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Perceptions of active and inactive prototypes are associated with objective measures of physical activity in adolescents

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ABSTRACT

The benefits of physical activity are known, but the proportion of adolescents meeting daily activity guidelines remains low. The Theory of Planned Behaviour (TPB), which assumes reasoned intentions explain actions, is a useful framework for predicting activity, but it leaves variance unexplained. The Prototype Willingness Model (PWM) which builds on the TPB, proposes a reasoned action pathway and a second social reactive pathway in which perceptions of social images, or prototypes, explain actions via behavioural willingness. We explored whether variables in the PWM's social reactive pathway explained variance in an objective measure of daily activity, over and above the reasoned action path. Participants aged 12–13 (n = 205) were invited to complete measures of constructs in the PWM and to wear an accelerometer for the next seven days. Overall, 126 students (65 males) participated. Reasoned intentions, attitudes and subjective norms explained 12.8% of variance in activity. Prototype perceptions and willingness explained an additional 13.1% of variance. Participants' perceived similarity to active prototypes, and unfavourable perceptions of inactive prototypes, significantly predicted activity. There were no significant differences between sexes on psychological variables. These findings highlight the importance of targeting prototype perceptions to encourage physical activity in this age group.

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Prototype Willingness Model; adolescent; physical activity; accelerometry

Introduction

Public health guidelines recommend that young people complete 60 min per day of moderate-to-vigorous physical activity or MVPA (World Health Organization, 2010). This is the type of activity that raises the heart and breathing rate: examples include brisk walking or running. Yet the global proportion of young people aged 11–17 achieving the recommended target is low, at around 22% of boys and just 15% of girls (Guthold et al., 2020). In Britain and around the world, there is evidence that young people become less

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active as they move through adolescence (Inchley et al., 2016). Evidence for successful strategies to increase physical activity (PA) in this age group is mixed, but stronger effects are found in programmes based on theories that aim to predict PA in relation to a set of psychological constructs such as attitudes and intentions (Craike et al., 2018). Exploring theories that might identify successful intervention targets in this age group is therefore important (Michie et al., 2008).

Much previous work has used the Theory of Planned Behaviour (TPB) to explain and predict PA (Hagger et al., 2002; McEachan et al., 2011). In this model, individuals' attitudes (their positive and negative evaluation of a behaviour); subjective norms (perceived social pressure from friends or family to engage in or abstain from the behaviour) and perceived behavioural control (self-efficacy and thoughts about how easy or difficult it is to perform the behaviour) determine conscious intentions, which in turn guide PA behaviour.

However, this model leaves a large proportion of variance in PA behaviour unaccounted for: there is a discrepancy between what individuals plan and what they do (Rhodes & Bruijn, 2013). As a consequence, it has been suggested that health behavioural theories reflecting rational, reflective processes alone might be too narrow (Marteau et al., 2012) and that the reasoned action approach could be augmented (Hennessy et al., 2018). One possibility is that more impulsive modes of decision-making including implicit attitudes and motivations might also guide PA (Dimmock & Banting, 2009; Oliver & Kemps, 2018) especially among adolescents, whose decision-making is inclined to be influenced by spontaneous processes, especially in social situations (Blakemore & Mills, 2014).

One model that accounts for both reasoned and reactive decision-making in social contexts is the Prototype Willingness Model (PWM; Gerrard et al., 2008; Gibbons & Gerrard, 1995) This dual process model (Figure 1) builds on the TPB by assuming two routes to behaviour. The 'reasoned action' pathway is a planned route via intentions, attitudes and subjective norms. However, unlike the TPB, this path does not include perceived behavioural control because social opportunity to perform the behaviour is thought to be more important than self-efficacy and control beliefs for adolescent health behaviours (Gibbons et al., 2009). The second, 'social reaction' pathway, accounts for more impulsive behaviour in the presence of peers. In this route, adolescents will be more willing to engage in behaviour to the extent they have a positive, or favourable, prototype or social image of the type of person who engages in the behaviour, and to the extent, they judge themselves similar to the prototype (Gibbons et al., 2003). For example, adolescents who hold favourable prototypes for drinkers (such as 'cool' or 'fun') have higher levels of willingness to drink in social situations (Davies et al., 2016). Young people who judge themselves similar to prototypes are more likely to engage in behaviour because they identify with the image and the behaviour it represents (Gibbons & Gerrard, 1995).

