Action Planning Makes Physical Activity More Automatic, Only If it Is Autonomously Regulated: A Moderated Mediation Analysis

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Abstract

Objectives. To examine whether automaticity mediated the association between action planning and physical activity and whether autonomous motivation moderated this mediation.

Methods and measures. Physical activity was measured by accelerometry during seven days among 124 adults. Action planning, automaticity and autonomous motivation were assessed by questionnaires.

Results. Automaticity mediated the association between action planning and physical activity (*c* path, $\beta = .30$, standard error [SE] = .09, $p < .001$) – action planning was associated with automaticity (*a* path, $\beta = .48$, SE = .08, $p < .001$), which in turn related to physical activity (*b* path, $\beta = .31$, SE = .10, $p < .001$). Autonomous motivation moderated the *a* path of this mediation ($\beta = .22$, SE = .10, $p = .029$) – action planning was associated with automaticity when autonomous motivation was high (+1 standard-deviation [SD]) ($\beta = .49$, SE = .11, $p < .001$), but not when it was low (-1 SD) ($\beta = .05$, SE = .15, $p = .720$).

Conclusion. These findings, not only support that action planning favors an automatic regulation of physical activity, but also highlight a boundary condition under which this mechanism operates: holding a high autonomous motivation toward physical activity.

Keywords: intention-action gap, self-regulation, motivation, automaticity, accelerometer

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Forming strong intentions is recognized as the cornerstone of behavioral regulation in the prominent theories of health behaviors (e.g., Ajzen, 1985; Prochaska & DiClemente, 1983). However, holding high intentions does not ensure that they will turn into action. Indeed, the so-called intention-action gap was underlined in the field of health behaviors (Sheeran, 2002), with meta-analyses revealing that a medium-to-large change in intention only results into a small-to-medium change in behavior (Webb & Sheeran, 2006). Particularly, in physical activity, about 36% of individuals who report intention to be physically active fail to convert this intention into action (Rhodes & de Bruijn, 2013). Narrowing this gap is yet crucial given the significant health benefits that even a modest increase in physical activity could have (Ekelund et al., 2019). For example, recent estimations suggest that a daily 10-min increase in physical activity would prevent the deaths of about 100,000 Americans across a year (Saint-Maurice et al., 2022). Yet, current trends rather reveal that physical activity levels are decreasing in developed countries (Conger et al., 2022), deepening the current pandemic of physical inactivity (Kohl et al., 2012). In this context, it is essential to identify and understand the strategies allowing individuals to convert their intention to be physically active into action.

One time- and cost-efficient strategy to promote the adoption of health behaviors is action planning[1]. Action planning refers to a deliberate and prospective self-regulatory strategy through which the individual specifies when, where, how they plan to engage in a certain behavior (e.g., “Every Friday, at 5pm, I will walk 30 minutes in the park next to my workplace”) (Sniehotta et al., 2005). Anchored within the volitional phases of several theoretical models (e.g., Fuchs et al., 2011; Heckhausen & Gollwitzer, 1987; Schwarzer & Luszczynska, 2008), the positive effects of action planning on the adoption of health behaviors have received strong empirical support, with a medium-to-large effect size being observed (d = .59) (Gollwitzer & Sheeran, 2006). This beneficial effect of action planning was also confirmed in the field of physical activity (see Bélanger-Gravel et al., 2013; Carraro & Gaudreau, 2013 for meta-analyses). But how to explain the effectiveness of action planning in promoting the adoption of health-related behaviors, such as physical activity?

Based on a dual process approach (Hofmann et al., 2008; Strack & Deutsch, 2004), once formed, action planning is expected to favor an automatic mode of behavioral regulation (i.e., fast, requiring relatively less cognitive resources and effort, and minimal need for conscious intent) (Gollwitzer & Sheeran, 2006; Sheeran et al., 2013). Specifically, this self-regulatory strategy allows to proactively link critical situational cues (e.g., every Friday, at 5 pm, in the park next to my workplace) with a goal-directed behavior (e.g., walking)(Gollwitzer & Sheeran, 2006; Sheeran et al., 2013). Critically, as a result of this cue-response association, behaviors are expected to be triggered automatically when encountering the related cues (Gollwitzer & Sheeran, 2006; Sheeran et al., 2013). Evidence from laboratory-based experiments has accumulated over years, with studies showing that, for example, developing action planning enhances the mental accessibility of the cues (e.g., Webb & Sheeran, 2007) and encourages a successful goal pursuit in critical situations through automatic decision-making processes (Bayer et al., 2009; Parks–Stamm et al., 2007). Further, neuroscientific studies confirmed that action planning favored a switch in action control, from deliberative top-down to more automatic bottom-up mechanisms (see Wieber et al., 2015 for a review).

