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Associations between Motivation, Attitudes, and Habit Strength in Physical Activity Behaviour

Natalie Hopkins[1,*], James Benstead[2], Megan Wardle[1], Alison Divine[1]

[1]School of Biomedical Sciences, University of Leeds, Leeds, LS2 9JT, United Kingdom
[2]Faculty of Science, Liverpool John Moores University, Liverpool, L3 5UX, United Kingdom
*Corresponding author: bsnlh@leeds.ac.uk

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Abstract Habits are a process which generate automaticity of a behaviour, therefore, the development of physical activity habits are key for ensuring maintenance. The adoption of physical activity is reliant on deliberate processes such as motivation and attitudes, which are thought to play a key role in the strengthening of habits. The aim of the present study was to assess the psychological variables that are associated with physical activity habit formation. In a sample of 82 adults (Mean age = 32.7 ± 12.5 yr), participants were recruited through advertisements on the University of Leeds campus gym social media accounts (Facebook and Twitter). Participants completed an online survey assessing physical activity motivation, affective and instrumental attitudes, and habit strength. Results showed that habit strength was higher in more physically active participants compared to those less active. Intrinsic (p=0.007), integrated (p=0.001) and identified (p=0.004) forms of motivation were associated with stronger habit strength suggesting that physical activity has an automatic component that is strengthened when behaviour is driven by autonomous motivation. Affective attitudes (p = .001) were positively related to habit strength whereas instrumental attitudes (p = .001) were negatively related. The findings highlight predictors such as motivation and attitude may aid the process of making physical activity automatic by driving repetition of the behaviour at a more autonomic level. Perhaps building upon a person's affective associations (e.g enjoyment and pleasure) of physical activity may result in the strengthening of habits. Physical activity interventions might consider features of habit formation and the antecedents that contribute to the process. Suggestions for possible future directions adopting more methodologically rigorous designs are presented.

Keywords: *physical activity, habits, motivation, affective attitudes, instrumental attitudes, self-determination*

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1. Introduction

Despite the well-known physical and mental health benefits of engaging in regular physical activity [1], many adults in the UK fail to meet the recommend guidelines of 150 minutes of moderate intensity physical activity per week [2]. Public health has attempted to tackle inactivity with the promotion of physical activity interventions [1,3], with little success. One proposed reason for the limited success of previous interventions is that they tend to focus on factors associated with initiation and not maintenance of physical activity behaviours [4].

One such maintenance level construct is habits. [5] Habits are a process which generate automaticity of a behaviour, which occurs as a result of repeating a behaviour in response to the same contextual cue or situation. [6] For example, most individuals will automatically associate attaching their seatbelt after getting into a car. When the behaviour or action is triggered by the contextual cue automatically, the behaviour becomes habitual and is thought to happen outside of conscious awareness. Research has shown that even complex behaviours, such as physical activity, have the ability to develop automaticity if repeated in a consistent context [7,8]. Habit research indicates that the role of reinforcement and rewards can influence the association between the cue and behaviour [9,10]. More specifically, small increases in intrinsic rewards such as enjoyment and satisfaction result in increased habit strength. [11] The development of exercise habits are key for ensuring maintenance. This is particularly true when comparing exercise intentions and habits; research suggests that stronger exercise habits are predictive of higher engagement in exercise behaviour, even after controlling for the influence of exercise intention. Thus, suggesting that the strength of the intention-exercise relationship is moderated by habit strength. [12]

There is considerable variability in the time it takes to develop a habit. Research indicates that it takes 18-254 days for health behaviours to become habitual, with complex behaviours including physical activity, taking 1.5 times longer than more simple health behaviours, such as

eating a piece of fruit with lunch. [13] In addition, there is significant dropout in physical activity, with 50% dropping out within the first 6 months.[14] One of the few studies conducted to quantify time taken to develop a physical activity habit found that new gym members take at least six weeks when engaging in a minimum of four exercise sessions per week. [7] Given the considerable variability in time it takes to achieve an exercise habit there are a number of potential factors that may determine how an individual comes to experience a behaviour as habitual beyond consistency. Indeed, Lally et al [13] found that over half of participants were not able to perform behaviours consistently enough to develop automaticity during intervention. As such, there is potential for additional constructs beyond consistency to influence habit formation. [10,15]

