

Habits and self-efficacy moderate the effects of intentions and planning on physical activity

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Objectives. Behavioural intentions as well as action planning can facilitate the adoption and maintenance of physical activity under certain conditions. The present study examined levels of plan-specific self-efficacy and habit strength as possible conditions that may modify this relationship.

Design. As a secondary analysis of a larger randomized trial to improve physical activity, $n = 225$ recipients of a planning intervention were followed up at five measurement points over one year.

Methods. Two-level models were fit. Within-person levels, that is, fluctuations of intention and action planning around person means, were modelled to predict self-reported moderate-to-vigorous physical activity. Moreover, between-person, that is, average person, levels of self-efficacy and habit strength were specified as putative moderators of this relationship.

Results. The within-person intention–activity relationship was moderated by between-person levels of habit strength, yielding a compensatory effect: higher-than-usual intention predicted physical activity only when average activity habit levels were low. The within-person planning–activity relationship was moderated by between-person levels of self-efficacy, yielding a synergistic effect: higher-than-usual planning combined with high average self-efficacy resulted in highest physical activity levels.

Conclusion. Higher-than-usual intention may only be required in the presence of low activity habits. Moreover, high self-efficacy seems to be required to translate higher-than-usual action planning into augmented physical activity because self-efficacious individuals may invest more efforts to enact their plans.

Statement of Contribution

What is already known on this subject?

- Behavioural intentions as well as action planning can facilitate the adoption and maintenance of physical activity.
- If health behaviour is strongly habitual, it may be less under motivational control.
- Self-efficacy can positively influence the process of planning and initiating health behaviours.

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What does this study add?

- Habitual engagement in physical activity predicts physical activity levels irrespective of intentions.
- When habit is weak, a behavioural intention appears to be a useful predictor of physical activity.
- Self-efficacy may be required to translate action planning into augmented physical activity.

Physical activity has been found to have a beneficial impact on health and well-being for virtually everyone (Rhodes, Janssen, Bredin, Warburton, & Bauman, 2017). The pressing need for behavioural change has led to a persistent research effort focused on psychological determinants of physical activity. Health behaviour theories posit the behavioural intention – the motivation to engage in physical activity – to be a proximal antecedent of behaviour change (Conner & Norman, 2015). However, meta-analyses have found only weak relationships between experimentally manipulated intentions and increased engagement in physical activity (Rhodes, & Dickau, 2012). This disconnect, the so-called intention-behaviour gap, describes on the one hand non-intenders who are subsequently active and on the other hand intenders who do not enact their desired target behaviour. For the latter group (i.e., inclined abstainers), a widely recognized technique to bridge the intention-behaviour gap is to form an action plan (Orbell & Sheeran, 1998; Webb & Sheeran, 2006). While forming action plans, individuals mentally link situational cues (e.g., ‘where’, ‘when’) to a behavioural response (i.e., ‘how to become active’; Gollwitzer, 1999). Nevertheless, null-effects and a considerable heterogeneity of effect sizes across planning-intervention studies show that action planning alone is no panacea for improvements in physical activity (Bélanger-Gravel, Godin, & Amireault, 2013). The failure of intentions and planning to fully account for subsequent behaviour change indicates that other psychological factors might moderate this relationship. Such moderating effects may explain: (1) conditions under which individuals engage in physical activity despite their low intentions or lack of action planning and (2) conditions under which good intentions or planning are effective. Possible candidates for such psychological moderators could be habit strength and self-efficacy.

Habit strength as a moderator

So far, health behaviour theories have largely focused on the role of reflective processes in predicting physical activity (Fishbein & Ajzen, 2010). However, habits, defined as learned processes by which a cue generates an impulse to act, are characterized by a high degree of automaticity and efficiency (Lally, Van Jaarsveld, Potts, & Wardle, 2010). Thus, habits are expected to produce behaviour in response to cues more rapidly and effectively than do reflective processes. Accordingly, studies examining if habit strength moderated the influence of reflective processes (i.e., intentions, planning) on physical activity suggest that high habit strength of physical activity may side-step motivational or volitional deficits or make them obsolete (van Bree *et al.*, 2013; de Bruijn & Rhodes, 2011; Gardner, de Bruijn, & Lally, 2011; Maher & Conroy, 2015; Rebar, Elavsky, Maher, Doerksen, & Conroy, 2014). Eight of nine systematically reviewed studies (Gardner *et al.*, 2011) and further studies beyond those covered in the review (van Bree *et al.*, 2013; de Bruijn & Rhodes, 2011) reported that intention was linked to behaviour only among participants with low and medium levels of habit strength, whereas among participants with strong habits, intention was not linked to health behaviour. Moreover, a daily diary study conducted by Rebar *et al.* (2014) found that persons’ average habits

were unrelated to physical activity unless their daily intentions were weaker than usual, suggesting a compensatory effect of behavioural intentions and habits when predicting physical activity (Rebar *et al.*, 2014).

