control and can be defined as “a predisposition towards rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions to the impulsive individuals or to others” (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001, p.1784). Impulsive individuals favor immediate rewards (e.g., sedentary behaviors such as watching TV) while discounting more valuable delayed rewards (e.g., the benefits of physical exercise). As a result, individuals with high self-control (i.e., high trait restraint and/or low trait impulsivity) should be good at controlling and overriding their impulses whereas those with low self-control (i.e., low trait restraint and/or high trait impulsivity) should act on their impulses more often (Friese et al., 2008; Hofmann et al., 2008).

Recent evidence suggests that impulsive processes interact with dispositional self-control in predicting unhealthy food intake (e.g., Friese & Hofmann, 2009, study 1; Honkanen, Olsen, Verplanken, & Tuu, 2012) and self-reported alcohol consumption (Burton, Pedersen, & McCarthy, 2012; Friese & Hofmann, 2009, studies 2a and 2b). For example, Friese and Hofmann (2009) found that automatic affective reactions interacted with trait restraint (or impulsivity) in predicting the consumption of potatoes chips and self-reported alcohol consumption — behavior of individuals low in trait restraint (or high in trait impulsivity) was more strongly influenced by impulsive precursors compared with those high trait restraint (or low trait impulsivity). Thus, the interplay between dispositional self-control and impulsive processes seems to be useful in understanding how individuals may (or may not) inhibit undesired behaviors.

1.2. The present study

Cheval et al. (2015) showed that reflective intentions to engage in PA and impulsive approach tendencies towards sedentary behaviors interacted to predict objectively measured PA: intentions predicted PA for those with low, but not high impulsive approach tendencies towards sedentary behaviors. Here, we provide a secondary analysis of this data set and investigate how restraint and impulsivity, as facets of self-control, modify the interplay of impulsive and reflective precursors on behavior. Maloney, Grawitch, and Barber (2012) advised researchers to regard restraint and impulsivity as related, but distinct facets of self-control, rather than a unitary construct. This allows for a more finely-grained analysis of their independent effects on behavior. Therefore, here we tested the assumption that the interaction between impulsive and reflective processes should depend on trait restraint and/or trait impulsivity. We hypothesized a moderated moderation pattern between PA intentions, IASB, and the restraint and impulsivity facets of dispositional self-control. Specifically, we expected the interactive effect between reflective PA intentions and IASB to be stronger in individuals with low self-control (i.e., high impulsivity and/or low restraint), because impulsive processes should exert a stronger influence in those with low as compared to high self-control. By contrast, the interactive effect between reflective PA intentions and IASB should be weaker in individuals who tend to control their impulsive tendencies more effectively (i.e., low impulsivity and/or high restraint).

2. Method

2.1. Participants, procedure and measures

One hundred and one rather inactive company-employees (52 women and 49 men; $M_{age} = 38.44, SD = 8.66$) were recruited through contacts at tertiary sector companies. At the end of a lab-session, they completed a questionnaire including the 8-items of the multi-factor Brief Self-Control Scale (BSCS; Tangney et al., 2004) validated by Maloney et al. (2012), to assess participants’ trait restraint (e.g., I am good at resisting temptation, 4 items) and impulsivity (e.g., Sometimes I can’t stop myself from doing something, even if I know it is wrong, 4 items). The next completed a task to assess their impulsive approach tendencies towards PA (IAPA) and sedentary behaviors (IASB; e.g., Mogg et al., 2003). Finally, participants’ intentions to be physically active (e.g., I intend to carry out at least 30 min MVPA per day on 5 or more days of the week) were assessed. In order to measure objective MVPA, each participant was given an accelerometer and instructed on how and when to wear it during the following eight days. Time spent on MVPA over one week was used as the dependent variable. The design, methods, and primary results of the randomized control trial have been described in detail elsewhere (Cheval et al., 2015).

