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Does action planning moderate the intention-habit interaction in the exercise domain? A three-way interaction analysis investigation

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Abstract Both habit strength and action planning have been found to moderate the intention-exercise behaviour relationship, but no research exists that has investigated how habit strength and action planning simultaneously influence this relationship. The present study was designed to explore this issue in a prospective sample of undergraduate students (N = 415): action planning, habit strength, intention, attitudes, subjective norms and perceived behavioural control were assessed at baseline and exercise behaviour was assessed 2 weeks later. Both habit strength and action planning moderated the intention-exercise relationship, with stronger relationship at higher levels of planning or habit strength. Decomposing a significant action planning × habit strength × intention interaction showed that the strength of the intention-exercise relationship progressed linearly through levels of action planning and habit strength. These novel results show that action planning strengthens the intention-habit strength interaction in the exercise domain: exercise interventions should therefore focus on simultaneously bolstering action planning and habit strength.

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Introduction

Engaging in sufficient exercise has various health benefits, including decreased chances for certain cancers (Leitzmann et al., 2008) and overweight (Donnelly et al., 2009; Kromhout et al., 2001). However, exercise participation rates continue to be suboptimal (Haskell et al., 2007). Models focusing on important and modifiable determinants of exercise behaviour are thought to be relevant for exercise intervention development (Rhodes & Pfaeffli, 2010). One of the most commonly applied theoretical models in this development phase is the theory of planned behaviour (Ajzen, 1991), which theorises that intention (a conscious motivation to act) is the primary determinant of any given behaviour. The intention concept is influenced by attitudes (positive and/or negative evaluations of performance), subjective norms (perceptions of social norms to act) and perceived behavioural control (perceptions of controllability and ease of performance).

Even though the theory of planned behaviour proposes that a positive exercise intention is sufficient for exercise behaviour to occur, recent summary evidence has indicated that intentional control of (exercise) behaviour is more limited than assumed in the theory of planned behaviour (Hagger & Chatzisarantis, 2009; Hagger et al., 2002; McEachan et al., 2011; Symons Downs and Hausenblas, 2005; Webb & Sheeran, 2006). For instance, a summary study of 60 physical activity determinant studies reported a medium effect sized average correlation of .42–.51 between intention and physical activity behaviour (Hagger et al., 2002), suggesting that more than half of the variance in exercise behaviour cannot be explained by exercise intentions (Hausenblas et al., 1997; McEachan et al., 2011; Symons Downs & Hausenblas, 2005). This finding is reflected in a recent synthesis of experimental evidence showing that changes in intention lead to only small-sized changes in behaviour (Webb & Sheeran, 2006). Because most people are not engaging in exercise behaviour without positive exercise intentions (Rhodes & Plotnikoff, 2006), it would appear that those who report positive intentions, but do not act in accordance with those intentions, are the main reason for the intention-exercise gap (Orbell & Sheeran, 1998; Rhodes & Plotnikoff, 2006). Identifying post-intentional factors that can bridge this gap is therefore relevant for better exercise interventions.

Two factors that have been proposed to bridge this gap are exercise habit strength (De Bruijn & Rhodes, 2011; Rhodes et al., 2010a) and exercise self-regulation (Sniehotta et al., 2005a, b). Self-regulation refers to the formulation of action plans (the specification of when, how, and/or where to act in accordance with one's positive exercise intentions) (Sniehotta et al., 2005a, b) and has generally shown beneficiary effects on exercise enactment in diverse samples, including rehabilitation patients (Lippke et al., 2004; Sniehotta et al., 2006), undergraduate students (Milne et al., 2002), and family members (Rhodes et al., 2010b). Furthermore, these interventions have also shown non-significant changes in exercise intention, indicating that self-regulatory strategies indeed act as a post-intentional strategy: they solidify and maintain exercise motivations by providing the *how* to achieve behavioural performance (Norman & Conner, 2005; Sniehotta, 2009).