Although research on the role of planning in habit formation suggests that planning and habit act in partial concert (Gardner, Sheals, Wardle, & McGowan, 2014), thus far the moderating effect of habit on the planning-behaviour link has received relatively little attention (Maher & Conroy, 2015). Action plans are assumed to tie situational cues with behavioural responses (Gollwitzer, 1999). Upon frequent repetition, individuals are assumed to internalize these cue-behaviour associations and behavioural control is assumed to shift to situational cues that become sufficient to prompt an automatic response (Gardner *et al.*, 2011). One study examining the moderating role of habit strength for the action planning-physical activity relationship found that participants with strong habits did not benefit from action planning (Maher & Conroy, 2015). In contrast, action planning was beneficial when participants reported weak physical activity habits (Maher & Conroy, 2015). Yet, further research is needed to clarify whether planning becomes superfluous when strong automatic processes take over or whether planning and habit formation are ongoing processes, respectively contributing to behavioural changes.

In the current study, participants formed action plans including individualized information about each activity's contextual cue. Thus, physical activity habits explicitly referred to behaviour within the context outlined by the plans allowing to disentangle mere behavioural repetition performed across contexts from habitual behaviour elicited by contextual cues (Snichotta & Pesseau, 2012).

Self-efficacy as a moderator

Individuals are not only reactive organisms, but proactive ones, anticipating what it will take to fulfil the self-set standards and in turn mobilize their effort and personal resources. Perceived self-efficacy reflects individuals' beliefs in their capabilities to exercise control over a particular task and over their own functioning, and it represents optimistic beliefs about one's capability to cope with barriers that arise during the period of behavioural maintenance (Bandura, 1997). Thus, individuals' self-examination of their own functioning is assumed to predict whether individuals adopt physical activity from positive initial intentions (Bandura, 1997). Accordingly, research investigating the role of self-efficacy in individuals who intended to engage in physical activity found that levels of self-efficacy distinguished between unsuccessful and successful intender profiles (Rhodes, Plotnikoff, & Courneya, 2008). That is, self-efficacious individuals were more likely to successfully translate their good intentions into action than individuals low in self-efficacy (Rhodes *et al.*, 2008).

As reviewed above, ample prior research has found support for planning mediating the intention-behaviour relationship (Webb & Sheeran, 2006). However, conditions for performing physical activity might be unfavourable, such as bad weather or physical discomfort, preventing the person from actually executing the plan. In such situations, self-efficacy is required to overcome obstacles that might derail the intended action, to overcome setbacks and recover from failed attempts to enact the target behaviour, and to stimulate self-motivation repeatedly. Correspondingly, self-efficacy was found to operate as a moderator explaining the relationship between planning and physical activity (Lippke, Wiedemann, Ziegelmann, Reuter, & Schwarzer, 2009; Luszczynska, Schwarzer, Lippke, & Mazurkiewicz, 2011). There is evidence that self-efficacious individuals were

more likely to translate their plans into behaviour than individuals who had low levels of self-efficacy (Lippke *et al.*, 2009; Luszczynska *et al.*, 2011). Findings support this moderation by self-efficacy for both spontaneous (Lippke *et al.*, 2009) and experimentally induced action planning (Luszczynska *et al.*, 2011).

In the current study, self-efficacy is assessed at a very specific, individual level (i.e., individuals' self-selected plans) to account for the idiothetic and specific nature of the self-efficacy construct (Scholz *et al.*, 2005). That is, items to assess self-efficacy precisely reflect the conditions of the specific activity (Scholz *et al.*, 2005).

Between-person vs. within-person processes of behaviour change

Socio-cognitive variables are assumed to contain a relatively stable trait-like component (i.e., between-person) and likewise, a state-like, time-varying component (i.e., within-person). The between-person component reflects differences in study variables between individuals (i.e., person average level across all measurement time points). The within-person component, on the other hand, indicates individuals' variation around their own mean level of a measure (i.e., higher/lower than usual; Inauen, ShROUT, Bolger, Stadler, & Scholz, 2016). Most studies have examined associations among the above-reviewed relationships focusing on between-person differences; however, associations such as the intention-behaviour relationship can and should also be conceptualized as within-person processes (Inauen *et al.*, 2016). Prior research has demonstrated that patterns of associations involving intentions, action planning, and physical activity at the between-person level did not necessarily translate to the within-person level (Bierbauer *et al.*, 2017). Accordingly, Rebar *et al.* (2014) found that whereas person average levels of intention did not moderate the link between average person habit strength and physical activity, within-person fluctuations of intention (i.e., higher or lower intentions than usual) moderated the habit-behaviour link (Rebar *et al.*, 2014). In the present study, within-person levels, that is, fluctuations of intention strength and action planning around person means, were modelled to predict physical activity levels.

