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**Date deposited:** 17/06/2010

**Version of file:** Author, final

**Peer Review Status:** Peer Reviewed

## Citation for published item:

Araujo-Soares V, McIntyre T, Sniehotta FF. [Predicting changes in physical activity among adolescents: the role of self-efficacy, intention, action planning and coping planning](#). *Health Education Research* 2009,**24** 1 128-139.

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## Predicting changes in physical activity among adolescents: the role of self-efficacy, intention, action planning and coping planning

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### Abstract

**This paper aims to test the direct predictors of the theory of planned behaviour (TPB), action planning and coping planning as predictors of changes in physical activity (PA) in 157 adolescents (mean age: 12). TPB measures, the Action Planning and Coping Planning Scales (APCPS) and the International Physical Activity Questionnaires were measured at baseline, 2- and 5-month follow-up. Hierarchical regression analyses were conducted regressing PA at Time 2 or Time 3 onto TPB and APCPS at baseline or Time 2, respectively. Past behaviour accounted for a significant 25–51% of the variance in PA in Step 1 of all three analyses. In Step 2, TPB accounted for an additional 3–10% with intention as a significant predictor. While no main effects for action planning or coping planning (Step 3) were found, all three analyses resulted in a significant amount of incremental variance accounted for by the interaction of action planning and coping planning (Step 4). Results suggest that the combination of high levels of action planning and coping planning is associated with increases in PA. Implications for theory of behaviour change in adolescents are discussed.**

### Introduction

A lack of physical activity (PA) is a risk factor for obesity [1], cardiovascular disease [2] and all-cause mortality [3, 4] leading to a tremendous personal and economic burden for developed countries [5]. Physical inactivity is prevalent among adolescents in the United States and in Europe despite governmental recommendations to engage in moderate to vigorous PA on most days of the week [6–8]. Epidemiological evidence also shows that PA decreases with age from early adolescence to adulthood [9, 10].

Effective interventions to increase PA are needed to prevent disease and promote the early development of active lifestyles [11]. There is a broad consensus that the design of behavioural interventions should be based on evidence-based theory, i.e. informed by a thorough understanding of the processes involved in changing and maintaining PA behaviours [12–15]. It has been suggested that trials of complex interventions should be preceded by a theorizing and a modelling phase, including predictive theory-based studies [16]. This paper aims to test the predictive power of the direct predictors of the theory of planned behaviour (TPB) and prospective planning for changes in PA among adolescents over 5 months.

### TPB

There is an abundance of evidence that behavioural intentions and confidence in one's ability to perform a new behaviour are crucial prerequisites of behaviour change [17–19]. The TPB suggests that the proximal determinant of behaviour is one's intention to engage in that behaviour. Intentions

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represent a person's motivation in the sense of a conscious decision to exert effort to perform the behaviour. Together with perceived behavioural control (PBC) or self-efficacy (perceived ability to perform the behaviour), intentions are assumed to determine behaviour [17, 20]. Intentions are conceptualized as a linear function of attitudes (the degree to which performing the behaviour is positively/negatively evaluated), subjective norms (perceived social pressure to perform the behaviour) and self-efficacy/PBC. PBC strongly overlaps with self-efficacy [17, 18] and recent evidence suggests that even state-of-the art measures for both constructs cannot reliably differentiate between the two [21].

A recent meta-analysis supports these assumptions for PA, although the predictive power of the direct predictors of behaviour within the TPB, intentions and self-efficacy, was slightly weaker in adolescents and young adults in comparison to older individuals [22]. The review also shows that few studies have applied the TPB to children and adolescents aged 10–16 and that more conclusive evidence is needed, especially from studies involving longer follow-up periods than 1 or 2 weeks.