2.2. Data analyses

Two participants had to be excluded due to accelerometer malfunctions and two further participants did not provide complete data. Data analyses were therefore carried out on 97 participants. Following Maloney et al. (2012), we examined the effects of the two dimensions of the BSCS (i.e. restraint and impulsivity) independently. We conducted two separate moderated moderation analyses (three-way interaction) to test whether the conditional effect of PA intentions × IASB on MVPA obtained in Cheval et al. (2015) varied depending on trait restraint (Model 1) and trait impulsivity (Model 2). Following the data analysis strategy in Cheval et al. (2015) we controlled for IAPA, and the known PA correlates: sex, age, and BMI. Finally, we examined the first two Models together to investigate the specific contribution of trait restraint and trait impulsivity for behavior regulation (Model 3). Predictor variables were centered in the case of continuous variables and dummy coded in the case of dichotomous variables.

3. Results

3.1. Descriptive statistics

Means, standard deviations, Cronbach alphas, and bivariate correlations are presented in Table 1. Inspection of Table 1 confirms that trait
impulsivity and trait restraint were moderately and negatively related to one another \((r = -0.43, p < 0.001)\), suggesting that they are distinct and may operate independently.

### 3.2. Moderated moderation analysis

Model 1 (see Table 2) confirmed the PA intentions × IASB interaction reported by Cheval et al. (2015), controlling for sex, age, BMI, and IAPA \((β = -0.290, p = .002)\). Simple slope analyses (see Fig. 1a) revealed that PA intentions significantly predicted MVPA when IASB levels were low \((β = -0.493, p < .001)\) or moderate \((β = -0.193, p = .038)\), but not when they were high \((β = -0.107, p = .414)\). The analysis further showed that this interaction was not further qualified by trait restraint \((βp > .570, for the three-way interaction).

In addition, a significant two-way interaction between trait restraint and IASB on MVPA emerged \((β = 0.183, p = 0.424)\). Simple slope analyses (see Fig. 1b) revealed that IASB was negatively related to MVPA for participants with low \((β = -0.431, p = .003)\) or moderate \((β = -0.204, p = .032)\), but not high \((β = 0.022, p = .883)\) trait restraint. Individuals with high restraint were not influenced by their IASB. The Model explained 35% of the variance in objective MVPA.

Model 2 (see Table 2 and Fig. 2) again confirmed the PA intentions × IASB interaction. Most centrally, this interaction was moderated by trait impulsivity \((β = -0.231, p = .008)\), controlling for sex, age, BMI, and IAPA. More precisely, the PA intentions × IASB interaction was negative and significant for participants with high (i.e., at M + 1SD; \(β = -0.464, p < .001\)) and moderate (i.e., at mean; \(β = -0.211, p = .023\)), but not low (i.e., at \(M - 1SD; β = -0.042, p = .732\)) trait impulsivity. The conditional effect of PA intentions on MVPA calculated at three values of both moderators (IASB and trait impulsivity) was significant among participants with low IASB, and high \((β = 0.650, p < .001)\), or moderate \((β = 0.333, p = 0.004)\) trait impulsivity. The effect was also significant among participants with moderate IASB and moderate trait impulsivity \((β = 0.203, p = 0.023)\). For participants with high IASB and high trait impulsivity, there was even a marginally significant trend for strong intentions being associated with less MVPA as compared to weak intentions \((β = -0.310, p = .087)\). For the other combinations of intentions, IASB, and impulsivity, the conditional effect was not significant. The Model explained 40% of the variance in objective MVPA.

### Table 1

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean (SD)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA intentions</td>
<td>3.77 (1.70)</td>
<td>.89</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>IAPA</td>
<td>50.22 (154.09)</td>
<td>.17</td>
<td>.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>IASB</td>
<td>64.74 (169.19)</td>
<td>.16</td>
<td>.22</td>
<td>.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trait restraint</td>
<td>2.82 (0.73)</td>
<td>.26</td>
<td>− .01</td>
<td>− .01</td>
<td>.60</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Trait impulsivity</td>
<td>2.84 (0.82)</td>
<td>.05</td>
<td>.04</td>
<td>− .08</td>
<td>− .43</td>
<td>.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MVPA</td>
<td>58.80 (64.34)</td>
<td>.34</td>
<td>.24</td>
<td>− .27</td>
<td>.10</td>
<td>.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>24.01 (4.29)</td>
<td>.25</td>
<td>.01</td>
<td>− .07</td>
<td>− .24</td>
<td>.20</td>
<td>.20</td>
<td>−1.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex, women number (%)</td>
<td>51 (52.6)</td>
<td>.04</td>
<td>.13</td>
<td>.19</td>
<td>.13</td>
<td>.06</td>
<td>.08</td>
<td>.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>38.30 (8.55)</td>
<td>.02</td>
<td>− .22</td>
<td>− .17</td>
<td>− .04</td>
<td>.07</td>
<td>.30</td>
<td>.12</td>
<td>− .13</td>
<td></td>
</tr>
</tbody>
</table>