The PWM is widely used to explain risky behaviours, such as drinking, crash-dieting or smoking, that are unplanned but volitional (Instone & Davies, 2019; Van Lettow et al., 2016). Recent studies have shown that the model might also have predictive utility for health-protective behaviours (Gibbons & Gerrard, 2016). For example, favourable evaluations of alcohol-abstainer prototypes, and similarity to healthy-eating images, have been shown to predict positive behaviour (Dohnke et al., 2015; Litt & Lewis, 2015). Previous studies suggest prototype similarity predicts PA among older adolescents through a process of identification with active images (Rivis et al., 2011), although a New Zealand study found that prototype perception did not improve the predictive validity of the TPB in relation to cycling to school

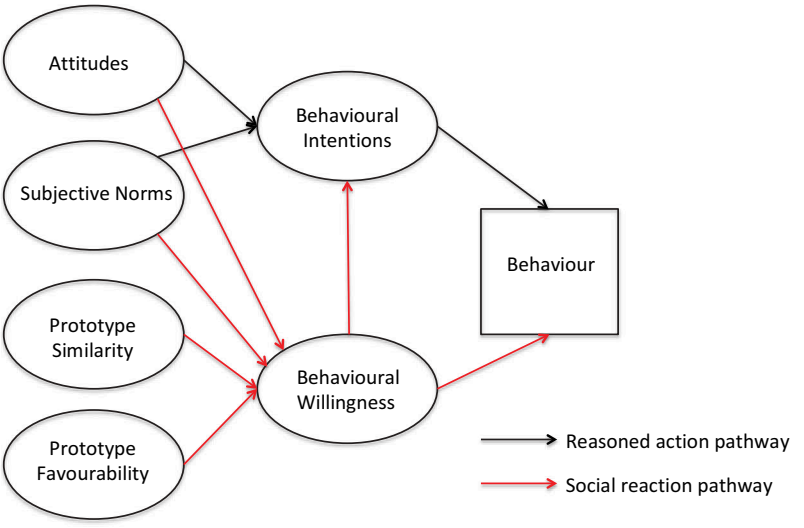

Diagram based on Gerrard, Gibbons, Houlihan, Stock & Pomery (2008)

Figure 1. The Prototype Willingness model.

(Frater et al., 2017). Prototypes are age- and culture-specific (Gibbons & Gerrard, 1995) and British adolescents appear to hold PA prototypes that are more nuanced than the almost entirely positive images described by older students in previous studies (Wheatley et al., 2017).

To date, studies investigating whether prototypes predict PA have used self-report surveys to measure planned exercise such as going to the gym. These instruments are subject to presentation bias (Adams et al., 2005) and might not capture the impact of prototype perceptions on all the impulsive decisions to be active (or inactive) during the day. By contrast, accelerometry can capture minute-by-minute unplanned PA choices, such as playground games or using stairs, as well as planned sport, and active commuting choices, that contribute to daily MVPA.

Boys are more active than girls in this age group (Inchley et al., 2016) yet few studies have examined whether healthy prototype perceptions vary by sex. Exploring whether boys and girls perceive active and inactive images differently could help target future interventions.

The aim of this study was to further explore the role of impulsive processes in adolescent PA decision-making by exploring whether variables from the social reactive path of the PWM – prototype favourability, similarity and willingness – explain objectively measured daily activity after reasoned action variables – intentions, attitudes and subjective norms – have been taken into account. A secondary aim was to measure the strength and valence of PWM variables among young adolescents and to further explore these by sex.

Method

Participants and procedure

Participants from Year 8 (aged 12–13) in three co-educational state secondary schools in one English county were invited to participate during June and July 2016, in a typical

week during term. The percentage of pupils receiving free school meals, an indicator of economic deprivation, was 4.1%, 4.8% and 8.1%, respectively, against the national average of 12.4% (Department of Education, 2018). Parents and pupils received an information sheet about the study. Pupils were asked to complete a survey concerning their beliefs about PA during morning registration and to wear an accelerometer for the following seven days. They were told they did not have to answer the questions and that they could remove their accelerometer at any time. Oxford University Research Ethics Committee approved the study.

Survey measures

Psychological variables were measured in relation to being 'physically active for an hour every day in a typical week during school term' to emphasise school commuting and after-school activities. Participants were instructed to think of PA as '*any activity that raises your heart rate and makes you breathe harder and feel warmer. Fast cycling to and from school, running around during school breaks, doing PE and taking part in after-school sports clubs are all examples of physical activity*'. Unless otherwise stated, responses were measured on seven-point Likert scales, with higher scores indicating more positive outcomes. To control for order effects, items were divided into three blocks and question order within each block was randomised.