Although some debate exists on the precise development of habituated performance (Ouellette & Wood, 1998; Wood & Neal, 2007), there is general consensus that habit strength emerges from repetition of behaviour in stable contexts: when behaviour is habituated, it is initiated and executed automatically and without much conscious deliberation upon encountering these contexts (Rothman et al., 2009; Verplanken & Orbell, 2003). Importantly, a recent meta-analysis (Gardner et al., 2011) on the habit strength—health behaviour relationship showed that habits have a summary relationship with health behaviour similar to intentions, affect and self-efficacy. However, research on the role of exercise habit strength in the intention-exercise relationship has been relatively limited in number and less univocal than studies employing self-regulatory strategies. In line with theoretical considerations (Triandis, 1977) empirical evidence in health behavioural domains other than exercise (De Bruijn et al., 2007, 2009) have mostly shown that stronger habits lead to weaker intention-behaviour relationships. For instance, in a study on fruit consumption (De Bruijn et al., 2007), the intention-fruit consumption relationship was seven times stronger at low levels of fruit consumption habit strength than at high levels. Likewise, in a study on active travel habits (De Bruijn et al., 2009) the intention-bicycle use relationship was more than six times stronger at lower levels of bicycle use that at higher levels. However, research on this interaction has shown mixed results in the exercise domain. Whereas cross-sectional data have shown the theorised weaker intention—exercise relationships at higher levels of exercise habit strength (De Bruijn & Rhodes, 2011), studies employing prospective designs have been unable to replicate this finding (Rhodes et al., 2010a, b). More importantly, research has also reported stronger intention-exercise relationships at higher levels of exercise habit strength (Maddux, 1997; Rhodes & De Bruijn, 2010). These counter-theoretical findings have been explained by the fact that vigorous exercise may be potentially aversive due to its strenuous nature (Ekkekakis et al., 2008; Maddux, 1997), therefore requiring substantial motivation even if strong exercise habits have developed (Rhodes & De Bruijn, 2010). As such, strong exercise habits may thus reflect action control, with those who have habituated their exercise behaviour also being better able to translate their exercise intentions into exercise behaviour (De Bruijn, 2011). More research on the interaction between exercise intention and habits is needed to ascertain their independent and interactive role in understanding exercise behaviour: such findings would not only be helpful for informing more effective exercise interventions, but also should be beneficiary for theory development on motivation and habit in the exercise domain.

Although behavioural initiation from a self-regulatory perspective partly mimics behavioural initiation from a habit theory perspective (see (Gollwitzer, 1999) for an extended discussion on this issue), effects of self-regulatory planning and habit strength have often been studied separately (Adriaanse et al., 2010; Holland et al., 2006; Verplanken & Faes, 1999), particularly in the exercise domain. Nevertheless, there appears to be merit in the simultaneous consideration of self-regulation and habitual performance. First, both automatic habits and self-regulatory action planning emphasise the role of contextual cues in behavioural initiation (Aarts et al., 1997b; Gollwitzer, 1999): action planning refers to the cognitive orientation needed to identify relevant contextual cues for behavioural enactment, whereas habit theory proposes that a particular behaviour will be automatically set in motion upon encountering situations that have been frequently paired with this behaviour (Bargh & Chartrand, 1999; Ouellette & Wood, 1998). Given the epidemiological evidence linking environmental factors with increased risk for obesity (Goran & Weinsier, 2000; Van Lenthe & Mackenbach, 2002) and decreased engagement in exercise behaviour (Spence & Lee, 2003), identifying causal pathways between the environment and physical activity behaviours should benefit both theory and practice (Baranowski et al., 2003; Owen et al., 2004).

Second, there is also evidence that self-regulatory strategies may be dependent upon automatic routines (Adriaanse et al., 2010; Holland et al., 2006; Verplanken & Faes, 1999, Webb et al., 2009). For instance, in an intervention study on nicotine dependence (as a proxy for habit strength), implementation intentions and smoking (Webb et al., 2009), results showed that smoking behaviour was reduced significantly amongst participants who had weak or moderate smoking habits, but not amongst those who had strong smoking habits. Further, by linking self-regulatory strategies to critical cues in one's environment, one should be able to suppress the habitual behaviour and instead enact the intended alternative (Adriaanse et al., 2010; Holland et al., 2006; Verplanken & Faes, 1999). In a recent study regarding this idea, it was indeed shown that implementation intentions specifying critical cues were more successful in changing snacking consumption than traditional implementation intentions specifying when and/or where (Adriaanse et al., 2009). At present, however, there is no evidence on how self-regulatory planning and a validated measure of habit strength simultaneously influence the intention-behaviour relationship in the exercise domain.