If action planning is presumed to prompt an automatic behavioral instigation as soon as related cues are encountered, only a handful set of studies carried out in ecological settings have corroborated this full mediating pathway in the health domain (i.e., action planning → automaticity → behaviors) (Potthoff et al., 2017). Particularly, regarding physical activity, previous work either assessed the relationship between action planning and behaviors (e.g., Sniehotta et al., 2006) or focused on the mediating pathway from action planning to automaticity, through physical activity behaviors (Fleig et al., 2013; van Bree et al., 2016). Regarding this mediating pathway, results were quite inconsistent. In two independent samples (N = 231 university students and N = 134 rehabilitation patients), Fleig et al. (2013) showed that action planning predicted automaticity toward physical activity, directly or through the mediating role of physical activity behaviors. Nevertheless, in two independent samples of older adults (N = 469 and N = 322), van Bree et al. (2016) did not replicate these results, with the relationship between action planning and automaticity through physical activity behaviors turning out to be non-significant. This inconsistency may first stem from the self-reported assessment of physical activity behaviors, which is likely to alter observed associations (Sheeran, 2002). Second, as these studies did not investigate potential moderators of the mediating pathway (Hagger et al., 2016), this inconsistency may result from differences in sampled populations. Altogether, the mediating pathway between action planning, automaticity and accelerometer-measured physical activity behaviors remains to be examined, as well as the boundary conditions under which this mechanism may potentially operate.

Indeed, one intriguing question deals with the variables which favor – or impede – the translation of action planning into automaticity (Hagger et al., 2016). While previous research mostly compared the different characteristics of action planning (e.g., routine-based cue planning [e.g., after breakfast] vs time-based cue planning [e.g., at 8am]) (Fleig et al., 2017), less attention was paid to motivational moderators, such as self-efficacy (Luszczynska et al., 2011) or personality traits (e.g., impulsivity) (see Churchill & Jessop, 2010 in the food domain). Consistent with a growing literature examining the role of reasons for action in self-regulatory mechanisms (Werner & Milyavskaya, 2018), another potential moderator of the mediating pathway between action planning, automaticity and physical activity is autonomous motivation. According to the Self-Determination Theory (Ryan & Deci, 2017), autonomous motivation encapsulates internal and self-concordant reasons for action, namely intrinsic motives (i.e., practicing physical activity for its pleasure or interest) and identified motives (i.e., practicing physical activity for its value and importance), with this type of motivation having proven to foster the adoption of desired behaviors (Gaudreau et al., 2012). Yet, the pathways through which it operates remains debated. Here we proposed that autonomous motivation would strengthen the association of action planning on PA by facilitating the automatization of related behaviors. At least two reasons lead us to believe that autonomous motivation would reinforce the association between action planning and automaticity. First, autonomous motivation, not only positively predicts action planning (Fuchs et al., 2012; Nurmi et al., 2016; Slovinec D'Angelo et al., 2007), but also favors the adoption of desired behaviors through action planning (Koestner et al., 2008). In other words, it seems plausible that autonomous motivation may help getting into a virtuous circle through which action planning enhances automaticity by behavioral repetition (Lally & Gardner, 2013), with automaticity, in turn, leading to the adoption of health behaviors (Gardner et al., 2011). Second, automaticity is assumed to develop more quickly when the behavior is perceived as concordant with own's values and interests (Gardner & Lally, 2013; Maltagliati, Rebar, et al., 2021; Radel et al., 2017). Indeed, automaticity is conceptualized as being shaped by the rewarding value assigned to a behavioral option, repeated in stable contexts (Wood, 2017). Accordingly, implementing action plans for which individuals hold a high (vs a low) autonomous motivation, the archetype of rewarding reasons for action, seems especially likely to foster the development of automaticity toward physical activity. However, to the best of our knowledge, the moderating effect of autonomous motivation on the mediation between action planning, automaticity and physical activity has never been examined.

Moreover, in contrast to autonomous reasons for action, controlled motivation encompasses introjected (i.e., practicing physical activity because of internal pressures, such as guilt or shame) and external (i.e., practicing physical activity because of external pressures, including external rewards or punishments) motives (Ryan & Deci, 2017). As the role of controlled motivation in self-regulatory processes remains controversial (Werner & Milyavskaya, 2019), we also aimed to explore whether controlled motivation moderates the mediation between action planning, automaticity and physical activity.