Two key problems with the TPB have been identified. Firstly, TPB predicts intentions much better than behaviour [22]. This 'intention-behaviour gap' is mainly due to individuals who hold intentions to act but subsequently fail to enact those intentions [23]. For example, Rhodes *et al.* [24] found that 9- to 11-year-old children reported very high intentions to be physically active every day over the next 3 months while only 13% of them reported actually engaging in daily PA. Secondly, the TPB is better in predicting levels of PA than 'change' in PA [22, 24, 25]. The theory's constructs are determined by past behaviour. When past behaviour is controlled for, the predictive power of TPB is substantially attenuated [22, 25]. However, even controlled for baseline behaviour, TPB contributes to the prediction of changes in PA in children and adolescents [23, 26]. Thus, intentions and self-efficacy do play a role in changing PA behaviours, but are insufficient to fully account for behaviour change. A similar pattern arises from

experimental studies. Interventions that successfully change intentions result in small changes in behaviour [27, 28]. It has been suggested to augment motivational theories by post-intentional volitional variables that explain how people act on their intentions to change behaviour [29, 30]. One of these variables is prospective planning. Planning is particularly promising for health education research as it can be addressed in simple and inexpensive interventions.

### *Prospective plans in self-regulation*

Planning is a prospective self-regulatory strategy that links responses to anticipated situational cues. There is compelling evidence that advance planning of the when, where and how of goal pursuit facilitates the realization of intentions [31]. There are two active components in self-administered planning: firstly, individuals define the means by which they will reach their goals. This can be described as a graded and hierarchical process of goal setting and defining means-end relationships that may guide individual self-regulation. Secondly, the cognitive representation of the link between specified situational cues and behavioural responses (implementation intention) enhances the accessibility of specified cues and automatizes the respective goal-directed responses mediated by cognitive processes [31].

In behaviour change, planning may serve two functions. 'Action planning' refers to the detailed specification of when, where and how to act in accordance with one's intention. It gives individuals alternative responses and activates cognitive processes that utilize situational cues for the intended action [30]. Planning when, where and how to act alone, however, does not address existing automatized contingencies between situational cues and unwanted behaviours (e.g. habitual responses, spontaneous reactions to current demands or social pressure). 'Coping planning' is a barrier-focused self-regulation strategy combining prospective if-then planning with relapse prevention or coping strategies. Coping plans represent a mental link between anticipated risk situations and suitable coping responses which can either be distraction/temptation

inhibiting (i.e. ignoring influences incongruent to the target behaviour) or task facilitating (i.e. increasing effort in the face of impediments) and are formed to shield and augment action plans [32, 33]. Individuals who have planned how to cope with risk situations are more likely to maintain a newly adopted behaviour in the face of difficulties [31, 34–36]. Few studies have tested planning as a self-regulation aid in adolescents. Although not fully conclusive, there is some evidence that similar planning effects may be assumed in adolescents and adults [31, 33, 37].

Recently, several researchers have measured planning as a continuous variable using multi-item scales and integrated them into social cognitive models of health behaviour [38–43]. These studies in adults show that planning adds to the prediction of behaviour over and above social cognitive predictors such as intentions and control beliefs. Although the experimental literature on implementation intentions suggests that planning interventions are moderated by intentions, e.g. instructions to form prospective plans are only effective in individuals that have formed an intention, there is little evidence for moderation of self-reported planning. To date, only Norman and Conner [44] found self-reported planning to be moderated by intentions. Based on the distinction between action planning and coping planning, a possible interaction between these two planning processes has been discussed [36]. Sniehotta *et al.* [32] found that action planning and coping planning were predictive of changes in PA in a sample of adults with heart disease, but they found no evidence for an interaction between intentions and planning or between the two forms of planning. The latter option seems particularly plausible for adolescents, as adolescents may fail to implement their action plans due to situational demands or peer pressure if they do not plan how to shield their intentions and action plans from those influences. Coping planning might add synergistically to action planning by shielding the execution of action plans against barriers for their implementation. Understanding what role planning processes play over and above the TPB predictors in adolescents will facilitate our understanding of

behaviour change in adolescents and strengthen theory [14, 45].

### **Aim of the study**

The present study aims to test the role of self-efficacy, intention, action planning and coping planning as predictors of changes in PA (out of school hours) in adolescents over 5 months. We hypothesize that (i) intentions and self-efficacy will predict PA over and above past behaviour (i.e. predict change in PA); (ii) action planning and coping planning will add to this prediction (all relationships are hypothesized to be positive) and (iii) the interaction of action planning and coping planning will account for incremental variance over and above TPB and planning main effects.