The initial stages of physical activity and exercise adoption are reliant on deliberate processes such as planning, attitudes, self-efficacy, motivation, and intentions. [16,17,18] One construct that has received some research attention is attitudes. Affective attitudes are based on the anticipated affective responses (i.e pleasure/displeasure and/or enjoyment) of the target behaviour whereas instrumental attitudes are based on the expected instrumental outcomes, such as health related benefits. [19] There is a strong body of research that indicates that affective attitudes are predictive of physical activity above instrumental attitudes. [20,21] When people anticipate enjoying physical activity, they are more likely to perform the behaviour and repeat it. Only a few studies have looked at the role between attitudes and habit. Those that have examined this relationship found that positive affective attitudes predicted stronger flossing habits above and beyond frequency of behaviour [15] and increased habit strength for fruit and vegetable consumption. [22] With respect to physical activity, frequency of weekly class attendance was not significantly associated with the automaticity of the decision to re-attend the classes, whereas positive affect was significantly associated with behavioural automaticity. [23] The above findings support the reinforcement role of positive affective attitudes in predicting habit, as a positive reward (i.e enjoyment) does not require conscious deliberation and may drive the behaviour at an unconscious level. [7] Thus affective attitudes may promote the strengthening of habits during the habit formation process by driving physical activity behaviour at an unconscious level. To our knowledge, there is a limited number of studies exploring affective and instrumental attitudes associated with physical activity habit strength and presents a gap in the literature.

Individuals who are regularly active are those who intrinsically enjoy being active. [16,24] Indeed, the few studies that have examined habit formation in physical activity suggest that intrinsic motivation plays an important role in the habit formation process. [11,25] Habit formation of a variety of health behaviours, including physical activity, was found to be partially mediated by self-determined motivation. [25] In addition Gardner & Lally [11] demonstrated both direct effect of more self-determined motivation and indirect effect with past behaviour to predict habit formation.

Self-Determination Theory [26] proposes that motivation can be categorised based on whether it is driven by internal factors (e.g satisfaction or pleasure) or by external demands (e.g avoidance of punishments or seek rewards). The theory proposes a continuum of motivational regulations distinguishing between controlled types of motivation and autonomously motivated regulations. These include: *amotivation,* little or no motivation, *external regulation,* where motivation is regulated by rewards or avoiding punishment, *introjected regulation,* where motivation is regulated by internal pressures directed towards avoidance or attaining a reward (e.g pride, avoid guilt), *identified regulation,* where motivation is regulated by personal value of the activity, *integrated regulation*, where motivation is regulated by self-identification with the activity and *intrinsic regulation*, where motivation driven by satisfaction or inherent interest in the activity. More self-determined types of motivation are associated with sustained physical activity behaviour over time [16] and an increase in physical activity, duration, and intensity. [27] Externally regulated motivation is maladaptive for sustained physical activity and is usually only successful for a short period of time until individuals drop out. [28] Thus, for initiates trying to develop a physical activity habit, the type of motivation may facilitate or impede habit formation. Intrinsic motivation develops over time, as physical activity becomes maintained. [16] Those who are beginning to be more active tend to be motivated less by intrinsic reasons and more so by controlling reasons such as appearance outcomes, ego, or recognition. [29,30] Intrinsic motivation has been associated with strengthening physical activity habits, independent of past behaviour. [11,31] Intrinsic rewards gained from exercising may translate into repeating the action by increasing the reinforcement value of the repeated behaviour. [32] However, exercising purely for intrinsic reasons (e.g enjoyment) is unlikely for many people, particularly for initiates, meaning individuals are perhaps more likely to achieve exercise maintenance when motivated by integrated or identified reasons. [33] If individuals gradually internalise the value of exercise and/or believe that exercise is consistent with their identity, the behaviour will become easier as exercise will be integrated into their personal value system, likely resulting in increased persistence and duration. [27] Exploring the role of all autonomous forms of motivation and the influence on habit formation is necessary as not all individuals will achieve a state of pure intrinsic motivation compared to developing a more autonomous approach to exercise. Autonomous extrinsic motives (integrated regulation) are perhaps more likely to achieve maintenance and strengthen habits as the behaviour is in congruent with their internal support system. [33] Lally and Gardner [10] explored whether intrinsic motives have a tendency to become more strongly habitual, using a relative autonomy index whereby controlled forms of motivation are subtracted from autonomous forms of motivation. [34] This type of measurement for motivation has been criticised as it sacrifices the multidimensionality of motivation and may lose information about the impact of motivation on other variables, research would benefit from measuring individual regulations.