The current study

The aim of the current study was twofold. First, we examined whether automaticity toward physical activity mediates the association between action planning and accelerometer-measured physical activity. Second, we tested whether autonomous motivation toward physical activity moderated this mediating pathway by strengthening the association between action planning and automaticity. We hypothesized that action planning would be positively associated with automaticity toward physical activity and, in turn, automaticity which would in turn be positively related to physical activity behaviors (H1). Moreover, we also expected that autonomous motivation would moderate the association between action planning and automaticity (H2), with the effect of action planning on automaticity being stronger among individuals with a high (vs a low) autonomous motivation. In additional analyses, we also explored the potential moderating effect of controlled motivation on the abovementioned mediating pathway.

Methods

Participants and procedure

The present study relies upon an experimental procedure and a dataset which was described elsewhere (masked for review). In brief, participants were recruited from local tertiary sector companies, had to be older than 18 years old, be willing to participate in a laboratory session and to wear an accelerometer for one week. Participants were excluded if they reported a physical impairment that prevented them to engage in physical activity and/or were receiving treatment for a psychiatric disorder. In total, 135 adults were enrolled in the study. First, they were invited to an individual laboratory session in which they completed a questionnaire assessing automaticity toward physical activity, autonomous and controlled motivation toward physical activity, as well as their intention to be physically active (see Sensitivity analyses). At the end of the laboratory session, they received an accelerometer Actigraph GT3X+ and the experimenter provided instructions about its use (e.g., how and when to wear it). They also received a notebook in which they reported the time at which they woke up, put the accelerometer on their hip, arrived at their workplace, quit their workplace, removed the accelerometer (e.g., to take a shower), and went to bed. Participants were asked to wear the accelerometer and to complete the notebook for the next seven days. Eight days later, participants came back to the laboratory, gave back their accelerometer and their notebook. They also completed a last short questionnaire which retrospectively measured action planning across the past week. Finally, participants were fully debriefed and thanked by the experimenter. Participants who reported having been injured or ill during this week were excluded from the present analyses (N = 11), leading to a total of 124 participants (63% of women, mean age = 40 ± 9 years, mean body mass index = 23.91 ± 4.01 $kg.m^{-2}$).

We conducted a post-hoc achieved power analysis was conducted on our first hypothesis with the package WebPower (Zhang & Yuan, 2018). Based on correlations reported by previous literature

(Fleig et al., 2013; van Bree et al., 2016), we entered medium-sized correlations ($r = .40$) between the predictor and the mediator (*a* path) and between the mediator and the outcome (*b* path), with variances set to 1 and $\alpha = .05$. With N = 124, we achieved a power of $\beta = 88\%$ to detect at least medium-sized associations between our variables.

The Research Ethics Committee of the university supporting this study approved this study (reference number: 2013-03-19-13).

Measures

Action planning (independent variable)

Following Brickell & Chatzisarantis (2007), participants were asked to read the following section: "*In this question we are interested in whether you plan and prepare when, where, and how you do physical activities during your leisure-time. Some people plan their physical activity, and other people have no set plans, they just let it happen. Both ways can be effective in getting you to do physical activity, so it does not matter if you have, or have not made plans for your physical activity over the past week. Please answer the following questions as honestly as possible.*". They were then asked to answer to four items ($\alpha = .93$) assessing the extent to which they had specific plans about when, where, how and how often to engage in physical activity across the past week (e.g., *During the last week, I had specific plans about the days or the moments of the day during which I would engage in moderate-to-vigorous physical activity*) (Sniehotta et al., 2005). Each item was assessed on a Likert scale ranging from 1 (*Completely disagree)* to 6 (*Totally agree*). Of note, this variable after the seven-day period of physical activity measurement in order to avoid altering participants' usual planning of physical activity behaviors (Conner et al., 2010).

Automaticity toward physical activity (mediating variable)

Automaticity toward physical activity was measured using the four-item automaticity subscale of the Self-Reported Habit Index (Gardner et al., 2012; Verplanken & Orbell, 2003). After the stem "*In general, the decision to engage in physical activity is something…*", participants indicated to which extent they agreed with four statements (e.g., *that I do automatically*) (α = .94). Answers were given on a Likert scale ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*).