To summarise, even though the simultaneous investigation of effects of self-regulatory planning and habit strength has proven useful in other behavioural domains, there is a lack of research on this issue in the exercise domain. Given the potential for exercise theory and intervention development, the present study was therefore set up to address the potential three-way interaction between intentions, habits, and self-regulation in the explanation of exercise behaviour. We opted to employ a three-way interaction study rather than a moderated mediation study in order to keep with the theoretical postulations in the theory of planned behaviour and habit theory. That is, whereas some studies have identified circumstances under which planning mediates the intention-behaviour relationship (Wiedemann et al., 2009), habit theory proposes a moderator effect of habit strength on the intention-behaviour relationship (Triandis, 1977). For the purpose of the present study, three hypotheses were formulated. The first two hypotheses related to the singular interaction of planning and habit strength with intention in the explanation of exercise behaviour. Based on prior evidence (Lippke et al., 2004; Milne et al., 2002; Norman & Conner, 2005; Rhodes et al., 2010a, b; Sniehotta et al., 2005a, b), we hypothesised that planning and intention would interact so that the intention-exercise relationship would be stronger at higher levels of self-regulatory planning. Regarding the interaction with habit strength, we expected a significant intention * habit interaction and tentatively hypothesised that the intention-exercise relationship would be stronger at higher levels of exercise habit strength (Rhodes & De Bruijn, 2010). Finally, we hypothesised that a significant three-way habit × planning × intention interaction would emerge and that the strongest intention-exercise relationships would emerge at high levels of both planning and habit strength.

Method

Participants

A prospective online study was conducted amongst undergraduate students who were participating for course credits in a social psychology course from a university in a major city in the Netherlands. Course enrolment was registered for 612 students ($M = 21.6$ (SD = 2.9), 31.7% male) and announcements for participation were made during college hours, course meetings and black board: data were collected via an online survey tool, hosted at the university. Baseline data included measures of planning, habit strength, and variables from the theory of planned behaviour; follow-up data included measures of exercise behaviour. At baseline, data were available from 551 participants ($M = 21.4$ (SD = 2.8), 29.2% male), whereas data at follow-up were available from 415 participants ($M = 21.4$ (SD = 2.9), 26.7% male). Dropout analysis (0 = retained; 1 = dropped out) indicated that females were more likely to drop out, OR = .58, 95% CI [OR = .41, .95], but no other demographics and study variables were significantly related with dropout. The Institutional Review Board approved the execution of this study.

Measures

Exercise behaviour was assessed using the relevant items from the International Physical Activity Questionnaire (Craig et al., 2003), which has been validated against doubly labelled water techniques (Maddison et al., 2007). Participants indicated on how many days in the past 2 weeks they were engaging in vigorous exercise behaviours, which was defined as 'activities that make you breathe deeper and faster and which may make you sweat'. In addition, participants indicated how long they were engaged in these activities on such a day. Multiplying frequency and usual duration computed an average amount of time in exercise activities per week. *Concepts from the theory of planned behaviour* were assessed regarding 'exercising on at least 3 days per week and at least 20 min per bout in the next 2 weeks'. *Intention* was assessed with two items, (1) I intend to exercise on at least 3 days per week and at least 20 min per bout in the next 2 weeks' and (2) 'I am sure I will exercise on at least 3 days per week and at least 20 min per bout in the next 2 weeks' ($\alpha = .96$).

Instrumental attitude was assessed with two items regarding the stem 'I find to exercise on at least 3 days per week and at least 20 min per bout in the next 2 weeks; anchored by 'very good (+3)' and 'very bad (−3)' and 'very healthy (+3)' and 'very unhealthy' (−3) ($\alpha = .84$) and *affective attitude* was assessed with three items regarding the same stem; items were anchored by (1) very pleasant (+3) and very unpleasant (−3), (2) very enjoyable (+3) and very unenjoyable (−3), and (3) very relaxing (+3) and very stressful (−3) ($\alpha = .93$). *Subjective norm* was assessed with five items reflecting perceived norms towards exercising on at least 3 days per week and at least 20 min per bout in the next 2 weeks from parents, friends, partner, fellow students, and roommates (+3 = they find it very important; −3 = they find it very unimportant) ($\alpha = .77$), while *perceived behavioural control* was assessed with two items reflecting ease of performance (+3 = very easy; −3 = very difficult) and controllability (+3 = definitely succeed; −3 = definitely not succeed) ($\alpha = .90$) regarding exercising on at least 3 days per week and at least 20 min per bout in the next 2 weeks. *Planning items* ($\alpha = .94$) were derived from recommendations (Sniehotta et al., 2005b) and previous studies (Rhodes et al., 2006; Van Osch et al., 2009) and questioned respondents about whether they had made detailed plans for the next 2 weeks regarding *where* to exercise, *with whom* to exercise, *when* to exercise, *what kind of sport* to do for exercise, and *how often* to exercise (+3 = totally agree; −3 = totally disagree). *Habit strength* ($\alpha = .95$) was assessed with the self-reported habit index (Verplanken & Orbell, 2003) that consists of twelve items querying participants about key elements of habit strength, including lack of awareness, uncontrollability, and automaticity (Bargh & Chartrand, 1999). Participants answered whether the following items applied to them (+3 = totally agree; −3 = totally disagree): exercising on at least 3 days per week and at least 20 min per bout in the next 2 weeks is something (1) I do regularly, (2) I have been doing for a long time, (3) I do automatically, (4) I do without having to consciously remember, (5) that makes me feel strange when I do not do it, (6) I do without thinking, (7) that would require effort not to do, (8) that belongs to my routine, (9) I start doing before I realize I am doing it, (10) I would find hard not to do, (11), I have no need to think about doing, and (12) that is typically me.