The aim of the present study was to assess psychological variables that are associated with habit

strength for physical activity. There are some studies evidencing the relationship between exercise and habit strength [7], however, to our knowledge, no study has looked directly at predictors of physical activity and the relationship between habit strength and such psychological variables. Affective attitudes, such as pleasure, are associated with the reinforcing properties of behaviours such as eating, though less is understood about affective attitudes and physical activity habits. We hypothesise that the more physically active participants will report stronger habits. We also hypothesise that stronger habits will be associated with more autonomous forms of motivation such as intrinsic regulation. Similarly, we hypothesise that affective attitudes will be positively related to habit strength whereas instrumental attitudes will not be significantly related to habit strength.

2. Methods

2.1. Participants and Procedures

Participants were recruited using social media posts to advertise the research project on a local community and university gym's Facebook and Twitter accounts. Inclusion criteria included being a minimum of 18 years old. Interested participants clicked on the link provided in the social media advertisements, which directed to an online survey. The first page of the survey was a participant information sheet and consent were given when participants click the button that said, "I consent to participate in this research, continue survey". The online survey took approximately 10 minutes or complete. For individuals giving consent, a following set of online questionnaires were to be completed, taking approximately 10-15minutes. Data collection lasted a total of 4 weeks, with the advertisements posted on the social media sites occurring during the first and third week. This study was approved by the University Ethics Review Board.

2.2. Measures

Demographics. Participants self-reported their age, gender, ethnicity, height, weight, level of education and household income (in increments of £5,000 to £30,000).

Physical Activity was assessed using the Godin Leisure-Time Questionnaire. [35] Participants were asked to report their typical frequency of weekly leisure-time physical activity in bouts of 15 minutes or more. The activities were divided into the distinct categories; Strenuous (Heart beating rapidly, sweating. e.g. Running), Moderate (Not exhausting, light perspiration. e.g. Fast walking), and Mild (Minimal effort, no perspiration. e.g. yoga). [35] Weekly frequencies of strenuous, moderate activities were multiplied by nine and five respectively; with the products being summed to produce an overall score for each participant. Comparing results to the cut-off scores provided by Godin [35] the activity level of participants was determined: scores of 24< = Active, 14-23 = Moderately Active, <14 = Sedentary. A mean score and respective standard deviation for all participants was calculated.

Habit Strength was assessed using the Self Report Behavioural Automaticity Index [36]. The SRBAI consists of 4 items on a 5-point Likert scale ranging from 1, "*strongly disagree*" to 5, "*strongly agree.*" Following the stem: "*Physical activity is something…*" and participants rate their agreement with the answers: "*I do automatically*", "*I do without having to consciously remember*", "*I do without thinking*" and "*I start doing it before I realise I am doing it*". The scores were averaged for each participant to create an average Habit strength score. The value represents the strength of an individual's habit along the scale of 1-5, with a higher number showing a stronger habit.