Accelerometer-measured physical activity (dependent variable)

Physical activity behaviors were estimated using a three-axis accelerometer (Actigraph GT3X+; Pensacola, USA). This device has been shown to provide acceptable validity when estimating physical activity (Aadland & Ylvisåker, 2015). It was worn at the right hip for seven consecutive days in free-living conditions. One-minute epochs were used for data analyses and non-wear time was defined as ≥ 59 consecutive minutes of zero counts. Days of measure were considered as valid if wear time was ≥ ten waking hours per day (Evenson & Terry, 2009). All participants reported at least five valid days of measure (with at least one weekend day) and were therefore included in analyses (Matthews et al., 2012). Total spent in at least ten-minutes bouts of moderate-to-vigorous physical was determined using validated cut-points (i.e., > 1952 counts per minute) (Freedson et al., 1998) and was used as the dependent variable in subsequent analysis.

Autonomous and controlled motivation toward physical activity (moderating variables)

Autonomous and controlled motivation toward physical activity was assessed using an eight-item scale (Brunet et al., 2015; Sheldon & Elliot, 1998). Participants were asked to rate the degree to which statements reflected their motivation to engage in moderate-to-vigorous physical activity during leisure time. The statements reflected four motivational regulations measured by two items each: intrinsic (e.g., "*Because of the pleasure I feel during physical activity*"), identified (e.g., "*Because I believe it is really important to be physically active*"), introjected (e.g., "*Because I would feel a bit ashamed if I were not physically active*") and external (e.g., "*Because people around me would not appreciate if I were not physically active*"). Answers were given on a Likert scale ranging from 1 (*Not at all for this reason*) to 7 (*Totally for this reason*). Intrinsic and identified items were averaged to compute a score of autonomous motivation (α = .90). Similarly, introjected and external items were averaged to compute a score of controlled motivation (α = .71).

Intention to be physically active

Intention to be physically active was also measured using a two-item scale ranging from 1 (Not true at all) to 6 (Absolutely true) (e.g., *During the next two weeks, I have the intention to engage in at least 30 minutes moderate-to-vigorous physical activity, at least five days a week, during my leisure-time*) (α = .95) (see Sensitivity analyses).

Statistical analysis

First, we standardized all variables before computing our models. Then, to test H1 (i.e., whether automaticity mediated the association between action planning and physical activity), we specified simple mediation models in which we entered action planning as the independent variable. Automaticity toward physical activity was added as the mediating variable, while physical activity behaviors were specified as the dependent variable. Then, to test H2 (i.e., whether autonomous motivation moderated the abovementionned mediating pathway), we computed a moderated mediation model, by adding autonomous motivation as a moderating variable on the different stages of the mediating pathway.

To examine the mediating pattern, the "component" approach (i.e., joint-significance testing of multiple parameter estimates) and the "index" approach (i.e., single test of a mediational index) were used in a complementary manner. First, as the "component" approach is expected to provide low rates of Type I errors, while keeping sufficient power (Yzerbyt et al., 2018), we first tested the two paths of the indirect effect (i.e., from the independent variable to the mediating variable [*a* path] and from the mediating variable to the dependent variable [*b* path]), with an indirect effect being supported when both components are significant ($p < .05$). For moderated mediation models, we examined whether autonomous motivation significantly moderated this mediation pattern (Muller et al., 2005). Second, as proposed by the "index" approach, we planned to confirm our results by respectively computing the index of indirect effect for simple mediation models and the moderated index of indirect effect for moderated mediation models (Hayes, 2015). A Monte Carlo 95% confidence interval (95CI%) for the indirect effect which did not contain 0 is assumed to indicate a significant indirect effect and/or a moderated indirect effect (with 5000 simulations).

All analyses were computed on R®, version 4.0.4. Models were specified using the package JSmediation (Batailler, 2021) and were inspected using the package performance (i.e., linearity and normality of residuals, homogeneity of variance, undue influence).

Additional analyses

We also tested whether controlled motivation moderated the mediating pathway between action planning, automaticity and physical activity.

Sensitivity analysis

As previously stated (Sheeran et al., 2005), action planning may be relevant only for individuals with a moderate-to-strong intention to be physically active. Accordingly, sensitivity analyses excluded individuals who reported a low intention to be physically active. As proposed elsewhere (Cheval et al., 2020, 2021), individuals with a score below the middle of the scale (i.e., < 3 on the six-point scale) were excluded from the sensitivity analyses (N = 39), leading to a subsample of 85 participants (Table S2).

We also computed additional sensitivity models, adjusting for age, sex, and body mass index.

Results

Descriptive statistics and bivariate correlations are provided in Table 1.

Table 1. Descriptive statistics and bivariate correlations.