Analyses

Basic descriptives and bivariate correlations were calculated for initial data description. The main analysis employed hierarchical multiple regression analysis, with exercise in minutes per week as the dependent variable and intention and perceived behavioural control (step 1), affective attitude, instrumental attitude, subjective norm (step 2), habit strength and planning (step 3), the three two-way interactions (step 4) and the three-way interaction (step 5) as independent variables. Multicollinearity was investigated using variance inflation factors (VIF); VIF scores > 5 were regarded as indicative of multicollinearity (Tabachnick & Fidell, 2000). The constituent variables for the interaction terms were centred before computing the interaction terms. Significant interactions were decomposed by simple slope analyses (Aiken & West, 1991) and, for the three-way interaction, followed up by slope difference tests using recommended formulations (Dawson & Richter, 2006). Effect size r and f (Cohen, 1992) were used to interpret correlations and the amount of explained variance. Statistical significance was set at $\alpha = .05$.

Results

Basic descriptives

Mean exercise behaviour per week was 131.86 (SD = 174.78) minutes per week, with 55.4% ($n = 230$) being active for at least 60 min per week. Mean values for most study variables were around midscale, with more positive mean scores for affective and instrumental attitude. Large effect sized correlations with exercise behaviour were found for exercise habit strength, perceived behavioural control, and intention and medium effect sized correlations for action planning and affective attitude. Regarding exercise intention, large effect sizes were found for the association with habit strength, action planning, perceived behavioural control, and affective attitude and a large effect was found for the intention–action planning association (Table 1).

Regression and interaction analysis

The initial regression model showed VIF-values exceeding critical thresholds for intention (VIF = 6.19) and perceived behavioural control (VIF = 5.73). Inspection of these variables indicated strong correlations between perceived behavioural control and intention items (range .75–.89). Consequently, given their lowest inter-item correlation ($r = .75$), the final regression model utilised single items for perceived behavioural control (succeed vs. not succeed) and intention (I intend to exercise) in order to assess more precise partial coefficients (Rhodes & Courneya, 2004; Tabachnick & Fidell, 2000). Table 2 reports standardised regression coefficients, F-change values and R^2 for this final regression model. Before the interaction terms were added in the fourth and fifth step, analyses showed that, as predicted, intention, perceived behavioural control, habit strength, and action planning were significant predictors of, and explained 58%

Table 1 Mean scores, standard deviations, and intercorrelations between study variables and demographics

Measure	1	2	3	4	5	6	7	8	9	*M*	SD
1. Exercise (minutes per week)	–									131.86	174.78
2. Intention	.53***	–								.65	1.92
3. Habit	.52***	.78***	–							−.19	1.74
4. Planning	.42***	.54***	.43***	–						.32	1.74
5. Instrumental attitude	.15**	.23***	.22***	.23***	–					2.26	.92
6. Affective attitude	.36***	.62***	.65***	.46***	.46***	–				1.39	1.42
7. Subjective Norm	.06	.22***	.19***	.20***	.19***	.18***	–			.25	.95
8. Perceived behavioural control	.54***	.86***	.78***	46***	.18***	.59***	.13**	–		.51	1.82
9. Age	−.06	−.03	−.03	.00	−.01	.03	.07	−.07	–	21.45	2.96
10. Gender (0 = female; 1 = male)	−.25*	−.17***	−.18**	−.06	.03	−.12*	−.04	−.17**	−.13*		

Scores for theory of planned behaviour concepts ranged from −3 (most negative) to +3 (most positive)

* $p < .05$; ** $p < .01$; *** $p < .001$

variance in, exercise behaviour, indicating a large effect size. Entering the two-way interaction terms showed that the habit*intention and the planning*intention interaction were significant, whereas the habit*planning interaction was not. Entering the three-way interaction in the final step showed that all interaction terms were statistically significant.