Aims and hypotheses

The present study aims to examine the relationships of intention strength and action planning with moderate-to-vigorous physical activity (MVPA). It is examined whether within-person fluctuations, that is, higher or lower than usual levels of intention strength or action planning, are linked to MVPA, as a function of between-person, that is, person average levels across all measurement time points of habit strength or self-efficacy. Based on behaviour change theories (e.g., Fishbein & Ajzen, 2010) and habit formation literature (e.g., Gardner *et al.*, 2011), participants high in between-person habit strength ('H'=Hypothesis; H1a), or self-efficacy (H1b) are expected to report higher MVPA than those with low between-person habit strength, or self-efficacy (i.e., main effects of moderators). Moreover, we propose that higher within-person intention strength (H2a) and action planning (H2b) would yield higher MVPA (i.e., main effects of predictors). In addition, we expect the link between within-person intention strength and action planning with MVPA to vary at different levels of between-person habit strength or self-efficacy (i.e., cross-level interactions). That is, we expect that the relationship of within-person intention strength (H3a) and planning (H3b) with MVPA should be attenuated for participants with high between-person habit strength compared to those with low between-person habit strength. Moreover, the

relationship of within-person intention strength (H4a) and planning (H4b) with MVPA should be more pronounced in individuals with higher between-person self-efficacy than for those with lower between-person self-efficacy.

Methods

Procedure and participants

This study is a secondary analysis from a pre-registered randomized controlled trial (RCT), designed to examine effects of a dyadic planning intervention on physical activity in 346 healthy, heterosexual, and cohabiting couples living in Berlin metropolitan area (Knoll *et al.*, 2017; ClinicalTrials.gov; NCT01963494). Detailed eligibility criteria, recruitment strategies, intervention procedures, and randomization procedures were reported elsewhere (Keller *et al.*, 2020; Knoll *et al.*, 2017).

Participants provided informed consent at baseline. During the intervention session (one week later), participants were randomly assigned to their study role (i.e., target person or partner) and to one of the three study conditions: a dyadic planning condition, an individual planning condition, and a control group (see Keller *et al.* [2020] for the intervention material). For the current study, data of $n = 225$ couple members were analysed who were assigned to the study role of a target person of the two planning-intervention arms of the trial ($n = 111$ from the dyadic planning condition and $n = 114$ from the individual planning condition). Data from target persons of the control condition, who did not form action plans, were not included. In the dyadic planning condition, target persons jointly formed and discussed their plans with their partner. In the individual planning condition, target persons formed their plans alone, while their partner worked on a stone sculpture interpretation task in a separate room. Target persons were instructed to form up to five action plans to increase daily physical activity in a 'when'-'where'-'how' format, followed up by reframing this information in an 'If/When, then' format (e.g., 'When I come home from work, then I will take a brisk 20-min walk in the park'). Subsequently, five assessments were a one-week, 6-week, 19-week, 26-week, and a 52-week follow-up. The study was approved by the last author's Institutional Review Board.

Of the examined sample of $n = 225$ participants (women: $n = 112$, 49.8%), $n = 181$ provided data at the 52-week follow-up (80.44%). Participants' mean age was 38.37 years ($SD = 15.14$, range: 19–78 years). Most participants ($n = 171$, 76%) reported having a high school diploma, and about half reported having a university degree ($n = 97$, 43.1%). The majority ($n = 157$, 69.8%) reported to be currently employed, and $n = 23$ (10.2%) were retired.

Measures

Unless otherwise noted, data were collected at the five post-intervention sessions, and response formats were 6-point Likert scales ranging from 'does not apply at all' (1) to 'applies exactly' (6). Item examples provided below are translated from German.

Moderate-to-vigorous physical activity (MVPA)

Across all follow-up assessments, self-reported physical activity was measured with the Office in Motion Questionnaire (OIMQ; Mader, Martin, Schutz, & Marti, 2006)

which was extended by items measuring housekeeping and work from the extended version of the Physical Frequency Questionnaire (PAFQ; Bernstein *et al.*, 1998). The questionnaire consisted of a list of 55 common physical activities (e.g., 'fast or uphill walking', 'cooking, doing the dishes', or 'basketball') with the option to include up to three additional activities. Participants indicated the number of days (0-7) and the duration (per day) they performed each activity on average over the past 7 days. Data on 38 different physical activities with metabolic equivalent of task (MET) levels of at least 3.0 were used to calculate the MVPA indicator (MET is an objective measure of the ratio of the rate at which a person expends energy; Jette, Sidney, & Blumchen, 1990). In case the total amount of hours reported (i.e., hours of sleep time plus hours spent in wake-time activities) did not sum up to 24 hr per day, a 2-step adjustment was made (Bernstein *et al.*, 1998). First, if the weekly sleep time exceeded 70 hr (i.e., >10 hr per day) or was below 45.50 hr (i.e., <6.5 hr per day), it was truncated to 70 or 45.50 hr, respectively. Second, an *adjustment variable* was computed representing proportional underestimation or overestimation of time spent in physical activity in relation to weekly sleep time and the week's full 168 hr (7 × 24 hr). Subsequently, the participant-reported duration for each physical activity was adjusted by multiplying the participant reports with the adjustment variable. This procedure resulted in a total of 168 week hours (7 × 24 hr) for each participant, when summarizing (adjusted) hours of sleep time and (adjusted) hours spent in wake-time activities. To derive daily minutes of MVPA across the past 7 days, data of the number of days and duration per day were multiplied for each physical activity, summarized across all 38 physical activities, and divided by 7. Univariate outliers were adjusted by winsorizing daily MVPA levels of $z > |3.29|$ to one unit lower or higher than the next lowest or highest value in the distribution (Tabachnick & Fidell, 2007).