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## **Methods**

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### **Participants and procedures**

The sample of 157 adolescents were recruited at eight schools from the Northern Portuguese districts of Minho, Trás-os-Montes and Douro Litoral in September 2002 and were allocated to the no-intervention control group of a randomized trial [46]. The Regional Health Administration of Northern Portugal selected schools with at least two classes of either sixth or seventh grade that were not enrolled in the European Network of Health Promoting Schools. The mean age of participants was 12.04 years [standard deviation (SD) = 0.95] with a range from 10 to 16 years. About half of them were male (47.8%), 57.9% lived in rural areas. The average body mass index was 19.5 (SD = 3.38).

PA, TPB and planning were measured at the beginning of the school year (September/October; Time 1), 2 months later (Time 2) and 5 months after the initial point of measurement (Time 3). All participants attended Time 1 (pre-intervention) and Time 2 (post-intervention) measurements. In the main trial, Time 3 served as process measurement and the primary behaviour outcomes were measured in an additional follow-up of 6 months after Time 3. Students who were to leave their schools at the end of the year were not included

in the follow-up as they would not be available for the scheduled primary follow-up of the trial, reducing the Time 3 sample to  $n = 105$  (66.9%) [46].

*Measures*

The TPB measures were developed based on previous belief elicitation studies with Portuguese adolescents using recommended techniques for their assessment [47]. Previous pilot studies confirmed reliability, factorial, construct and predictive validity of these measures [47, 48]. Before the items were presented, an explanation of regular moderate to vigorous PA was given. ‘Behavioural intentions’ were assessed by six items, e.g. ‘I intend to engage in regular moderate to vigorous PA in the forthcoming week’. ‘Self-efficacy’ was assessed by 10 items; the stem ‘I am certain that I can engage in regular moderate to vigorous PA in the forthcoming week, even if ...’ was followed by 10 possible barriers such as (i) ‘... I have a lot to do’ or (ii) ‘... I have to say no to friends’ invitations to do other things’. This measure focussed on self-efficacy because controllability items have proven to be difficult for this age group in a pilot study [47]. Attitudes and subjective norm, the indirect predictors of the TPB, were also assessed but are not reported here.

Action planning and coping planning were measured using the Action Planning and Coping Planning Scales [32] adapted to adolescence. Action planning was assessed by four items: ‘I have made a detailed plan regarding (when/where/how/how often) to engage in regular moderate to vigorous PA’. Coping planning was assessed by four items, for example ‘I have made a detailed plan regarding ... (i) what to do when something interferes with my plans (e.g. If I have a test during that week, if my friends want to go out). All items were scored on a five-point Likert scales ranging from completely disagree to completely agree.

Mean values and SD correlations for Time 1, Time 2 and Time 3 and  $\alpha$  coefficients for all scales are displayed in Table I.

PA was assessed with a Portuguese adaptation of the short International Physical Activity Questionnaire (IPAQ; [49]) for adolescents using the ‘last 7-day recall’. From this questionnaire, a measure of ‘general moderate to vigorous physical activity and exercise’ (PA) was derived consisting of a composite score that multiplied the frequency of sessions per week with minutes per session. IPAQ measures in minutes showed high retest reliability ( $r_{T1-T2} = 0.58$ ,  $r_{T1-T3} = 0.53$  and  $r_{T2-T3} = 0.71$ ; Time 1: mean = 94,

**Table I.** Correlations and Cronbach’s alphas for self-efficacy, intentions, action planning, coping planning and PA over the three points of measurement

	2	3	4	5	6	7	8	9	10	11
Time 1										
Self-efficacy $\alpha = 0.86$	0.47**	0.43**	0.26**	0.23*	0.52**	0.37**	0.25**	0.29**	0.19	0.21*
Intentions $\alpha = 0.86$		0.52**	0.38**	0.24*	0.40**	0.61**	0.31**	0.33**	0.34**	0.43**
Action planning $\alpha = 0.90$			0.61**	0.25*	0.27**	0.42**	0.57**	0.51**	0.33**	0.30**
Coping planning $\alpha = 0.75$				0.14	0.17	0.22*	0.50**	0.55**	0.25*	0.33**
PA					0.21*	0.28**	-0.02	0.08	0.58**	0.53**
Time 2										
Self-efficacy $\alpha = 0.89$						0.53**	0.12	0.21*	0.25**	0.20*
Intentions $\alpha = 0.89$							0.32**	0.28**	0.44**	0.48**
Action planning $\alpha = 0.93$								0.79**	0.25*	0.27**
Coping planning $\alpha = 0.84$									0.20*	0.25*
PA										0.71*
Time 3										
PA										