Note. Scale reliabilities (Cronbach’s alpha) are shown on the diagonal. IAPA = impulsive approach tendency towards physical activity; IASB = impulsive approach tendency towards sedentary behaviors; MVPA = moderate to vigorous physical activity (in min/week).

### Table 2

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex*</td>
<td>β</td>
<td>LL95</td>
<td>UL95</td>
</tr>
<tr>
<td>Age</td>
<td>.309</td>
<td>.07</td>
<td>3.78</td>
</tr>
<tr>
<td>BMI</td>
<td>−0.203</td>
<td>−5.93</td>
<td>−0.16</td>
</tr>
<tr>
<td>Intentions</td>
<td>.193</td>
<td>0.43</td>
<td>14.82</td>
</tr>
<tr>
<td>IAPA</td>
<td>.200</td>
<td>0.01</td>
<td>0.16</td>
</tr>
<tr>
<td>IASB</td>
<td>−0.204</td>
<td>−0.16</td>
<td>0.01</td>
</tr>
<tr>
<td>Trait restraint</td>
<td>.156</td>
<td>−14.33</td>
<td>16.77</td>
</tr>
<tr>
<td>Trait impulsivity</td>
<td>−0.014</td>
<td>−10.21</td>
<td>8.70</td>
</tr>
<tr>
<td>Intentions × trait restraint</td>
<td>.183</td>
<td>0.01</td>
<td>0.24</td>
</tr>
<tr>
<td>IASB × trait restraint</td>
<td>−0.290</td>
<td>−0.12</td>
<td>0.03</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>.350</td>
<td>.404</td>
<td>.385</td>
</tr>
</tbody>
</table>

Note. PA = physical activity; IAPA = impulsive approach tendency towards PA; IASB = impulsive approach tendency towards sedentary behaviors; MVPA = moderate to vigorous physical activity (in min/week); IC = confidence interval for the effects; LL95 = lower bound; UL95 = upper bound.

* Women = 0, men = 1.
† \(p < .10\).
* \(p < .05\).
** \(p < .01\).
*** \(p < .001\).
Results of Model 3 (see Table 2) revealed that controlling for sex, age, BMI, and IAPA the conditional effect of PA intentions × IASB on MVPA significantly varied depending on the level of trait impulsivity ($\beta = -.265, p = .012$). However, the significant two-way interaction between trait restraint and IASB on MVPA that we found in Model 1 was no longer significant ($\beta = -.028, p = .810$). Note that this Model should be interpreted with caution because of the many predictors it includes. The Model explained less variance than the more parsimonious Model 2.

4. Discussion

Given the extensive health benefits associated with PA behavior (Warburton et al., 2010) increasing the population’s level of PA behavior is a central health priority. In recent years dual-process models such as the RIM (Strack & Deutsch, 2004) have suggested that both reflective and impulsive processes exert some influence on behavior. Drawing on this model, a recent study revealed an interactive pattern between reflective and impulsive processes (Cheval et al., 2015): Reflective PA intentions predicted objective MVPA only for individuals with low or moderate, but not high IASB. The present work reported a follow-up secondary analysis of this data set to test the assumption that this interactive pattern depends on dispositional self-control. Because low self-control is associated with stronger influences of impulsive processes on behavior (e.g., Friese & Hofmann, 2009; Friese et al., 2008), we hypothesized a moderated moderation pattern between PA intentions, IASB, and dispositional self-control. In accordance with several authors (e.g., Maloney et al., 2012), two facets of self-control were investigated: restraint and impulsivity.