Simple slope analysis

The significant habit × intention and planning × intention interactions were decomposed using simple slope analyses. Regarding the habit × intention interaction, these analyses showed that intention was a stronger predictor at high levels ($\beta = .62$, $p < .001$) than at medium ($\beta = .42$, $p < .001$) and low ($\beta = .16$, $p = .024$) level of exercise habit strength. Regarding the planning*intention interaction, a similar pattern was observed with a stronger intention-exercise relationship at high levels ($\beta = .63$, $p < .001$) of action planning than at medium ($\beta = .42$, $p < .001$) and low levels ($\beta = .27$, $p < .001$).

Decomposing the significant habit × intention × planning interaction revealed a nonsignificant intention-exercise relationship at low levels of action planning and habit strength ($\beta = -.08$, $p = .444$) and at high levels of action planning and low levels of habit strength ($\beta = .17$, $p = .111$). Stronger and significant relationships were found at low levels of action planning and high levels of habit strength ($\beta = .25$, $p = .023$) and at high levels of action planning and habit strength ($\beta = .74$, $p < .001$) (see Fig. 1). Follow-up tests revealed significant differences in intention–exercise slopes between low planning–low habit strength and the low planning–high habit strength, $t(413) = 3.75$, $p < .001$, between the low planning–low habit strength and the high planning–low habit strength, $t(413) = 2.59$, $p = .010$, between the low planning–low habit strength and the high planning–high habit strength, $t(413) = 5.79$, $p < .001$, between the low planning–high habit strength and high planning habit strength, $t(413) = 4.32$, $p < .001$, between the high planning–low habit strength and high planning–high habit strength, $t(413) = 5.20$, $p < .001$, between not between the low planning–high habit strength and high planning–low habit strength slopes, $t(413) = -.43$, $p = .67$.

Discussion

The present study was set up to integrate empirical knowledge and theoretical considerations in the post-intentional exercise phase by considering habitual and self-regulatory strategies in the explanation of prospective exercise behaviour. The reported main effects of these variables were in line with earlier research: stronger exercise habits and self-regulatory planning were predictive of engaging in more exercise behaviour, even when statistically controlling for the influence of exercise intention and perceived behavioural control. Given that meta-analytical evidence on exercise determinants has shown that intention and perceived behavioural control are the strongest predictors of exercise behaviour (Hagger et al., 2002), constructs that are able to affect exercise behaviour after these two variables have been taken into account should be both theoretically (Ajzen, 1991) and practically (Baranowski et al., 1998) informative. Further, these two constructs also interacted with intention in the explanation of exercise behaviour: decomposing a significant intention × planning interaction revealed stronger intention–exercise relationships at higher levels of action planning than at lower levels of action planning. These findings are in line with theoretical postulations (Sniehotta, 2009) and earlier evidence from exercise determinant studies (Norman &

Table 2 Unstandardized and standardized regression coefficients and R^2 and F-value for exercise in minutes per week