Intention strength (Henceforth intention)

Intention strength (i.e., the intensity of participants' commitment to act on their intentions, Rhodes & Rebar, 2017) was assessed using a scale adapted from Sniehotta *et al.* (2005). Participants responded to three general intentional statements: (1) 'I intend to be more physically active during my leisure time (e.g., swimming, walking)', (2) 'I intend to be more physically active during everyday life (e.g., taking the stairs, housework, or gardening)', and (3) 'I intend to travel more frequently on foot or by bicycle'. Cronbach's alpha ranged from .66 to .85.

Action planning (Henceforth planning)

Action planning was assessed with four items using the stem 'During the past 7 days, I have made detailed plans. . .', followed by (1) 'when', (2) 'where', (3) 'how', and (4) 'how often to be physically active' (Sniehotta *et al.*, 2005). Cronbach's alpha ranged from .95 to .96.

Plan-specific self-efficacy (Henceforth self-efficacy)

At the intervention session, self-efficacy was assessed for each of the five plans. Participants responded on a 4-point scale [ranging from 'not true' (1) to 'exactly true' (4)]

to the statement 'I am confident that I will be able to perform my behaviour in the situation exactly as planned' (Scholz *et al.*, 2005). Cronbach's alpha was .43.

Plan-specific habit strength (Henceforth habit strength)

At all follow-up assessments and specific to participants' self-selected plans (i.e., their activity in combination with the contextual cue), habit strength was assessed using the previously validated self-reported behavioural automaticity index (SRBAI), a subscale of the Self-Report of Habit Index (SRHI, Gardner *et al.*, 2012; Verplanken & Orbell, 2003). The item stem 'Being as physically active, *as I have planned it*, is something...' was followed by four statements concerning automaticity (e.g., 'I do automatically' or 'I do without thinking'). Cronbach's alpha ranged from .91 to .94.

Covariates

The following covariates assessed at baseline were included: gender (0 = women, 1 = men), age, and objectively measured body mass index (BMI). Also, a dummy-coded planning condition variable (0 = individual planning condition; 1 = dyadic planning condition) was used as a covariate.

Full measures of psychological variables and five (out of 38) exemplary items for MVPA measure are provided in Appendix S1.

Analyses

Using IBM SPSS 25, descriptive statistics and intraclass correlations (ICC) of study variables and their bivariate correlations were computed. We estimated 2-level models with repeated assessments nested in individuals using Mplus 7 (Muthén, 1998–2012). Repeated assessments of predictor variables (i.e., intention and planning) and habit strength were grand-mean centred and then person-mean centred, creating between- and within-person components (Bryk & Raudenbusch, 2002). The between-person component describes the deviation of a participant's average score from the grand mean (average score across all participants). The within-person component reflects each participants' deviation from their own person mean (i.e., a participant's average score across all assessments). Four separate '*intercept and slope as outcomes*' 2-level models with MVPA as the outcome were fit (Luke, 2004). Models 1a (within-person intention as predictor) and 1b (within-person planning as predictor) included between-person habit strength as the moderator and Models 2a (within-person intention as predictor) and 2b (within-person planning as predictor) included between-person self-efficacy as the moderator. To test for cross-level moderator effects, the random slopes of the within-person predictors (within-person intention or planning) were specified as a function of the between-person predictors (between-person self-efficacy or habit strength). All models were controlled for between-person indicators of the respective predictor (intention or planning), time-dependent variation in MVPA by adding a random linear time slope (coded in weeks following the intervention) to each model, and covariates. A full information maximum-likelihood procedure was applied to keep all available data in the analyses.

Simple slopes for moderators were plotted at their mean and at one standard deviation below and above their mean. This was followed up by simple slope analyses using the Johnson–Neyman technique to examine regions of significance of the simple slopes (Preacher *et al.*, 2006).

Results

Descriptive results

Table 1 displays descriptive statistics and ICCs among study variables. Across follow-up assessments, participants reported to spend a mean of 95.24 ($SD = 78.45$) minutes in MVPA per day. The ICC for MVPA was 0.46 indicating that less than half of the total variance in overall MVPA was explained by between-person differences, whereas the majority of the variance was due to within-person differences and measurement error.