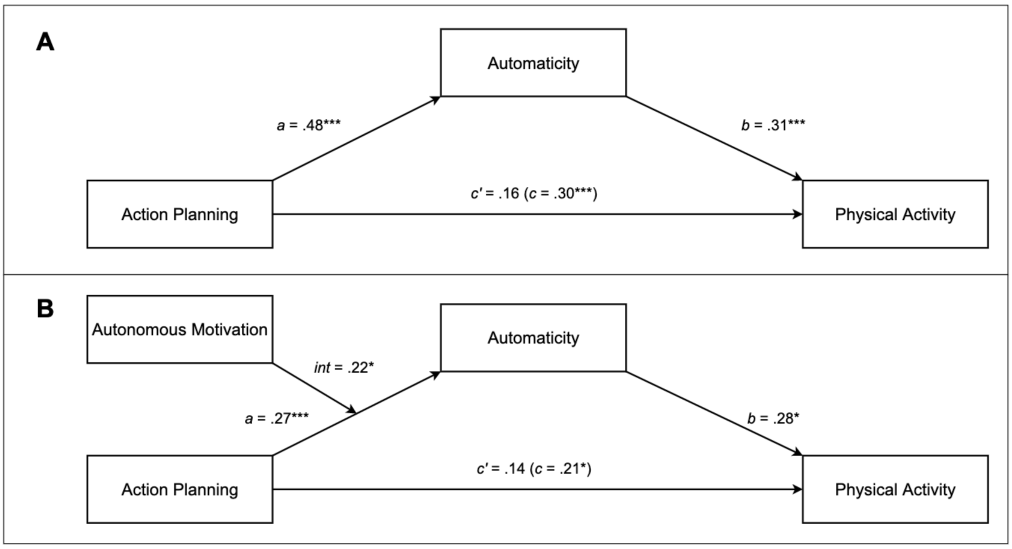
N = 124	Mean (SD)	Range	1.	2.	3.	4.	5.
1. Action planning	3.09 (1.78)	1-6	-	.48***	.39***	.11	.30***
2. Automaticity	2.23 (1.54)	1-6		-	.52***	-.04	.38***
3. Autonomous motivation	6.01 (1.14)	1.7			-	.05	.24**
4. Controlled motivation	2.63 (1.27)					-	-.05
5. Physical activity (in min)	69 (90)	0-532					-

Note. SD: standard deviation. ***: p < .001; **: p < .01.

Simple mediation models (H1)

The simple mediation model revealed a significant total effect of action planning on physical activity (*c* path, β = .30, standard error [SE] = .09, $t(122) = 3.53$, $p < .001$) (Figure 1A). Joint significant tests showed a significant association of action planning with automaticity (*a* path, β = .48, SE = .08, $t(122) = 6.08$, $p < .001$) and a significant association of automaticity with physical activity (*b* path, β = .31, SE = .10, $t(121) = 3.24$), $p < .001$). Consistent with this analysis, the bootstrapped Monte Carlo confidence interval for the indirect effect did not contain 0, CI 95% [0.054; 0.256]. After controlling for automaticity, action planning was no longer associated with physical activity (*c'* path, β = .16, SE = .10, $t(121) = 1.65$, $p = .102$). Moreover, automaticity mediated around 49% of the association between action planning and physical activity.

Figure 1. Simple mediation model (A) and moderated mediation model (B).