\* $P < 0.05$ ; \*\* $P < 0.01$ .

median = 70, SD = 99; Time 2: mean = 84, median = 45, SD = 0.104 and Time 3: mean = 0.86, median = 45, SD = 102). The skewness of this measure was 0.194 at Time 1, 0.194 at Time 2 and 0.236 at Time 3 and the kurtosis 0.385 at Time 1, 0.385 at Time 2 and 0.467 at Time 3. Since a log transformation did not result in a more favourable distribution and the residuals of change in PA used for the crucial analyses approached normality, the measures were used without further transformation.

## Results

No baseline differences in social cognitive variables and PA were found between participants who completed all three points of measurement and those who did not. While intentions were moderately high at baseline (M = 2.9, SD = 0.9), self-efficacy (M = 1.9, SD = 1.0), action planning (M = 2.3, SD = 1.2) and coping planning (M = 2.0, SD = 1.4) showed average levels (all scales scored 0–4). No changes over the period under study were observed for TPB and planning measures, while a repeated measures analysis of variance indicated that PA was lower at Time 2 than at Time 1 and Time 3 [ $F(2,103) = 11.697, P < 0.001$ ].

At all times, PA was significantly correlated with self-efficacy, intentions, action planning and coping planning except for the insignificant cross-sectional baseline correlation between coping planning and PA (see Table I). Self-efficacy, intentions, action planning and coping planning were highly to moderately intercorrelated at each time point. Action planning highly correlated with intentions and coping planning, while the latter showed slightly lower correlations to intentions.

To examine the predictive power of self-efficacy, intentions, action planning and coping planning for changes in PA, hierarchical linear regression analyses were conducted. All predictors were centred (divided by the mean) before the interaction terms were computed to reduce correlations between the lower order terms and the interaction terms. In the first step, baseline measures of PA (past behaviour) and age were entered into the equation. In a second

step, self-efficacy and behavioural intentions were added. In Step 3, action planning and coping planning, and in Step 4, the interaction term action planning  $\times$  coping planning completed the final model following standard procedures [50]. [The specific power for detecting small effects ( $f^2 = 0.15$ ) in Step 3 given a alpha error level of  $P < 0.05$  is 0.99 for T1–T2 ( $n = 157$ ) and 0.95 for tests involving T3 ( $n = 105$ ). For the interaction term in Step 4, the power is 0.999 for T1–T2 and 0.98 for tests involving T3.] Table II shows the regression of Time 2 PA on Time 1 PA, age, self-efficacy intentions, action planning, coping planning and action planning  $\times$  coping planning interaction. (Interactions between intentions and action planning and between intentions and coping planning were tested for each constellation of measurement points. These interactions were not significant and were not entered into the models to avoid problems of multicollinearity.)

The final model accounted for 28% of the variance in PA 2 months after T1 [ $F(7,149) = 9.712, P < 0.001$ ]. While the inclusion of intentions to the model led to a significant confirming Hypothesis 1, the inclusion of both planning scales did not add incremental explanatory power to the model. This finding contradicts Hypothesis 2. However, the

**Table II.** Hierarchical linear regression of PA at Time 2 onto age and Time 1 measures of PA, self-efficacy, intentions, action planning, coping planning and the interaction term between action planning and coping planning

Step	Time 1 predictors	Beta 1	Beta 2	Beta 3	Beta 4
1	Past behaviour (PA T1)	0.504***	0.460***	0.451***	0.431***
	Age	-0.002	0.021	0.017	-0.001
2	Self-efficacy		0.000	0.010	0.010
	Intentions		0.183**	0.142*	0.122
3	Action planning			0.017	0.042
	Coping planning			0.087	0.078
4	Action planning**				0.146**
	Coping planning				
	$R^2_{\text{change}}$	0.254***	0.032**	0.008	0.020**

Adjusted  $R^2 = 0.281$ .