Step	Predictor	*b* (SE)	*β*	R^2	*F*	Δ R^2	Δ*F*
Step 1				.56	173.32		
	Intention	21.44 (7.35)	.24**				
	PBC	32.64 (7.76)	.34***				
Step 2				.56		.00	.75
	Intention	21.39 (7.88)	.24**				
	PBC	31.52 (7.88)	.33***				
	Instrumental attitude	6.85 (8.90)	.04				
	Affective attitude	2.66 (7.08)	.02				
	Subjective norm	−9.30 (7.87)	−.05				
Step 3				.58	186.73	.02	13.41***
	Intention	6.95 (8.15)	.18*				
	PBC	23.86 (8.12)	.25**				
	Instrumental attitude	7.11 (8.66)	.04				
	Affective attitude	−9.17 (7.33)	−.08				
	Subjective norm	−13.37 (7.77)	−.08				
	Habit strength	23.22 (7.25)	.23**				
	Planning	20.59 (4.90)	.20**				
Step 4				.61	199.57	.03	12.84***
	Intention	16.84 (8.02)	.18*				
	PBC	17.03 (7.91)	.19*				
	Instrumental attitude	.94 (8.43)	.01				
	Affective attitude	.79 (7.26)	.01				
	Subjective norm	−10.03 (7.42)	−.06				
	Habit strength	15.15 (7.10)	.15*				
	Planning	25.48 (4.81)	.25***				
	Habit strength × planning	−7.14 (3.72)	−.13				
	Habit strength × intention	11.50 (2.68)	.22**				
	Planning × intention	10.61 (3.20)	.20**				
Step 5				.62	207.89	.01	8.32**
	Intention	19.79 (8.01)	.17*				
	PBC	16.71 (7.84)	.22**				
	Instrumental attitude	1.07 (8.35)	.01				
	Affective attitude	−1.38 (7.24)	−.01				
	Subjective norm	−9.86 (7.36)	−.05				
	Habit strength	9.49 (7.31)	.10				
	Planning	14.55 (6.09)	.14*				
	Habit strength × planning	−7.64 (3.70)	−.15*				
	Habit strength × intention	13.67 (2.76)	.24***				
	Planning × intention	11.95 (3.20)	.25***				
	Planning × intention × habit strength	3.47 (1.20)	.15**				

PBC perceived behavioural control
* $p < .05$; ** $p < .01$; *** $p < .001$

Conner, 2005) and provide further fidelity that self-regulatory action planning does not only promote exercise behaviour in patient samples (Lippke et al., 2004; Sniehotta et al., 2006) and family members (Rhodes et al., 2010a, b), but should also be employed in exercise interventions in young adults (Conner et al., 2010).

When the significant intention–habit strength interaction was decomposed, findings were also in line with our tentatively formulated hypothesis: intention was a stronger predictor of exercise behaviour at higher, rather than at lower, levels of exercise habit strength. This finding is noteworthy, because it counters theoretical considerations

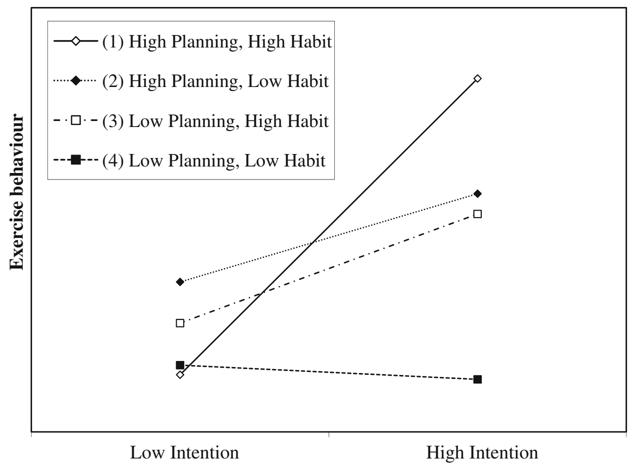

Fig. 1 Slopes for intention-exercise relationship across levels of action planning and habit strength

(Aarts et al., 1997b; Triandis, 1977) and empirical evidence in other health behavioural domains (De Bruijn et al., 2007, 2008), including more moderate activity behaviours (De Bruijn & Gardner, 2011; De Bruijn et al., 2009; Rhodes & De Bruijn, 2010) that suggest limited intentional control of behaviour at high levels of habit strength. As noted, however, the strenuous and effortfulness nature of exercise behaviour may require strong motivational and automatic components simultaneously, rather than a trade-off between these components (Maddux, 1997; Rhodes & De Bruijn, 2010). Apparently, strenuous behaviours may set some boundary limitation on the intention–habit trade-off observed in more everyday behaviours, such as fruit and fat consumption (De Bruijn et al., 2007, 2008) and transport mode choices (De Bruijn et al., 2009). Alternatively, some considerations (Ajzen, 2002) have also proposed that a distinction should be made between automaticity in executing behaviour and automaticity in the decision to take action. It would seem that, for exercise behaviours, the automatic component of habit strength might be more relevant for behavioural decisions (e.g. going for a mountain bike ride at a specific time and place), rather than the behavioural performance itself (Ajzen, 2002; Ajzen & Fishbein, 2001; Rhodes & De Bruijn, 2010; Verplanken & Melkevik, 2008). For behavioural performance, habit strength measures may reflect the importance for action control, with those who have habituated exercise behaviour demonstrating more success in translating their positive exercise intentions into actual exercise behaviour (De Bruijn, 2011; Rhodes et al., 2010a, b).