Motivation was assessed with The Behavioural Regulation in Exercise-3 [37,38] was used to measure participant's motivations for exercise. The BREQ-3 questionnaire consisted of 23 items (grouped into the 6 factors of SDT) with a five-point Likert scale. [39] Participants indicated on the scale how true each statement was for them; ranging from 0 (Not true for me) to 4 (very true for me). Subscales scores for each factor of SDT (Amotivation, External, Introjected, Identified, Integrated and Intrinsic Regulation) were calculated. The BREQ-3 is a valid and reliable instrument for measuring an individual's behavioural regulation of underlying self-determination theory in the exercise domain. Within the current study all subscales demonstrated reliability with Cronbach alpha between 0.78 -0.93.

Affective and instrumental attitudes was measured using a bipolar adjective scale which has been used successfully in previous studies. [40,41] This scale assessed the instrumental (worthless – valuable, harmful – beneficial, unimportant - important, unhealthy - healthy, bad - good) and affective (enjoyable – unenjoyable, pleasant – unpleasant, pleasurable – painful, invigorating - exhausting) components of attitude towards exercise. Participants were asked to rate each item based on the statement that precedes the adjectives, which was: "For me to participate in regular exercise is". Each statement was rated using a nine-point Likert scale, one relating to the negative component, e.g. unpleasant and nine relating to the positive component, e.g. enjoyable, apart from one statement that was reversed. Instrumental and affective scores were calculated separately by summing all statements from the different components and dividing by the number of statements making up the relative component.

2.3. Analysis

Differences in habit strength. Reported habit strength scores were used to separate the participants into 2 different Habit category groups for testing. Group 1 (n=33) included participants with low habit scores of 2.75 and below. Group 2 (n=49) included participants with high habit scores at 3.25 and above. This choice was made for 2 reasons; both inclusion values are just above and below the median score of 3, as well as the division allowing for fairly equal group sizes, improving representativeness of future comparison. To assess the differences in type of motivation for high and low strength habits a one-way (group: high and low habit strength) Multivariate Analysis of Variance was used. Habit strength category was entered

as a fixed factor, compared against the other 6 sub-scales of motivation, affective and instrumental attitudes.

2.4. Predicting Habit Strength

A hierarchical regression was conducted to assess the role of motivation, affective and instrumental attitudes predicted exercise habit beyond the role of physical activity. Physical activity levels was entered in the first step, with the six subscales of motivation, affective and instrumental attitudes entered in the second step.

3. Results

A total of 82 (Mean age = 32.7 ±12.5) participants completed the online questionnaire. Demographic information for the total sample and for each habit strength group are presented in Table 1. Those with stronger habit strength were significantly more active (t= 2.72, p =.008) than those with a weaker habit strength. The groups did not differ on education, income, or age. Means and standard deviations for self-reported habit strength and motivation are presented in Table 2.

3.1. Relationship between Determinants and High or Low Habit Strength

Multivariate tests indicated that there is a significant difference in motivation between those who have a stronger and weaker habit ($F_{(7,74)}$ = 2.386, p=0.029, and η^2 = 0.184). Specifically, those with stronger habit strength endorsed being motivated to a greater extent by identified regulation, ($F_{(7,74)}$ = 8.896, p=0.004, and η^2 = 0.100); integrated regulation, F (7,74) = 13.380, p=0.001, and η^2 = 0.143; and intrinsic regulation ($F_{(7,74)}$ = 7.683, p=0.007, and η^2 = 0.088) than the weaker habit strength group. There were no significant differences in amotivation ($F_{(7,74)}$ = 1.246, p=0.268, and η^2 = 0.015); external regulation ($F_{(7,74)}$ = 2.730, p=0.102, and η^2 = 0.033) and; introjected regulation ($F_{(7,74)}$ = 0.913, p=0.342, and η^2 = 0.011) between habit strength groups.