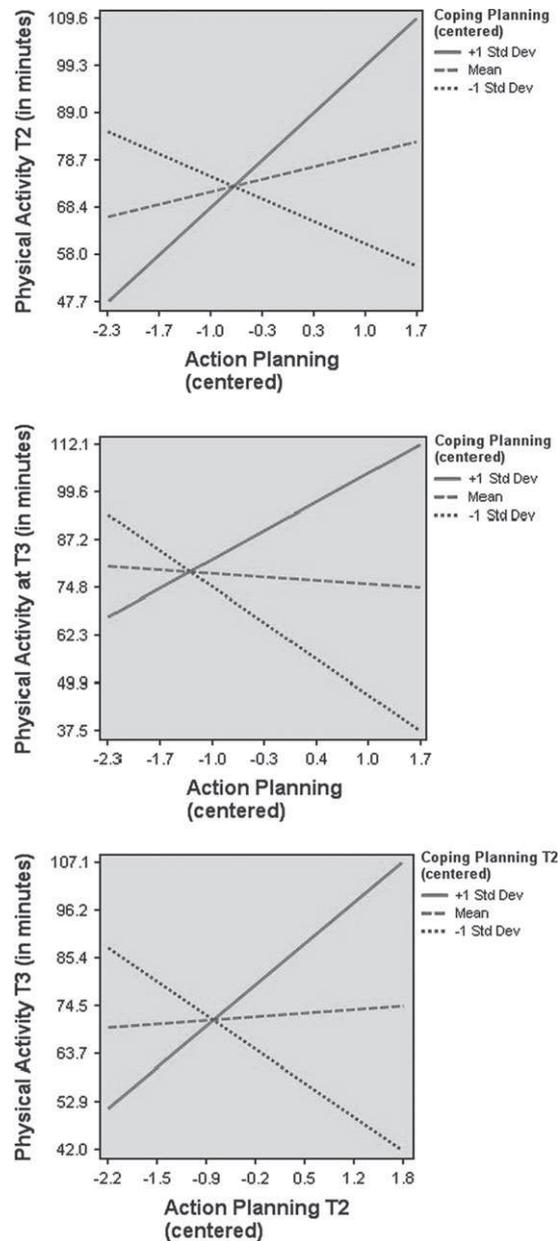
\* $P < 0.10$ ; \*\* $P < 0.05$ ; \*\*\* $P < 0.01$ .

interaction accounted for significant 2% of incremental variance in PA supporting Hypothesis 3. In the final model, past PA was the best predictor of  $PR_{change}^2$  A at Time 2, and the interaction term was the best predictor of change. Age, self-efficacy and intentions did not contribute significantly to the prediction. The simple slopes for the interaction were plotted for the mean and  $\pm 1$  SD of the moderator (Fig. 1). The figure shows that action planning is associated with increases in PA only if matched with high levels of coping planning. The slopes are significant for higher levels of the moderator ( $P_{+3 SD} = 0.02$ ;  $P_{+2 SD} = 0.03$ ;  $P_{-2 SD} = 0.03$  and  $P_{-3 SD} = 0.01$ ) but not at  $\pm 1$  SD or at the mean.

The collinearity statistics show high tolerance values for past behaviour (0.91), age (0.96), self-efficacy (0.78) and the interaction term (0.95) while slightly lower tolerances in intentions (0.66), action planning (0.53) and coping planning (0.60) indicate that a larger proportion of these measures is accounted for by other independent variables in the model. Post hoc analyses leaving out past behaviour, age, intention and self-efficacy (Steps 1 and 2 in the previous regression) of the equation show that both the planning main effects ( $R_{change}^2 = 0.064$ ,  $P < 0.01$ ) and the interaction ( $R_{change}^2 = 0.051$ ,  $P < 0.01$ ) do account for significant variance in PA at Time 2.

Table III presents a similar analysis as Table II, but here Time 3 PA (5 months after T1) was regressed on Time 1 PA, age, self-efficacy, intentions, action planning, coping planning and the interaction term between action planning and coping planning.