Associations and interactions of within- and between-person predictors with MVPA

Models testing hypotheses are displayed in Tables 2 and 3. In accordance with H1a and H1b, significant associations of between-person habit strength and between-person self-efficacy with MVPA were found. Participants who reported high average levels of habit strength or self-efficacy were likely to spend more minutes in MVPA. Not in line with H2a, within-person intention was not linked with MVPA. In accordance with H2b, within-person planning was positively linked with MVPA. That is, participants who planned more than usual also spent more minutes in MVPA.

In line with H3a, the association between within-person intention and daily MVPA significantly varied as a function of different levels of between-person habit strength. Simple slope analyses (see Figure 1) illustrated that higher-than-usual intention was related to more MVPA in participants with low average habit strength ($b (SE) = 10.75 (2.40), p < .001$) and medium average habit strength ($b (SE) = 4.21 (1.72), p = .026$). In participants with high average habit strength, reporting higher-than-usual intentions was unrelated to MVPA ($b (SE) = 2.33 (2.42), p = .349$). Post-hoc analyses on regions of significance using the Johnson–Neyman technique indicated that within-person intention–MVPA relationships were significant given centred between-person habit strength levels were below 0.09. Not in accordance with H3b, the relationship between within-person planning and MVPA was not moderated by habit strength (see Table 2).

Also not in line with H4a, the relationship between within-person intentions and MVPA was not further moderated by between-person self-efficacy, as indicated by a non-significant intention x self-efficacy interaction (see Table 3). In line with H4b, the association between within-person planning and MVPA differed as a function of between-person self-efficacy, as reflected by a significant planning x self-efficacy interaction ($b (SE) = 11.13 (0.06), p < .001$). Simple slope analyses (see Figure 2) showed that planning more than usual was significantly related to more MVPA in participants who reported high

Table 1. Means, standard deviations, and intraclass correlations

Variables	Range	$M_B (SD_B)$	SD_W	ICC
1 Daily MVPA	0–355.87	95.24 (78.45)	51.08	.46
2 Habit Strength (1–6)	1–6	2.67 (1.07)	0.74	.58
3 Intentions (1–6)	1–6	4.28 (1.18)	0.68	.57
4 Planning (1–6)	1–6	3.49 (1.59)	1.17	.31
5 Self-Efficacy (1–4)	1–4	3.05 (0.35)		
6 BMI	18.11–45.11	25.59 (4.57)		
7 Age	19–78	38.37 (15.14)		

Note. M_B : Mean at the between-person level. SD_B : Standard deviation at the between-person level. SD_W : Standard deviation at the within-person level. ICC: Intraclass correlation.

Table 2. Effects of 2-level models testing the relationship between intention (Model 1a) and planning (Model 1b) with MVPA, moderated by habit strength

	Outcome: Daily MVPA			
	Model 1a		Model 1b	
	<i>b</i> (SE)	<i>p</i>	<i>b</i> (SE)	<i>p</i>
Fixed effects				
Intercept	90.80 (7.37)	<.001	89.89 (7.32)	<.001
Time	−0.06 (0.12)	.613	−0.05 (0.11)	.691
Intention (within)	4.21 (2.94)	.153		
Planning (within)			5.45 (1.59)	.001
Intention (between)	−1.13 (4.28)	.790		
Planning (between)			1.01 (3.83)	.776
Habit Strength (between)	13.51 (3.69)	<.001	13.71 (3.75)	<.001
Intention (within) × Habit Strength (between)	−6.17 (2.55)	.015		
Planning (within) × Habit Strength (between)			0.93 (1.41)	.510
Random Effects				
	Var (SE)		Var (SE)	
Intercept	3131.55 (444.27)	<.001	3048.51 (444.08)	<.001
Time	0.63 (0.30)	.033	.46 (0.28)	.098
Intention (within)	184.48 (145.64)	.205		
Planning (within)			19.56 (39.72)	<.001
Residual	2946.54 (186.76)	<.001	3042.58 (187.99)	<.001

Note. Models controlled for gender, age, body mass index, intervention group, and between-person components of intention, or planning.

(b (SE) = 9.35 (1.46), p < .001) and medium average levels of self-efficacy (b (SE) = 5.39 (1.24), p < .001). Within-person planning was unrelated to MVPA for participants who reported low between-person self-efficacy (b (SE) = 1.42 (1.46), p = .344). Post-hoc analyses on regions of significance using the Johnson–Neyman technique showed that within-person planning–MVPA relationships were significant given centred between-person self-efficacy levels were above −0.24.

Across all models, between-person intention and between-person planning were unrelated to MVPA.