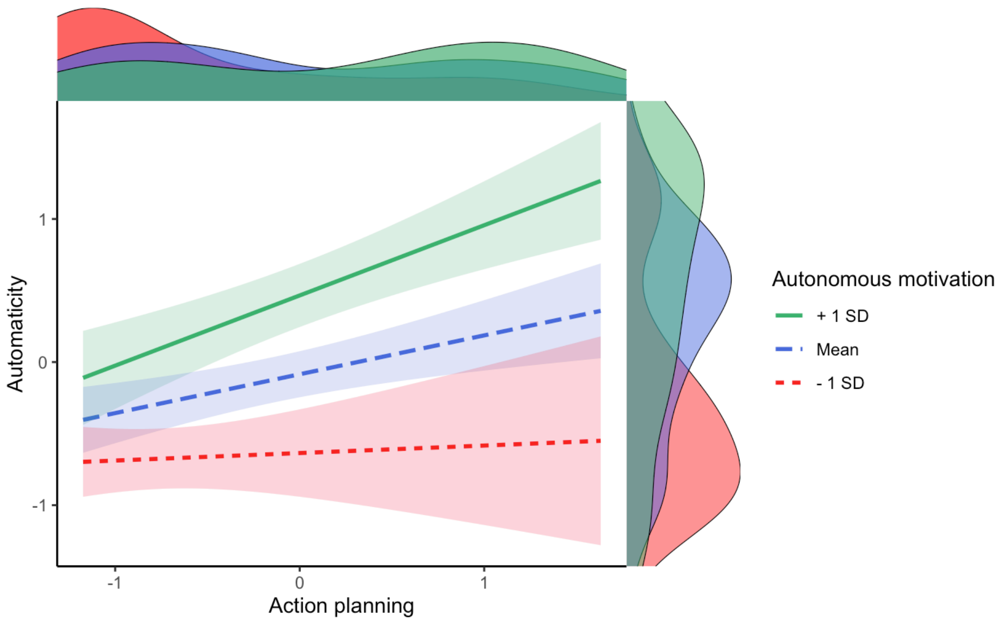


Note. Standardized beta coefficients are displayed for all paths. int: Interaction term between action planning and autonomous motivation on automaticity. ***: p < .001; ^: p < .10.

Moderated mediation models (H2)

Moderated mediation analyses revealed that autonomous motivation significantly moderated the association between action planning and automaticity (*a* path × moderating variable, β = .22, SE = .10, $t(120) = 2.22$, $p = .029$). The first stage index for the moderated indirect effect revealed that the bootstrapped Monte Carlo confidence interval for the moderated indirect effect did not contain 0, CI 95% [0.003; 0.146]. Further, simple slopes analysis revealed that the association of action planning with automaticity was significant, with a medium-sized magnitude, for a high autonomous motivation (+1 standard deviation [SD]) (β = .49, SE = .11, $t(120) = 4.62$, $p < .001$) (Figure 2). However, when autonomous motivation was low (-1SD), the association between action planning and automaticity was non-significant (β = .05, SE = .15, $t(120) = 0.47$, $p = .720$) (Figure 2).

Figure 2. Simple slopes of the associations between action planning and automaticity, depending on autonomous motivation.



Note. Variables were standardized before being entered in the model. Density plots by level of autonomous motivation are displayed for action planning (on top) and automaticity (on the right).

Further, analysis of the region of significance, using the Johnson Neyman approach, showed that the association between action planning and automaticity was significant when autonomous motivation was higher than -0.35 SD above the sample mean (i.e., above ~5.6 on the seven-point Likert scale) (Figure 3). Autonomous motivation did not significantly moderate the other paths of the mediating pathway.

Additional analyses

Controlled motivation did not significantly moderate the association between action planning and automaticity (Table S1). Accordingly, the mediating pathway between action planning and physical activity through automaticity was not moderated by controlled motivation.

Sensitivity analyses

When including only participants with a moderate-to-strong intention to be active, results were consistent with those observed in the main analysis (Table S2): in simple mediation models, automaticity toward physical activity (thought marginally) mediated the effect of action planning on physical activity. Moreover, in moderated mediation models, the (marginal) mediating effect of automaticity on the association between action planning and physical activity was moderated by autonomous motivation.

When further adjusting for participants' age, sex and body mass index, results remain consistent with those observed in the main analysis (Table S3).

Discussion

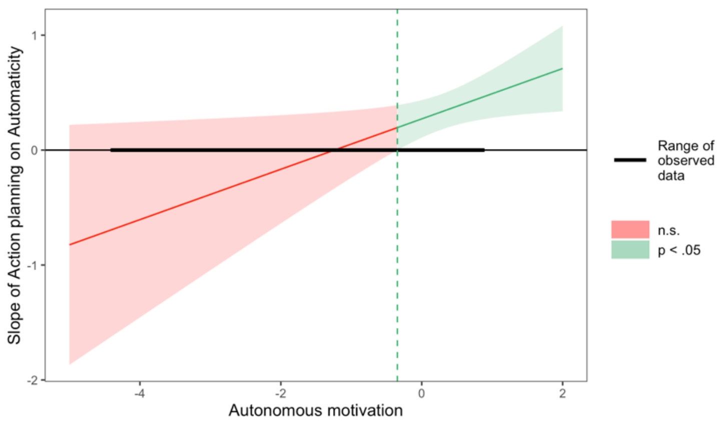
Once developed, action planning has been identified as playing a pivotal role in health behaviors by facilitating an automatic mode of behavioral regulation (Gollwitzer & Sheeran, 2006). Here, we demonstrate, for the first time, that automaticity mediated the association of action planning with accelerometer-measured physical activity. Further, we show that autonomous motivation moderated this mediating pattern by strengthening the relationship between action planning and automaticity. Hence, the current study not only provides evidence on the mechanisms underlying the beneficial effect of action planning on physical activity behaviors, but it also broadens our understanding of the boundary conditions under which action planning operates.