The predictors in this model jointly accounted for 39% of the PA variance at Time 3 [ $F(7,97) = 10.482$ ,  $P < 0.001$ ]. As in the previous analysis, intention predicted PA at Time 3 over and above baseline PA, therefore supporting Hypothesis 1. The subsequent addition of action planning and coping planning did not enhance the predictive power of the model, contradicting Hypothesis 2. However, the beta for coping planning approached significance ( $P = 0.055$ ). The inclusion of the interaction term of action planning and coping planning at Step 4 enhanced the pre-



**Fig. 1.** Simple slope analyses for interactions between action planning and coping planning based on Tables II–IV.

dictive power of the model, supporting Hypothesis 3. As in the previous analysis, the interaction term accounted for  $\sim 2\%$  of additional variance in Time 3 PA over and above baseline measures of age, PA,

self-efficacy and intentions. In the final model, intentions and the interaction term between action planning and coping planning were significant predictors of changes in PA (Fig. 1). The slopes for this interaction are significant for low levels of the moderator ( $P_{-3 SD} = 0.03$  and  $P_{-2 SD} = 0.04$ ) but between +1 SD and -3 SD of the moderator (Fig. 1). The collinearity statistics show that tolerances for intention (0.63), action planning (0.47) and coping planning (0.60) indicate some overlap which may account for the non-significance of the planning main effects in Step 3. Post hoc analyses leaving past behaviour, age, intention and self-efficacy out of the equation show that both the main effects ( $R^2_{\text{change}} = 0.122$ ,  $P < 0.001$ ) and the interaction ( $R^2_{\text{change}} = 0.052$ ,  $P < 0.05$ ) do account for significant variance in PA at Time 3.

Table IV presents a similar analysis as Tables II and III, but here Time 3 PA was regressed on Time 2 PA, age and Time 2 measures of self-efficacy, intentions, action planning, coping planning and the interaction term between action planning and coping planning.

The predictors in this model jointly accounted for 54% of the PA variance at Time 3 [ $F(7,97) = 18.425$ ,  $P < 0.001$ ]. As in the previous

analysis, intentions at Time 2 predicted Time 3 PA over and above the Time 2 PA. The subsequent addition of Time 2 action planning and coping planning did not enhance the predictive power of the model, but the inclusion of the interaction term action planning and coping planning at Step 4 did. It explained variance in Time 3 PA over and above the measures of age, Time 2 PA, self-efficacy and intentions. In the final model, intentions and the interaction term between action planning and coping planning were the strongest predictors of changes in PA. The interaction between action planning and coping planning is similar in all three analyses. Action planning is only predictive of PA, if individuals have high levels of coping planning. The slopes are significant for higher and lower levels of the moderator ( $P_{+3 SD} = 0.01$ ;  $P_{+2 SD} = 0.02$ ;  $P_{-2 SD} = 0.03$  and  $P_{-3 SD} = 0.01$ ) but not at the mean or at  $\pm 1$  SD. Again, only intention (0.56), action planning (0.34) and coping planning (0.36) showed tolerance values  $< 0.70$ . Without controlling for the variables in the first two blocks of the regression, both the main effects ( $R^2_{\text{change}} = 0.077$ ,  $P < 0.05$ ) and the interaction term ( $R^2_{\text{change}} = 0.091$ ,  $P < 0.01$ ) accounted for significant variance in T2 PA.

**Table III.** Hierarchical linear regression of PA at Time 3 onto age and Time 1 measures of PA, self-efficacy, intentions, action planning, coping planning and the interaction term between action planning and coping planning

Step	Time 1 predictors	Beta 1	Beta 2	Beta 3	Beta 4
1	Past behaviour (PA T1)	0.521***	0.453***	0.448***	0.421***
	Age	-0.083	-0.050	-0.048	-0.077
2	Self-efficacy		-0.061	-0.067	-0.067
	Intentions		0.345***	0.306***	0.294***
3	Action planning			-0.057	-0.021
	Coping planning			0.193*	0.160
4	Action planning**				0.163**
	Coping planning				
	$R^2_{\text{change}}$	0.283***	0.097***	0.025	0.024**

Adjusted  $R^2 = 0.390$  (0.055).  
\* $P < 0.10$ ; \*\* $P < 0.05$ ; \*\*\* $P < 0.01$ .