Table 1. Demographic Information for all participants with completed data combined and divided into habit strength categories

Characteristic	Total Sample (N=82)	Low habit score (n=33)	High habit score (n=49)
Age	32.7 (12.5)	35.6 (12.8)	30.7 (11.9)
Height (cm)	169.3 (9.7)	169.7 (9.1)	169.1 (10.1)
Weight (kg)	71.2 (21.5)	78.4 (24.4)	66.3 (17.7)
Gender N (%)			
Female	60 (73.2)	25 (75.5)	35 (71.4)
Ethnicity N (%)			
White British	77 (93.9)	30 (90.9)	47 (95.9)
Income N (%)			
<£10,000	5 (6.1)	1 (3)	4 (8.2)
£10,000 - £15,000	6 (7.3)	1 (3)	5 (10.2)
£15,001 - £30,000	17 (20.7)	8 (24.2)	9 (18.4)
£30,001 - £50,000	25 (30.5)	13 (39.4)	12 (24.5)
£50,001 - £70,000	15 (18.3)	3 (9.1)	12 (24.5)
£70,001 - £100,000	12 (14.6)	6 (18.1)	6 (12.2)
£100,001 <	2 (2.4)	1 (3)	1 (2)
Education N (%)			
GCSE	1 (1.2)	0 (0)	1 (2)
A Levels	9 (11.0)	3 (9.1)	6 (12.2)
Bachelor's Degree	36 (43.9)	15 (45.5)	21 (42.9)
Master's Degree	23 (28.0)	9 (27.3)	14 (28.6)
Certificate/Diploma	5 (6.1)	2 (6.1)	3 (6.1)
Doctorate	6 (7.3)	3 (9.1)	3 (6.1)
None of the Above	2 (2.4)	1 (3)	1 (2)
Physical Activity M (SD)	48.20 (26.23)	39.68 (18.28)	53.93 (29.24)
Active N (%)	71 (86.6)	27 (81.1)	44 (89.8)
Moderately Active N (%)	8 (11.0)	4 (12.1)	5 (10.2)
Sedentary N (%)	2 (2.4)	2 (6.1)	0 (0)

Note: Means (SD) presented unless otherwise noted.

Table 2. Means and standard deviations for Habit strength and Motivation scores, for all participants and respective habit category groups

Variable	Overall Participants (N=82)	Low habit score (n=33)	High habit score (n=49)
SRBAI			
Habit strength score	3.1 (1.1)	1.9 (.5)	3.8 (.6)
BREQ-3			
Amotivation	.17 (.46)	.24 (.49)	.13 (.43)
External Regulation	.76 (.84)	.94 (.90)	.64 (.77)
Introjected Regulation	2.22 (1.13)	2.07 (1.10)	2.31 (1.15)
Identified Regulation	3.11 (.78)	2.81 (.88)	3.31 (.64)
Integrated Regulation	2.53 (1.25)	1.96 (1.40)	2.92 (.97)
Intrinsic Regulation	2.92 (.97)	2.58 (1.16)	3.16 (.75)

Note: SRBAI, Self-report Behavioural Automaticity Index; BREQ-3, Behavioural Regulations in Exercise Questionnaire -3.

Table 3. Results of the Hierarchal Multiple Regression

Variable	Standardized βeta	Standard error	*p*-value	95% confidence interval
Step 1				
Physical activity	.365	.005	.001	.007 - .028
Step 2				
Physical activity	.142	.006	.153	-.496 -3.099
Amotivation	.118	.292	.364	-3.16 - .850
External Regulation	.003	.251	.982	-.311 - .798
Introjected Regulation	-.036	.108	.756	-.250 - .182
Identified Regulation	.139	.293	.471	-.373 - .798
Integrated Regulation	.121	.168	.514	-.225 - .445
Intrinsic Regulation	.062	.062	.751	-.421 - .581
Affective attitudes	.544	.105	.001	.146 - .567
Instrumental attitudes	-.502	.097	.001	-.550 - -.162

3.2. Motivation and Attitudes as Predictors of Habit Strength

Results of the linear regression assessing predictors of habit strength demonstrated that at step 1, physical activity significantly contributed to the regression model ($F(1,72) = 11.09$, $p = .001$) explaining 12% ($R^2 = .12$) of the variance in habit score. Physical activity had a positive moderate relationship with habit strength ($\beta = .365$, $p = .001$). Motivation, affective and instrumental attitudes was added to the model at stage 2 and accounted for an additional 21% of the variance in habit strength ($\Delta R^2 = .34$). Affective attitudes was positively related ($\beta = .544$, $p = .001$) and instrumental ($\beta = -.502$, $p = .001$) attitudes were negatively related to habit strength. However, physical activity was no longer a significant predictor ($\beta = .142$, $p = .229$) of habit strength. Motivation regulations were also not significant predictors of habit strength (Table 3).