Comparison with previous studies

Our findings first contributed to accumulating evidence on the positive link between action planning and physical activity behaviors (see Bélanger-Gravel et al., 2013; Carraro & Gaudreau, 2013 for meta-analyses). In contrast with previous research which mostly relied upon self-reported assessment of physical activity (but see Roberts et al., 2010), we confirmed the beneficial effect of action planning on an accelerometer-based estimation of physical activity. Crucially, our results lend support to the idea that automaticity largely explains the association between action planning and physical activity behaviors. Thought the potential of action planning in favoring behavioral automatization was robustly demonstrated in laboratory-based studies (e.g., Webb & Sheeran, 2007), its translation to real-life settings was remaining limited (Potthoff et al., 2017). To the best of our knowledge, our study was the first to provide support for the mediating effect of automaticity on the association between action planning and physical activity, as measured by accelerometry in daily-life settings

Our findings further showed that autonomous motivation (but not controlled motivation) moderated this mediating pathway by strengthening the association between action planning and automaticity. Previous research already proposed that motivational factors could alter the potential of action planning in fostering an automatic behavioral regulation (Hagger et al., 2016). For example, only individuals with a moderate-to-high self-efficacy toward physical activity were shown to benefit from a planning intervention (Luszczynska et al., 2011). Extending a burgeoning line of research on the relationships between self-determined motivations and goal pursuit (Werner & Milyavskaya, 2019), we observed that the potential of action planning in triggering an automatic behavior regulation turned out to be stronger when autonomous motivation was high (vs low). Given the intertwined relationships between action planning and autonomous motivation (Courtney et al., 2021), several mechanisms could underlie this moderating effect, thought they were not empirically tested here. First, autonomous motivation could strengthen the link between action planning and automaticity, by promoting the enactment of plans (Koestner et al., 2008). Further, autonomous motivation has been shown to favor a *smooth* behavioral enactment, in spite of potential temptations (Leduc-Cummings et al., 2022; Milyavskaya et al., 2015; Werner et al., 2016), which is expected to accelerate the development of automaticity (Verplanken & Orbell, 2022; Wood & Neal, 2016). Second, it is likely that action planning fosters the automatization of the related behavior when the latter is performed for autonomous reasons (e.g., for its pleasure or its perceived importance) (Gardner & Lally, 2013; Maltagliati, Rebar, et al., 2021; Radel et al., 2017). Indeed, behavioral automatization is thought to depend on the rewarding value assigned to the related behavior, with highly-rewarding outcomes triggering a faster development of automaticity (Wood, 2017).

Figure 3. Region of significance of the association between action planning and automaticity, depending on autonomous motivation.



Note. Variables were standardized before being entered in the model.

Strengths and limitations

Among the main strengths of the study are the accelerometer-based estimation of physical activity, the consistency of our results across sensitivity analyses, and the recruitment of a well-powered sample of middle-aged adults. However, some limitations should temper the conclusions that can be drawn from our findings. First, leisure-time was identified thanks to participants' notebook, which may have led to reporting inaccuracies (leisure vs working time). Second, we did not measure plan enactment/behavioral repetition, a variable which could underlie the association between action planning and automaticity (Fleig et al., 2013; van Bree et al., 2016) or that may underlie the moderating role of autonomous motivation (i.e., mediated moderating effect). Third, our measures of action planning and automaticity were general (i.e., toward physical activity in general), rather than targeting specific cues-behaviors links (Sniehotta & Presseau, 2012). Future studies could aim to examine whether behavior-specific action planning is particularly associated to automaticity toward the corresponding behavior (e.g., association of planning to walk on Friday at 5pm with automaticity toward walking on Friday at 5pm). Finally, our variables were not measured following the principle of temporal precedence in mediation analyses (e.g., Yzerbyt et al., 2018). Hence, inferring we cannot infer causality between our variables. Future randomized interventional studies are needed to provide more robust evidence on the causal pathway underlying the effects of action planning.

Conclusion

In search of mechanisms favoring individuals' engagement in protective health behaviors, this study reinforces the key role of action planning in fostering an automatic behavioral regulation of physical activity. It also suggests that the type of motivation hold by individuals may shape this mechanism – action planning may foster an automatic behavioral regulation only when individuals endorse a high autonomous motivation toward the related behavior, which was here physical activity. We thus encourage future studies to consider the boundaries conditions under which action planning and automaticity might synergistically operate on health behaviors. From a practical perspective, our findings suggest that targeting both action planning and autonomous motivation could be fruitful in favoring the engagement in health behaviors, such as physical activity. In lay terms, think about someone who plans to walk after work, every Friday at 5 pm. What are the chances that this behavior could become automatized if they do not truly enjoy walking in the park nearby?