First, in agreement with our hypotheses, the moderated moderation pattern between PA intentions, IASB, and self-control was clearly supported for the “impulsivity” facet. The negative interactive effect between intentions and IASB on objective MVPA was more pronounced when trait impulsivity increased. In other words, depending on the level of trait impulsivity, high IASB blocked any positive effect of PA intentions on MVPA. More precisely, PA intentions did not interact with IASB to predict MVPA among participants with low trait impulsivity (see Fig. 3a). By contrast, the discrepancy between participants with low versus high IASB who reported strong PA intentions is even greater for those with high rather than low trait impulsivity (see Fig. 3b and c). For those with high trait impulsivity, while a low IASB (i.e., high impulsive avoidance tendency towards sedentary behaviors) is positively associated with MVPA, a high IASB (i.e., high impulsive approach...
tendency towards sedentary behaviors) tended to be negatively associated with MVPA. It appears quite remarkable that highly impulsive individuals who reported having strong intentions to engage in PA tended to do the opposite when they had strong predispositions towards engaging in sedentary activities (i.e., activities that are at odds with PA). We refrain from over-interpreting this non-significant finding, but speculate that dealing with the incompatibility of strong intentions to engage in PA and strong IASB draws on self-regulatory resources (Baumeister, Vohs, & Tice, 2007). Reduced resources are associated with an increased influence of impulsive system on behavior (Hofmann et al., 2008). As a result, for some individuals, dispositional (i.e., high trait impulsivity) as well as situational (i.e., low self-regulation resources) conditions act together to reinforce the weight of impulsive processes on behavior, thereby increasing the probability of engaging in sedentary behaviors for participants with a high IASB. This explanation is somewhat aligned with the "ironic rebound effect" which suggests that when individuals attempt to suppress thoughts or impulses, these thoughts or impulses resurface even more intensely than before (Wegner, Schneider, Carter, & White, 1987).

On the contrary, high trait impulsivity can assume quite a different role when individuals have low IASB (i.e., high impulsive avoidance tendency towards sedentary behaviors). Participants who had strong PA intentions, low IASB, and high trait impulsivity were those with the highest level of MVPA. This result shows that high trait impulsivity is not deleterious per se. Instead, high trait impulsivity may be beneficial for individuals whose impulsive system predisposes them to active behavior, whereas it may be detrimental for those whose impulsive system predisposes them to inactive behavior. This reasoning fits well with the logic of the RIM suggesting that impulsive processes exert a stronger influence on the behavior of individuals with high rather than low trait impulsivity (e.g., Friese & Hofmann, 2009; Friese et al., 2008).

The moderated moderation pattern between PA intentions, IASB, and self-control was not confirmed for the "restraint" facet. However, a significant interaction between trait restraint and IASB was found. IASB negatively predicted MVPA, but only among individuals with low or moderate trait restraint. By contrast, individuals with high trait restraint prevented their IASB from negatively influencing their PA behavior (see Fig. 1b). This finding is in accordance with results of previous research showing that automatic affective reactions towards tempting stimuli were more strongly related to behavior for individuals with low than high trait restraint (e.g., Friese & Hofmann, 2009). Whereas previous research focused on controlling potentially problematic behaviors such as eating unhealthy food or drinking alcohol, our study is the first to demonstrate that trait restraint may also moderate the effect of impulsive processes on the adoption of health protective behaviors, and not only the cessation of health detrimental behaviors. However, the moderating effect of trait restraint disappeared when trait impulsivity (and the respective interactions) was controlled for. These findings imply that in conjunction with impulsive and reflective processes, trait impulsivity accounted for the unique variance in the regulation of PA whereas the unique variance of trait restraint in conjunction with impulsive and reflective processes was negligible.

In conclusion, the present research extends previous findings showing the interaction between intentions and IASB to predict objective PA. We show that this interaction was moderated by trait impulsivity. This study appears to be the first to reveal a moderated moderation pattern, highlighting that not only impulsive and reflective processes interactively predict behavior, but also that dispositional moderators related to self-control (i.e., trait impulsivity) change their interactive relationship with behavior. The predictive validity of health behavior models should be enhanced by the combined consideration of these three precursors.

References

Note. MVPA = Moderate to vigorous physical activity (in min/week); IASB = Impulsive approach tendency towards sedentary behaviors. Low IASB represents an impulsive avoidance tendency towards sedentary behaviors. High IASB represents an impulsive approach tendency towards sedentary behaviors.

Fig. 3. Slopes for intentions — objective MVPA relationship across three levels of IASB and trait impulsivity.