The final purpose of the present study was to investigate the three-way interaction between planning, habits, and intention in the prediction of exercise behaviour. The decomposition of a significant interaction term showed that the strength of the intention-exercise relationship progressed linearly across levels of action planning and habit strength: the weakest relationship was found at low levels of planning and habit strength, whereas the strongest relationship was found at high levels of planning and habit strength. Thus, stronger self-regulatory planning and exercise habits do not only independently lead to more exercise behaviour and stronger intention-exercise relationships, but also work in concert to produce or solidify the intention –exercise behaviour relation. These findings counter results from an earlier smoking intervention (Webb et al., 2009), where stronger smoking habits decreased the effectiveness of an implemental planning interventions. Although results similar to this latter study have also been reported in the dietary domain (Adriaanse et al., 2010; Verplanken & Faes, 1999), it should be noted that habit strength and self-regulatory strategies have only been studied relatively recent in health promotional research. Moreover, whereas self-regulatory strategies have been studied between behaviours (i.e. planning and habits related to different behaviours, e.g. fruit consumption and snack intake), studies employing habitual considerations of behaviour have often been conducted within behaviours (i.e. intentions and habits related to the same behaviour). Given that habit theory also considers counter-intentional habits as inhibitors of motivational action, future research should also investigate which behaviours have habitual capacities that inhibit action following from exercise intentions.

Although exercise behaviour in itself it linked with chronic diseases and is plagued by low adherence, the limited research on the simultaneous investigation of habits and self-regulation prohibits definite conclusions regarding the pathways that link these constructs with intention and health behaviour in general. Clearly, replications of the interaction between these variables in other health behavioural domains are needed to identify the universality of the present findings or to ascertain whether this effect is affected by relevant moderator variables, such as behaviour type. For instance, within the physical activity domain, intensity of the activity behaviour (i.e. more moderate activities such as walking vs. more vigorous activities such as exercise) has been found to moderate the effect of habit in the intention-activity relationship (Rhodes & De Bruijn, 2010). Likewise, significant interaction effects between intention and habit have consistently been reported in the dietary domain (De Bruijn, 2011; De Bruijn et al., 2007, 2008) and the travel domain (De Bruijn & Gardner, 2011; De Bruijn et al., 2009), but evidence from other health behaviours, such as binge drinking (Norman, 2011), have failed to find significant interactions. Moreover, mixed findings have also been reported with regard to the effectiveness of action planning, with some studies reporting only limited (De Nooijer et al., 2006; Sniehotta et al., 2005a, b) or no effects (De Vet et al., 2009; Koestner et al., 2006; Rise et al., 2003) on behavioural changes. Evidently, habits do not always set boundary limitations on the intention-health behaviour relationship and self-regulatory strategies do not always guarantee behavioural action. Thus, more research on how habits, planning, intentions and behaviour interrelate is needed to better detail the mechanisms of this interaction in order inform and modify behaviour change theories and intervention strategies.

One particularly relevant way to better detail these mechanisms is to experimentally manipulate action planning, rather than assessing it through survey measures. In this respect, Weinstein (2007) has argued that ongoing behaviours (those that people perform regularly) may lead people to create or strengthen their perception of, and the reasons for, their behaviour based on performing the behaviour. Rooted in dissonance (Festinger, 1957) and self-perception (Bem, 1967) theory, these reasons and perceptions may lead to unjustified claims of causes of behaviour, particularly when assessed with survey measures (Schwarz, 1999). For instance, a recent series of systematic reviews reported limited evidence for the influence of environmental factors on obesogenic behaviours based on observational survey-based studies. In contrast, though, when contextual variables were manipulated in intervention research, much stronger effects on obesogenic behaviours were reported (Brug et al., 2006). These results demonstrate that reliance on observational and/or self-reported survey data may lead to misinforming theory and intervention and emphasize that experiments or quasi-experiments should be prioritized in health promotional research (Weinstein, 2007). Whereas the application of self-regulatory strategies in these experimental settings may be straightforward, the promotion of habituation of exercise behaviour is arguably more challenging. That is, self-regulatory interventions typically require the participant to formulate implementation intentions specifying where and/or when to act, with nonsignificant differences in intervention effectiveness between self-generated or experiment-provided implementation intentions (Armitage, 2009).