Discussion

Engagement in and maintenance of physical activity requires knowledge about conditions that affect the likelihood of acting on one's own behavioural intentions and plans. This study investigated how within-person intention and within-person planning were linked to MVPA and whether these links varied as a function of between-person habit strength or between-person self-efficacy. As hypothesized, participants who reported higher average levels of habit strength (H1a), higher average levels of self-efficacy (H1b), or more than usual planning (H2b) were more likely to engage in higher MVPA. Not in line with H2a, participants' higher-than-usual intention was not linked to more minutes spent in MVPA. However, when participants reported weak or medium average levels of habit strength,

Table 3. Effects of 2-level models testing the relationship between intention (Model 2a) and planning (Model 2b) with MVPA, moderated by self-efficacy

	Outcome: Daily MVPA			
	Model 2a		Model 2b	
	b (SE)	p	b (SE)	p
Fixed effects				
Intercept	92.57 (7.47)	<.001	90.08 (7.44)	<.001
Time	-0.08 (0.12)	.483	-0.04 (0.11)	.707
Intention (within)	4.51 (3.00)	.132		
Planning (within)			5.47 (1.53)	<.001
Intention (between)	-2.72 (4.39)	.535		
Planning (between)			2.00 (3.89)	.607
Self-Efficacy (between)	26.25 (11.01)	.017	25.23 (6.19)	<.001
Intention (within) × Self-Efficacy (between)	-1.52 (8.03)	.850		
Planning (within) × Self-Efficacy (between)			11.03 (0.06)	<.001
Random effects				
	Var (SE)		Var (SE)	
Intercept	3,194.98 (451.05)	<.001	3,148.87 (3.78)	<.001
Time	0.56 (0.30)	.059	0.38 (0.13)	.005
Intention (within)	217.17 (155.05)	.161		
Planning (within)			0.338 (0.04)	<.001
Residual	2,997.59 (190.40)	<.001	3,099.40 (159.70)	<.001

Note. Models controlled for gender, age, body mass index, intervention group, and between-person components of intention, or planning.

higher-than-usual intention was a significant positive correlate of MVPA, whereas for participants with high average levels of habits, intention was unrelated to MVPA (H3a). Unexpectedly, the relationship between within-person planning and MVPA was not further qualified by participants' habit strength (H3b). Not in line with H4a, the within-person intentions and MVPA association was not further moderated by between-person self-efficacy. However, the within-person planning–MVPA relationship was particularly pronounced among participants with medium or high between-person self-efficacy, whereas it was not observed at low levels of between-person self-efficacy (H4b). That is, higher-than-usual planning combined with high average self-efficacy resulted in highest physical activity levels.

Mirroring the results reported by Bierbauer *et al.* (2017), we found higher-than-usual intentions not being associated with more physical activity. This corroborates a large body of research that has evidenced the existence of an intention-behaviour gap at the between-person level (Rhodes, & Dickau, 2012; Sheeran, 2002; Sheeran & Webb, 2016) leading to the assumption that behaviour is – amongst others (e.g., see for overview Sheeran & Webb, 2016) – guided by non-reflective automatic processes (i.e., habit). Accordingly, in line with prior research, we found that only in the absence of strong physical activity habits, a close association between intentions and physical activity emerged (van Bree *et al.*, 2013; de Bruijn & Rhodes, 2011; Gardner *et al.*, 2011). Habits may render individuals immune to behavioural consequences of low intentions, whereas intentions can translate