**Table IV.** Hierarchical linear regression of PA at Time 3 onto age and Time 2 measures of PA, self-efficacy, intentions, action planning, coping planning and the interaction term between action planning and coping planning

Step	Time 2 predictors	Beta 1	Beta 2	Beta 3	Beta 4
1	Past behaviour (PA T2)	0.711**	0.622**	0.615**	0.593**
	Age	-0.008	-0.010	-0.010	-0.032
2	Self-efficacy		-0.089	-0.097	-0.123
	Intentions		0.250**	0.237**	0.212*
3	Action planning			-0.013	0.015
	Coping planning			0.088	0.093
4	Action planning*				0.147*
	Coping planning				
	$R^2_{\text{change}}$	0.507**	0.039*	0.006	0.018*

Adjusted  $R^2 = 0.540$ .  
\* $P < 0.05$ ; \*\* $P < 0.01$ .

In summary, interaction between action planning and coping planning was significantly predicting behaviour in all three analyses. Intentions significantly predicted behaviour in two out of the three analyses. Self-efficacy and main effects of planning were not significant.

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## Discussion

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This study aimed to test the predictive power of the TPB, action planning and coping planning for changes in PA among adolescents. Over three measurement constellations and a period of up to 5 months, we found a consistent pattern of results. The TPB, in particular behavioural intentions, accounted for variance in PA over and above age and past behaviour and is thus predictive of behaviour change in adolescents. This is in line with previous research [22, 24, 26]. Except for the regression of Time 2 PA on Time 1 predictors, intentions were the strongest predictor of changes in PA supporting Hypothesis 1. Self-efficacy did not contribute to the prediction of PA although there were moderate cross-sectional correlations (0.22–0.25) with PA at all measurement points. The moderately high correlations between self-efficacy and intentions (0.42–0.53 cross-sectionally) suggest that some of the shared variance might have been included in the prediction by intentions. Overall, these findings support the assumption that intentions are a necessary prerequisite to change PA levels during adolescence.

Action planning and coping planning did not add main effects over and above past behaviour, age, intention and self-efficacy although all longitudinal correlations between planning and PA were significant. The tolerance statistics indicated that this might be due to shared variance with measures previously added in the model. Without these controls, action planning and coping planning were predictive of PA. For the 5 months prediction of PA, coping planning approached significance ( $P = 0.055$ ). This might be a weak indicator that coping planning is a better predictor for long-term than for short-term changes [32]. Overall, the data did not

support Hypothesis 2 as no planning main effects on behaviour change were found.

The interaction between action planning and coping planning consistently adds 2% of independent variance accounted for to the prediction of PA over and above the most established and powerful predictors of behaviour: self-efficacy, intention and past behaviour. This pattern has been replicated over three measurement point constellations spanning 5 months. Interactions are difficult to detect in correlation studies [51] and even small effects can indicate important relationships. The findings may be cautiously interpreted as action plans and coping plans operate synergistically. Action planning only relates to increases in PA among adolescents, if they are matched with high levels of coping planning. At low levels of coping planning, action planning may have detrimental effects.

Adolescents may make action plans to increase their PA but fail to implement them because they do not have the means to resist temptations, to be assertive in the face of peer pressure or to cope with a temporary lack of motivation. A recent study by Scholz *et al.* [25] shows how failure or mastery in enacting action plans can affect self-efficacy to perform the plan and that this ‘plan execution self-efficacy’ is an important determinant of successful changes in PA. Adolescents who flank their action plans with coping plans are more likely to resist temptations [33], implement their plans and experience mastery.

High levels of action planning together with high levels of coping planning are associated with changes in PA. This finding emphasizes that competent regulation of behaviour requires planning when, where and how to act, as well as the capacity to disregard competing intentions/goals and behaviours. In order to have the ability to do this, the adolescent needs to be able to inhibit incongruent behaviour. Prospective planning might support the capacity of inhibiting behaviours as a central executive process in self-regulation and a prerequisite for all other executive functioning [52, 53]. In line with this argument, Gawrilow and Gollwitzer [54] found that children with Attention Deficit Hyperactivity Disorder improved their performance

in a response inhibition task when they formed prospective plans (implementation intentions). During adolescence, action planning does not seem to be sufficient to inhibit conflicting behaviour and coping planning might be crucial as adolescents can rely on performing previously planned responses. Thus, coping planning might facilitate the executive processes to inhibit the initial responses to an event by stopping ongoing responses and controlling interferences with ongoing activities. It is therefore advantageous to the adolescent to plan for both the action and the coping with possible obstacles.