However, research on habit formation has shown that habituation of exercise behaviour can take up to 90 days (Lally et al., 2009), suggesting that behavioural recurrence is needed for exercise habituation to occur. Further, models on habit development propose that this recurrence should be accompanied by stable and supporting environmental cues (Aarts et al., 1997a, b; Ouellette & Wood, 1998). While these suggestions are in line with ecological models of health behaviour (Kremers et al., 2006; Spence & Lee, 2003), the often-observed large effect size correlation between affect and habit strength (De Bruijn, 2011; De Bruijn & Rhodes, 2011; Rhodes et al., 2010a, b) indicates that promoting affective evaluations may also be beneficiary to habit formation. In fact, considerations and evidence from not only a habit theory perspective, but also from a self-determination theory perspective, have outlined the potential relevance of positive affective responses in human action. That is, not only has positive affect been found to be an implicit motivator of automatic action (Custers & Aarts, 2005), positive affective responses are also viewed as self-determined intrinsic motivations in self-determination theory (Hagger & Chatzisarantis, 2009). Intrinsic motivation reflects the extent to which action is undertaken based solely on experiential positive rewards, such as enjoyment, pleasure and fun (Hagger & Chatzisarantis, 2009; Rhodes et al., 2009). Moreover, recent evidence has indicated that those affective evaluations are strong predictors of activity behaviours (Rhodes et al., 2009) that may influence behaviour outside of conscious intentions (Keer et al., 2010; Lawton et al., 2009, 2007) in a manner similar to how habits affect behaviour (De Bruijn & Van den Putte, 2009; Verplanken & Orbell, 2003). Although these findings indicate that employing affective strategies and persuasive messages should be preferably included in exercise promotion interventions that aim to develop and/or foster strong exercise habits, there is only limited evidence of those strategies actually being employed in exercise behaviour change interventions (Conner et al., 2011; Parrot et al., 2008) and no evidence exists whether these exercise behaviours are maintained for sufficient periods to reach an acceptable level of automaticity (Lally et al., 2009).

Despite its practical and theoretical informative nature, the present study is subject to limitations. The first limitation relates to the self-report measures of exercise behaviour that were employed in the study, which may have led to measurement errors from recall bias (Prince et al., 2008). The second limitation relates to the study population, which consisted of a convenience sample of undergraduate students. Although studies employing population-based samples (Rhodes & Plotnikoff, 2006; Rhodes et al., 2008b) have reported similar intention-exercise relationships as those presented in the current study and research has indicated that there is little evidence for differences in theoretical relationships between undergraduate and other samples (Rhodes et al., 2008a), there is evidence of a positive link between educational level and physical activity levels (Van Lenthe et al., 2004). Consequently, our study sample may have had an overrepresentation of sufficient exercisers. Another limitation of our study was the use of single items for intention and perceived behavioural control that was deemed necessary in order to deal with multicollinearity issues and conceptual and/or measurement redundancy, also based on earlier studies indicating measurement issues between perceived behavioural control and intention (Rhodes & Courneya, 2004). Future studies may need to consider this potential overlap when assessing perceived behavioural control and intention in order to reduce the potential inflation of coefficients, which are particularly evident when motivation is not held constant (Rhodes & Courneya, 2004), thereby potentially misinforming exercise interventions. Also, although the items that were kept for the final analyses directly addressed the domain of the respective constructs, constructs assessed with single items have limited construct validity and psychometric properties (Streiner & Norman, 2003). A fourth limitation of our study relates to the short time period between assessing intentions, planning items and habit strength and follow-up exercise behaviour. Although short time periods are relatively common in studies on exercise behaviour and habit strength (De Bruijn, 2011; Rhodes et al., 2010a, b) and self-regulatory strategies (Milne et al., 2002) and also suggested for research using the theory of planned behaviour (Ajzen, 1991; Ajzen & Fishbein, 2001) in order to allow for more accurate predictions, this short time lag does not provide evidence on how exercise behaviour, intentions, habits and self-regulatory planning have developed across time: studies using cross-lagged panel data are needed to unravel these potential interrelating pathways. One final limitation relates to our use of action planning as the sole post-intentional strategy. There is, however, evidence that preparatory planning (i.e. formulating preparatory behaviours needed for goal achievement) outperforms action planning in the prediction of fruit consumption (Van Osch et al., 2010). Although determinants of fruit consumption and exercise behaviour may differ, these findings do suggest including multiple self-regulation strategies in determinant and intervention studies in order to detect their surplus value in predicting exercise behaviour.

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