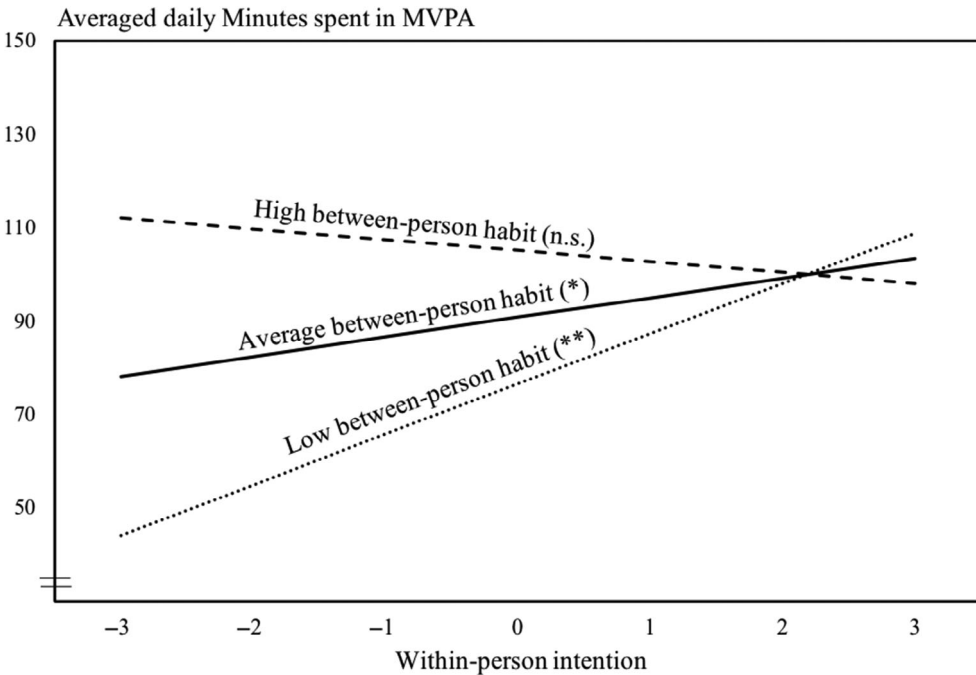


Figure 1. Relationship between fluctuations of within-person intention and minutes spent in moderate-to-vigorous physical activity (MVPA) for low ($M-1SD = -1.06$), average, and high levels ($M + 1SD = 1.06$) of between-person habit strength. Note. n.s.: non-significant. * $p < .05$; ** $p < .01$.

into behaviour when habits are weak. Where habits and intentions conflict, behaviour tends to proceed in line with the habits and not with the intentions (van Bree *et al.*, 2013; de Bruijn & Rhodes, 2011; Gardner *et al.*, 2011). This can be seen as beneficial when strong habits compensate for motivational and volitional deficits in the maintenance or increase of regular physical activity (Gardner *et al.*, 2011). Moreover, increasing intention may be an effective tool for increasing non-habitual behaviour (i.e., varying contexts and activities; Ouellette & Wood, 1998). However, when physical activity levels are low, but strongly habitual, increasing intention may be ineffective for yet necessary behaviour change. Indeed, people who have strong physical activity habits may less likely be in need for a motivational intervention targeting their physical activity. Nevertheless, the present findings underpin the promise of targeting intentions in people who have weak physical activity habits.

Participants who planned more than usual also engaged in more physical activity. This supports findings on the beneficial role of planning for behavioural enactment (Carraro & Gaudreau, 2013). In the present study, spontaneous planning following an intervention was an important physical activity correlate, irrespective of a person's plan-specific habit strength, whereas Maher and Conroy (2015) found that the effectiveness of experimentally formed plans in promoting physical activity depended on general physical activity habit strength. In the present study, habit strength did not refer to general physical activity but to behaviour outlined in the specific action plans themselves, making an interference less likely. Nevertheless, the present results support the assumption that forming if-then plans would supersede weak habits in controlling behaviour (Adriaanse, Gollwitzer, De

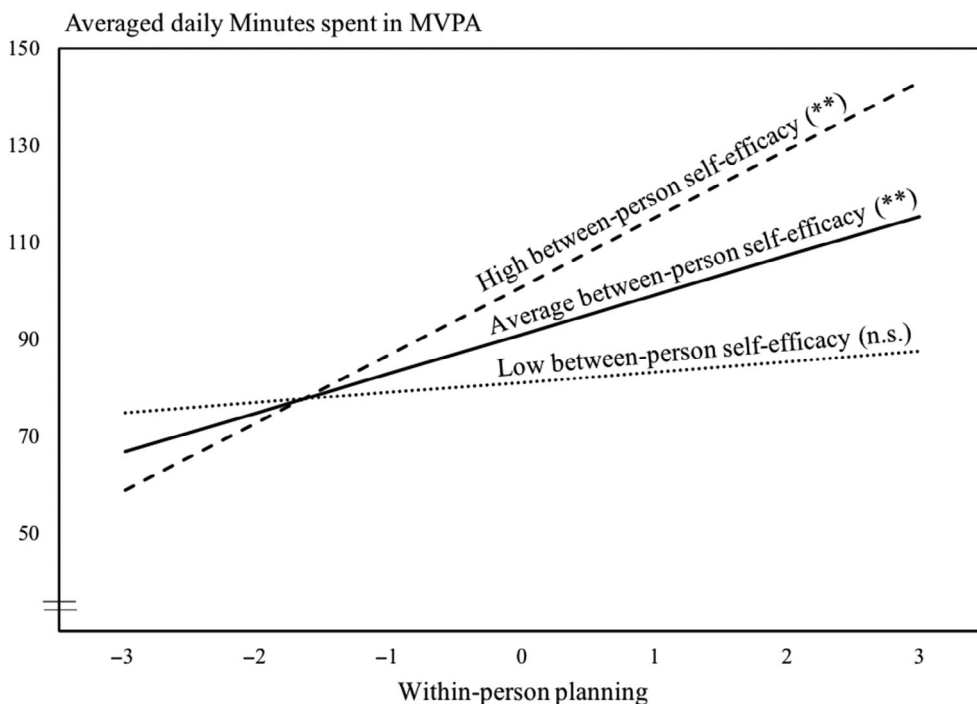


Figure 2. Relationship between fluctuations of within-person planning and minutes spent in moderate-to-vigorous physical activity (MVPA) for low ($M-1SD = -0.37$), average, and high ($M + 1SD = 0.37$) levels of between-person self-efficacy. Note. n.s.: non-significant. $**p < .01$.