Attitude to physical activity was the mean score of four items on a semantic differential scale (*unimportant/important; boring-fun; stressful-relaxing; dissatisfying-satisfying*). Cronbach's alpha was good (four items, $\alpha = .82$).

Subjective norms were captured with two items (*strongly disagree* to *strongly agree*, higher scores indicate stronger agreement). The first, *'Most of my friends think I should be physically active . . .'* measured injunctive norms and the second, *'Most of my friends will be physically active . . .'* measured descriptive norms. *Pearson's r* (two items), $r = 0.52$.

Intention was measured with a single item (reversed): '*I intend to be physically active . . . .*' ('*definitely yes*' to '*definitely no*').

Prototype favourability was rated against social characteristics, or attributes, that adolescents understand, share and apply to active and inactive prototypes. These social characteristics were four, syllable-matched adjectives (*confident, popular, determined, attractive*) drawn from qualitative research in this age group (Wheatley et al., 2017). First, participants read a standard prototype definition, based on a description in Gibbons et al. (1995, p. 85). Participants were then asked to consider active and inactive prototypes: '*Think of someone your age who is physically active (inactive) for an hour every day in a typical week during school term'* and indicate '*how far the following words describe*' this type of person ('*not at all*' to '*extremely*'). Average scores across the four attributes were calculated separately for active (four items, $\alpha = .74$) and inactive prototypes (four items, $\alpha = .84$) and used as measures of favourability.

Similarity was measured with a single item ('*very dissimilar*' to '*very similar*'): e.g. '*In general, how similar are you to the type of person who is physically active . . . ?*'

Willingness was measured by presenting participants with scenarios in which they could choose to be active or inactive in a social, school setting. In the first scenario, '*It's lunchtime at school and the teachers have organised an obstacle race on the playing field for a challenge. Some students are taking part and others are watching*'. In the second, *'It's*

nearly the end of the school year. To celebrate, the teachers have organised some activities. You have been offered the option to either spend the afternoon doing some sort of physical activity such as canoeing or ice-skating – or going home early'. For each scenario, two items (one reversed) assessed whether participants would be willing to *choose* or *avoid* PA ('*extremely unlikely*' to '*extremely likely*') e.g. *How likely are you to choose one of the physical activity options?* Cronbach's alpha was good (four items. α = .79).

Physical activity measures

Daily average MVPA was measured with a wrist-mounted Axivity AX3 accelerometer over five weekdays and two weekend days. We defined a 'valid wear' weekday as 12 consecutive hours from 8.0 to 20.0 to capture school commuting and after-school sport and PA (Trost et al., 2000). On weekend days, to account for later waking times, we accepted any consecutive ten-hour period between 8.0 and 20.0 and standardised total MVPA to 12 h. Non-wear time was at least 30 consecutive minutes of zero activity. We converted raw accelerometer data into 'counts' – accelerations in some combination of the three planes of movement the AX3 detects – per 60-s epoch. We then calculated whether each minute-long epoch was spent in MVPA by applying 'cut-points' – or defined counts per epoch – that have been shown to correspond to different activity intensities, such as brisk walking (moderate) or running (vigorous) in this age group (Phillips et al., 2013).

Sample size, data and statistical analysis

The sample size required was 89, assuming a conservative effect size of 0.15, α = .5, required power (1- β error probability) of 0.95 and eight predictor variables. Participants with at least three valid weekdays and one valid weekend day of PA data were included in the analysis (Troiano et al., 2008). We calculated daily average MVPA over one week using the following formula (Menai et al., 2017):

[(5 x mean daily weekday MVPA mins) + (2 x mean daily weekend MVPA mins)]/7

We used IBM SPSS 25 for all data analysis. For each item, fewer than 5% of responses were missing: these were replaced with the series mean in all cases (Tabachnick et al., 2001). We used Spearman's correlation and the Mann–Whitney U test for non-normally-distributed data, and applied a Bonferroni correction to account for multiple comparisons, $p < 0.006$. Data met assumptions for regression and hierarchical linear regression were used to explore whether variables from the PWM's social reactive pathway explained variance in PA over and above intentions, attitudes and subjective norms.

Results

Descriptive statistics

Overall, 126 participants (male = 65; 51.5%) completed the questionnaire and returned accelerometers with sufficient valid data to be included in the analysis. The proportion of the final sample from each school was 41%, 35% and 24%.

Physical activity

Mean (SD) daily average MVPA is presented in Table 1. Boys were significantly more active than girls, $t(124) = 6.11$, $p < 0.001$.