Footnotes

[1]: In this article, we will refer to action planning and this term will be considered here as equivalent to implementation intention (Gollwitzer & Sheeran, 2006). These two terms have often been used interchangeably in previous research, thought their conceptual distinction was previously established (Hagger & Luszczynska, 2014).

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Supplementary material

Table S1. Moderated mediation models with controlled motivation as the moderating variable.

Table S2. Sensitivity analysis with participants having a moderate-to-strong intention to be physically active (N = 85).

Table S3. Sensitivity analysis adjusting for age, sex and body mass index.

Table S1. Moderated mediation models with controlled motivation as the moderating variable.

	β (SE)	***t***	***p*-value**
***a* path**			
Independent variable	.49 (.08)	6.17	< .001
Action planning × Controlled motivation	.03 (.07)	0.38	.703
***b* path**			
Automaticity	.31 (.10)	3.21	.002
Automaticity × Controlled motivation	.05 (.09)	0.59	.558
***c'* path**			
Direct effect	.16 (.10)	1.70	.092
Direct effect × Controlled motivation	-.13 (.09)	1.48	.143
***c* path**			
Total effect	.32 (.09)	3.65	< .001
Total effect × Controlled motivation	-.10 (.08)	1.22	.225

Note. Standardized β coefficients, standard-errors (SE), *t*-values are reported.

Table S2. Sensitivity analysis with participants having a moderate-to-strong intention to be physically active (N = 85).

	β (SE)	***t***	***p*-value**
Simple mediation models			
***a* path**	.31 (.10)	3.00	.004
***b* path**	.26 (.11)	2.30	.024
***c'* path**	.11 (.11)	1.00	.321
***c* path**	.19 (.11)	1.76	.081
Moderated mediation models			
***a* path**			
Action planning	.27 (.10)	2.61	.011
Action planning × autonomous motivation	.20 (.10)	2.01	.048
***b* path**			
Automaticity	.24 (.13)	1.86	.067
Automaticity × autonomous motivation	-.02 (.13)	.01	.893
***c'* path**			
Direct effect	.18 (.12)	1.48	.142
Direct effect × autonomous motivation	.11 (.12)	0.93	.357
***c* path**			
Total effect	.12 (.13)	0.92	.361
Total effect × autonomous motivation	.07 (.13)	0.51	.611

Note. Standardized β coefficients, standard-errors (SE), *t*-values are reported.

Table S3. Sensitivity analysis adjusting for age, sex and body mass index.

	β (SE)	*t*	*p*-value
Simple mediation models			
***a* path**	.45 (.08)	5.45	< .001
***b* path**	.30 (.10)	3.15	.002
***c'* path**	.11 (.10)	1.17	.243
***c* path**	.25 (.09)	2.78	.006
Moderated mediation models			
***a* path**			
Action planning	.28 (.08)	3.45	.001
Action planning × autonomous motivation	.22 (.10)	2.24	.027
***b* path**			
Automaticity	.29 (.11)	2.70	.008
Automaticity × autonomous motivation	.08 (.14)	.09	.601
***c'* path**			
Direct effect	.11 (.10)	1.06	.293
Direct effect × autonomous motivation	.01 (.15)	0.09	.931
***c* path**			
Total effect	.19 (.10)	1.90	.060
Total effect × autonomous motivation	.13 (.12)	1.07	.287

Note. Standardized β coefficients, standard-errors (SE), *t*-values are reported. Any covariate was significantly associated with the dependent variables in these analyses.

Table S3. Sensitivity analysis adjusting for age, sex and body mass index.

	β (SE)	***t***	***p*-value**
Simple mediation models			
***a* path**	.45 (.08)	5.45	< .001
***b* path**	.30 (.10)	3.15	.002
***c'* path**	.11 (.10)	1.17	.243
***c* path**	.25 (.09)	2.78	.006
Moderated mediation models			
***a* path**			
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Automaticity	.29 (.11)	2.70	.008
Automaticity × autonomous motivation	.08 (.14)	.09	.601
***c'* path**			
Direct effect	.11 (.10)	1.06	.293
Direct effect × autonomous motivation	.01 (.15)	0.09	.931
***c* path**			
Total effect	.19 (.10)	1.90	.060
Total effect × autonomous motivation	.13 (.12)	1.07	.287

Note. Standardized β coefficients, standard-errors (SE), *t*-values are reported. Any covariate was significantly associated with the dependent variables in these analyses.