The negative action planning–behaviour relationship at lower levels of coping planning can also be interpreted as an ironic effect [55]. (We thank an anonymous reviewer for this suggestion.) According to Wagner’s Ironic Processing Theory, a conscious process that directs attention towards the desired behaviour while a parallel ironic control process is monitoring indicators of failure governs intentional control of thoughts and behaviour. As the ironic control process is thought to be more automatic and less effortful, it can directly produce unwanted effects when the actor is facing cognitive overload or stress [55]. Coping planning might play a role in relieving the burden of coping with barriers at the time of action initiation and thus strengthening the intention–behaviour relationship by releasing resources for conscious monitoring and control efforts.

Predicting changes in PA over 5 months makes the assumption that these changes are more than just random variations. This assumption is supported by findings that PA levels decrease over the course of adolescence [9, 10] as they did over the course of this study. PA was lower at Time 2 than at Times 1 and 3, and the median of PA was lower at Times 2 and 3. This might be due to seasonal influences or to factors not controlled for in this study. These patterns might reflect environmental constraints. The fact that theory-based measures were predictive of changes indicates that changes occurred not just at random. If future intentions to be physically active diverge vastly from current behaviour as in this study, investigating behavio-

ral change becomes an important means in disentangling habits from intentions.

This is the first study that tests the predictive power of action planning and coping planning in adolescents and it provides evidence for an interaction effect between action planning and coping planning. This is in contrast to previous research conducted with adults, which found main effects rather than interactions. These findings indicate that planning processes might play a different role in adolescence than in adulthood. Adults might be more capable of flanking their action plans by generating spontaneous fallback options and self-regulatory strategies generalized from past experiences. Short of this experience, adolescents may only benefit from action planning if they prepare strategies to cope with impediments for their action plans; without coping plans adolescents are likely to fail to enact their action plans and become discouraged.

The findings of this study need replication using experimental designs. Moreover, future studies should incorporate objective measures of behaviour (e.g. accelerometry). Self-report measures for PA are potentially susceptible to bias due to limitations in terms of accuracy of recall [56]. The IPAQ used in this study is among the best-studied self-report measures and validation studies indicate good reliability and acceptable validity with regard to accelerometer measures [49]. The use of the ‘last 7 days’ reference period was chosen to circumvent biases in recall. Children from 10 years on were shown to be able to report PA accurately over this time period [57]. On the other hand, observational measures and the use of monitoring devices can have strong demand characteristics which might affect both behaviour and self-monitoring. The 7-day recall method was here used together with intentions focussing on ‘PA in the forthcoming week’. This causes a correspondence problem as the time lags used in the study were much longer. However, we decided to use these items as our pilot study found that children were less certain about their intentions for longer time periods.

This study identified relationships between theory-based measures and changes in PA among adolescents. The findings suggest that children with

higher intentions and higher joint levels of action planning and coping planning show more favourable changes in PA over time and might be promising targets for interventions. However, correlate predictors are not necessarily determinants or mechanisms of change [57]. These measures are derived from established and evidence-based theories, which justify their tentative interpretation as determinants of behaviour change. The findings of this study do not imply that these constructs play a causal role in behaviour change, but they certainly justify using intentions and planning as targets in intervention studies. Randomized intervention studies are needed to establish if these factors do or do not play a causal role in changing adolescents' behaviour.

The present findings support the conclusion that behavioural intentions and the joint contribution of action planning and coping planning are important determinants of changes in PA in adolescents. These findings enhance our understanding of self-regulation mechanisms in youth and open an agenda for future research that will need to not only replicate these findings but also test if these effects can be utilized for health promotion interventions.

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### Funding

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Regional Health Administration of Northern Portugal (ARS-Norte).

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### Acknowledgements

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The authors wish to thank the Regional Direction of Education North (DREN) for their support and the students, and educators for participating.

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### Conflict of interest statement

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None declared.

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*Received on April 6, 2007; accepted on January 3, 2008*