4. Discussion

This study explored the role of motivation and attitude on habit strength for physical activity. We first hypothesised that the more physically active participants would report stronger habits. Results supported the prediction that stronger habits are associated with more active individuals and weaker habits are associated with less active behaviour patterns as there was a positive moderate relationship between physical activity and habit scores. These findings are in support of previous research; for example, Rhodes, Bruijn and Matheson [12] distributed measures of habit and intention to 153 undergraduate students and found that 70% of individuals with strong habits engaged in regular physical activity in comparison to low habit students who were classed as inactive and did not intend to be active. The literature addresses that habits play an important role in predicting physical activity behaviour, as automaticity is positively associated with easier enactment of behaviour [10] and therefore physical activity is likely to be regulated by non-conscious processes (i.e habits). [42] Interest in understanding possible factors that may influence automaticity and habit strength of physical activity has increased, in attempt to increase adherence of physical activity patterns in the general population. The current study supports the notion that physical activity has an automatic component and when strong habits are built, individuals are more likely to repeat the behaviour than if habits were weaker. Therefore, as the automaticity of physical activity increases, individuals are less reliant on the conscious and effortful drives, such as memory and planning, and the behaviour is likely easier to perform. These findings support previous research that habits are a mechanism for behaviour maintenance, as habitual behaviours are performed frequently and often self-sustained. [15]

Secondly, we hypothesised that stronger habits would be associated with more autonomous forms of motivation. Our results supported the hypothesis as identified, integrated, and intrinsically motivated individuals shown evidence of stronger physical activity habits. As individuals develop automaticity for exercise behaviour and therefore habit strength is increased, motives for exercise behaviour are likely to be more self-determined. Our findings are consistent with Gardner and Lally [11] who found that frequently active participants reported stronger habits when more autonomously motivated, independent of past behaviour and therefore larger intrinsic reward of the behaviour might strengthen the relationship between behaviour and habit. In addition, Phillips et al [31] found that intrinsic rewards (e.g enjoyment and stress reduction) promoted exercise repetition in initiates but promoted habit strength in maintainers. Similarly, the study findings add to the literature understanding of the relationship between strong habits and identified and integrated regulation, suggesting that autonomous extrinsic motives promote behavioural automaticity and likely play a role in the strengthening of physical activity habits. The current literature predominately states that intrinsic regulation is highly linked to habit strength [11,31], whereas our results suggest that all three autonomous forms of motivation (integrated, identified, and intrinsic) are equally as important. Given that intrinsic motivation is rarely achieved for many individuals [33], to achieve long-term maintenance, public health should perhaps focus less on promoting exercise purely for fun and enjoyment and foster the internalisation process to promote identified and integrated regulation. That is, the creation of an identity around exercise, for example fostering the belief that exercise is part of 'who I am'. If individuals truly identify with and integrate exercise into their personal value system, they are more likely to develop automaticity due to consistency and repetition. [27,33] For instance, regular exercises no doubt value the benefits of physical activity which has likely resulted in the behaviour being incorporated into their sense of identity. For initiates,

interventions could work by integrating exercise into a person's personal value system, perhaps introducing goal setting to establish exercise-related goals in order to influence the person's exercise identity. Therefore, intrinsic motives will likely develop over time as individuals internalise the value of physical activity and incorporate exercising into their sense of identity.