Ridder, de Wit, & Kroese, 2011). Likewise, action planning did not become superfluous although automatic processes were strong, suggesting that also people who have strong physical activity habits would nevertheless benefit from action planning intervention to boost their physical activity. Future research should examine more fine-grained dynamics of how planning and habit strength are interrelated and contribute to behaviour change (Lally *et al.*, 2010).

Self-efficacious individuals are assumed to expend more effort in goal pursuit and to be more persistent in the face of setbacks or difficulties (Lippke *et al.*, 2009; Luszczynska *et al.*, 2011; Rhodes *et al.*, 2008). Accordingly, in this study, participants who reported higher average self-efficacy also engaged in more physical activity. Moreover, the combination of high average self-efficacy and more planning than usual resulted in the highest physical activity levels which can be interpreted as a synergistic effect. The more confidence individuals had in their own abilities, the more they benefitted from planning, whereas participants with low average levels of self-efficacy did not translate their plans into action. This finding supports physical activity intervention approaches that focus on instilling confidence in one’s ability to remain active (Keller, Gellert, Knoll, Schneider, & Ernsting, 2016).

Strengths, limitations, and future directions

The current study has several strengths. First, it adds insights on within-person links between physical activity, intentions, and planning following a planning intervention.

The investigation of within-person associations is of particular importance as they can differ from those at the between-person level in size or even direction (Inauen *et al.*, 2016). So far, in research on habits, longitudinal studies spanning one year are scarce. Moreover, very little research has examined the interplay between plan-specific activity habits and the deliberate planning to act on activity intentions. Both habit strength and self-efficacy are assumed to be best captured when referring to specific situations and individualized activities (Scholz *et al.*, 2005; Sniehotta & Premeau, 2012). Accordingly, we assessed plan-specific habit strength and plan-specific self-efficacy referring to individualized self-selected action plans.

However, some limitations also warrant attention. First, the sample consisted of healthy adults in a longer-term relationship who appeared to be more active than the general population (Knoll *et al.*, 2017; Keller *et al.*, 2020; Pauly *et al.*, 2020). Thus, as results may not generalize to less active adults not living in a relationship, replication is needed to infer more definite conclusions. Second, self-reports assessing physical activity are prone to social desirability, recall bias (Sallis & Saelens, 2000), and overestimation of high-intensity physical activity (i.e., MVPA, Prince *et al.*, 2008; Schaller, Rudolf, Dejonghe, Grieben, & Froboese, 2016). Third, we relied on habit strength self-reports that are assumed to capture habit strength merely as a subjective *experience* of automaticity (e.g., perceived ‘fluency’ with which the behaviour was enacted) and thus may not assess the actual habitual process that is harder to identify retrospectively (Hagger, 2019). Therefore, objective measures of physical activity (i.e., accelerometry) and habit strength (i.e., automatic behavioural repetition) should be favoured in future research. Fourth, implied predictive direction remains questionable as within-person associations were based on simultaneous measurement points in time, respectively. Future studies might apply interventional daily diary designs to allow for causal inferences. Fifth, examining the link between planning and physical activity, we cannot conclude whether individuals responded to the cues specified by their action plans. Broad physical activity measures can only serve as a proxy for whether individuals enacted their plans (i.e., plan enactment; Fleig *et al.*, 2017). Future research should measure the degree to which individuals enacted their action plans and how this interacts with self-efficacy and habit strength.

Conclusion

In sum, this study was innovative in its emphasis on the interplay of four psychosocial constructs and their relationships with physical activity. By using multilevel modelling, the study has succeeded in unravelling between-person from within-person components of intentions and planning being related to physical activity under certain conditions of plan-specific between-person self-efficacy and habit strength. This points to possible mechanisms that link higher-than-usual intention to activity when average habits are weaker and that link more than usual planning to activity when average self-efficacy beliefs are stronger.

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Author contributions

Sally Di Maio (Data curation; Formal analysis; Investigation; Methodology; Project administration; Software; Validation; Visualization; Writing – original draft; Writing – review & editing). Jan Keller (Data curation; Formal analysis; Investigation; Methodology; Project administration; Software; Supervision; Writing – review & editing). Diana H. Hohl (Data curation; Investigation; Project administration; Writing – review & editing) Ralf Schwarzer (Methodology; Supervision; Writing – review & editing) Nina Knoll (Conceptualization; Funding acquisition; Investigation; Project administration; Resources; Software; Supervision; Writing – review & editing).

Conflicts of interest

All authors declare no conflict of interest.

Data availability statement

Research data cannot be shared.

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Supporting Information

The following supporting information may be found in the online edition of the article:

Appendix S1. Full measures of psychological variables and exemplary items for the MVPA measure.