TPB and PWM variables

Median intentions, attitudes and norms concerning the completion of 60 min of MVPA daily were all above 4, representing a positive endorsement (see Table 2). Median favourability towards, and similarity to, active prototypes was positive. Median favourability towards, and similarity to, inactive types was negative. Median willingness to engage in PA in a school setting was positive. There was no significant difference between sexes on any of the variables at the $p = 0.006$ level.

Hierarchical linear regression

At step one we entered intention, attitudes and subjective norms into a hierarchical linear regression model with daily average MVPA as the outcome variable. These variables explained 12.8% of variance in MVPA, $F(3,122) = 5.99$, $p = 0.001$, $R^2 = 0.128$. Intention significantly predicted activity, and attitudes approached significance in this model (Table 3). At step two we entered intention, attitudes, subjective norms, four prototype perception variables (active/favourable, active/similar, inactive/favourable, inactive/similar) and willingness. This model explained 25.9% of variance in MVPA, $F(8,117) = 5.09$, $p < .001$, $R^2 = 0.259$. Adding social reactive variables explained an additional 13.1% of variance, $\Delta F(5,117) = 4.10$, $p = .002$, $\Delta R^2 = 0.131$. Similarity to active images was a significant positive predictor of activity, while favourability towards inactive images was a significant negative predictor.

Table 1. Mean daily average MVPA, by sex (n = 126).

Sex	Sample (N = 126)	Guideline daily MVPA (min)	Mean (SD) daily MVPA* (min)	% Meeting guidelines
Male	65	60	71.43(32.2)	58.5
Female	61	60	42.67(18.1)	13.1
Total	126		57.5(29.9)	37.3

*MVPA measured objectively: raw accelerometer data processed using validated algorithm (Phillips et al., 2013).

Table 2. Median scores on reasoned action and social reaction variables, by sex (n = 126).

	Median (IQR*)			Gender comparison		
Variable	Total	Male	Female	U	Z	P*
Intention	6.0(2.0)	6.0(2.0)	5.5(2.0)	1659	−1.62	.105
Attitude	5.4(1.5)	5.5(1.2)	5.2(1.5)	1895	−.43	.668
Subjective Norms	5.0(1.5)	5.0(2.0)	5.0(1.2)	1894	−.44	.662
Active/Favourable	5.2(1.1)	5.5(1.2)	5.0(0.9)	1533	−2.20	.028
Active/Similar	5.0(2.0)	5.0(2.0)	5.0(2.0)	1556	−2.14	.032
Inactive/Favourable	3.2(1.5)	3.4(1.6)	3.2(1.4)	1963	−.09	.924
Inactive/Similar	2.4(2.0)	2.0(2.0)	3.0(2.0)	1812	−.85	.393
Willingness	5.0(1.7)	5.0(1.6)	5.1(1.6)	1893	−.44	.661

*Applying a Bonferroni correction for multiple comparisons, p < 0.006 indicates statistical significance.
*Inter Quartile Range.

Table 3. Hierarchical linear regression model of physical activity in adolescents (n = 126).

Predictor Variables	B	β	t	p*
Step 1: R^2 = 0.128				
Intention	4.70	.201	2.16	.032
Attitude	6.27	.184	1.91	.058
Subjective Norms	2.13	.078	.837	.404
Step 2: R^2 = 0.259; ΔR^2 = 0.131				
Intention	3.06	.131	1.44	.151
Attitude	−.794	−.023	−.212	.832
Subjective Norms	2.96	.108	1.21	.228
Active/Favourable	1.23	.035	.411	.682
Active/Similar	4.81	.215	2.11	.036*
Inactive/Favourable	−5.82	−.232	−2.28	.024*
Inactive/Similar	−.249	−0.10	−.116	.908
Willingness	5.22	.193	1.87	.063

*p <.05 indicates statistical significance.

Discussion

This study was the first to investigate whether young British adolescents' prototype perceptions explained an objective measure of PA that captures both impulsive and planned activity behavior during a typical day. Similarity to active images, and favourability towards inactive images, were significant predictors of behavior. Overall, variables from the social reactive pathway of the PWM explained significant variance in daily average MVPA over and above reasoned action variables. Participants reported positive perceptions of active prototypes and negative perceptions of inactive images. Boys were significantly more active than girls, but there were no significant differences by sex on any of the predictor variables. Overall, the study provides initial evidence that the addition of social reactive variables might more fully explain adolescent PA decision-making than a model based on rational intentions alone.