We lastly hypothesised that affective attitudes would be positively associated with habit strength whereas instrumental attitudes would not be associated. This hypothesis was supported, affective attitudes were positively related to habit strength whereas instrumental attitudes were negatively related to habit strength. These findings are in line with previous research which has found that when behaviour is thought of as pleasurable and satisfying the frequency of fruit and vegetable consumption increased. [22] Wiedemann and colleagues [22] findings draw upon the reward aspect of food and the impact on habit, such as the pleasurable taste of food facilitating learning of the context-behaviour relationship and the greater the reward, the larger the incentive to repeat the behaviour. However, we know that exercise as a behaviour is more complex and does not necessarily produce rewards for individuals, particularly initiates, instantaneously and physical activity does not necessarily feel pleasurable for individuals with no experience of exercise. Negative feelings caused by unfavourable experiences result in conscious deliberation before performing the behaviour whereas positive associations, such as affective attitudes, result in repetition of a behaviour at an unconscious level. Humans tend to prioritise instant gratification, i.e intrinsic rewards, over long-term health considerations i.e instrumental associations. [43] Findings of intervention studies comparing affective messages and instrumental/cognitive messages of exercise behaviour support this contention. [20] Affective messages (individuals smiling during exercise) consistently resulted in higher levels of exercise compared to instrumental messages (diagrams of a heart). These findings indicate that utilising the positive association between affective attitudes and habit strength, by targeting affective judgements, could aid habit formation, as affective judgements will drive repetition of exercise at a more unconscious level. Targeting affective attitudes would be beneficial in inactive populations as research on gym members indicates that positive affect and consistency are the largest predictors of people starting a habit. [7] Inactive individuals would gain the largest health benefits from adopting exercise into their lifestyle and to avoid drop out, which is common in initiates, building on antecedents for habit formation, such as affective attitudes, means there is less chance for the habit formation process to be disrupted resulting in strong, healthy habits formed. The development of strong physical activity habits are instrumental for a person's health, to avoid the negative consequences of inactivity and live a healthy lifestyle.

There are some limitations of the current study that must be acknowledged. Firstly, the cross-sectional design of the study prevented understanding of whether participants with strong habit strength had developed as a result of being autonomously regulated. As motivation is considered a dynamic construct which tends to fluctuate over time, for example motivational profiling research indicates that there is often a combination of motivational mechanisms operating simultaneously [44], collecting data at more than one time point would be beneficial to build a more rounded picture of the variables that influence the habit formation process. Indeed, to understand whether there is a causal relationship between habit strength and motivational regulations, or whether both constructs develop independently. Therefore, fully capturing the direction of effect on habit formation can only be assessed through longitudinal methodologies. It is also important to mention that the main methodological measure was self-report and although self-report measures have many benefits, utilising more objective measures, such as cue-response associations to track habit formation, would enhance robustness of the research.

In summary, habit strength was significantly associated with more physically active participants suggesting that habits strengthen as physical activity becomes maintained. The results also offer important indications that autonomous forms of motivation (identified, integrated and intrinsic regulation) are associated with strong habits compared to weaker habits. This suggests that autonomous forms of motivation may be crucial in the habit formation process as physical activity is more likely to be repeated due to the internal importance and pleasure of the behaviour. The findings may inform the development and improvement of physical activity promotion interventions by highlighting the importance of the autonomous motives in habit strengthening. Promoting an autonomy-supportive approach may aid intervention success by increasing interest and engagement in physical activity, resulting in enhanced repetition, and proliferating the habit strengthening process. Indeed, physical activity interventions promoting self-determined regulation and intrinsic rewards such as enjoyment and stress reduction may increase habit strength and improve the likelihood that the behaviour will be maintained over time. Our findings also present potential relationships between affective attitudes and habit strength, whereby positive affective attitudes are associated with habit strength in comparison to instrumental attitudes being negatively associated. Our findings contribute to previous research suggesting that predictors such as motivation and attitude may aid the process of making physical activity automatic. The results point to potential research avenues to further explore in order to apply theory into practice and develop successful interventions to encourage a healthier and more active lifestyle to a range of population groups.

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Competing Interests

The authors have no competing interests.

List of Abbreviations

SDT: Self-Determination Theory

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