Prototype perceptions predict daily average MVPA

This study presents initial evidence that objective daily activity levels are linked to PA prototype perceptions in the early years of secondary school, when activity levels are declining (Inchley et al., 2016). Our findings are supported by previous research showing that prototype perceptions predict self-reported PA among older adolescents and university students (Ouellette et al., 2005; Rivis & Sheeran, 2003; Rivis et al., 2011).

Similarity to active images – or identifying as active – was associated with higher daily average MVPA, although *favourability* towards this type of person was not. By contrast, low favourability towards inactive types – believing them to be unpopular or unattractive, for example, – was significantly associated with more minutes of MVPA, but identifying as an inactive type of person was not related to activity. These results align with previous studies showing that variance in health-promoting behaviour such as healthy eating and activity is linked with similarity, while variance in health-abstaining behaviour is allied with favourability (Gibbons & Gerrard, 2016). Strikingly, rational intention did not predict activity behaviour, suggesting that reasoned planning has less influence on adolescent activity decisions than more impulsive, heuristic processes. Behavioural

willingness does not predict activity either, leaving open the possibility that prototype perceptions influence behaviour directly via a desire to identify with a prototype.

Implications for physical activity interventions

While we do not show causality, our study's prospective design provides initial evidence that prototype perceptions predict significant variance in adolescent PA. Further between-group studies could determine whether altering prototype perceptions causes a change in PA, and whether such manipulations could form the basis of future interventions.

Our results suggest that targeting perceived similarity to active images may have potential to increase PA. They also point to further reducing favourability towards inactive prototypes, although this could have potential ethical implications if it led to stigmatizing certain groups who can struggle to engage in physical activity such as those with obesity (Puhl & Suh, 2015).

Previous interventions in the PWM framework have manipulated prototype similarity by encouraging social comparison. An alcohol study that prompted young adults to compare themselves with drinkers found that participants who judged themselves dissimilar to heavy drinkers in terms of social characteristics became less willing to drink (Lane et al., 2011). A physical activity study by Ouellette et al. (2005) asked participants to consider their health and appearance 20 years ahead, thinking about whether, over that period, they exercised regularly or not. These future self-images had components of both similarity and favourability. A Delphi study considering suitable behaviour change techniques to reduce adolescent alcohol misuse identified the creation, or provision, of a positive (or negative) group identity to help change prototype perception (Davies et al., 2016). For young adolescents, future research might consider a whole-school intervention to encourage an active group identity including, for example, active commuting and active lesson breaks. There was no difference between how positively girls and boys rated prototypes, suggesting that interventions could work equally well for both sexes.

Implications for theory

It has been suggested that prototype similarity prompts adolescent behaviour via a desire for self-consistency: young people in this sample engaged in PA because their self-image was active or sporty (Aloise-Young et al., 1996). Yet these results indicate that self-identifying as *inactive* does not predict *lower* activity levels. One possible explanation for this discrepancy involves social comparison: young people mistakenly identify as inactive because they compare themselves to high-active peers. Another possible account concerns self-presentation. Young people are less willing to rate themselves similar to risky health images, but they are more willing to benchmark themselves against positive, healthy or active images (Gibbons & Gerrard, 2016). At the same time, adolescents typically offer a wider range of favourability responses to negative images such as reckless drivers or binge-drinkers because they tend to include positive traits – 'cool' or 'relaxed' for example, – as well as negative characteristics. In line with this interpretation, the range of favourability rating awarded to inactive prototypes was larger than for active images.

Low favourability towards inactive images, and the associated negative social consequences of inactivity – unpopularity, for example, – predicted behaviour, while favourability towards

active images did not. Generally, negative or risky social images are thought to be more salient and carry greater influence than positive images (Skowronski & Carlston, 1989) and here it appears that, among adolescents, inactive images represent unfavourable or negative future social consequences that they wish to avoid by being active (Ouellette et al., 2005). Notably, they are not persuaded to be active by the positive characteristics they attribute to active prototypes, perhaps because of barriers such as perceived competence. Overall, these findings provide initial evidence that adolescent PA behaviour may be influenced not only by social considerations but also by internal processes involving self-perception.

Strengths and limitations

The use of objectively measured MVPA is a key strength of this study. Not only can this measure be directly compared with government guidelines but it also captures unintentional but volitional activities, such as running upstairs, that might not be recalled during self-report.

A large proportion of participants did not meet the accelerometer wear time threshold necessary for their data to be included in the analysis: such compliance issues are typical of this age group (Cain et al., 2013) but they might introduce bias. The final sample was also relatively active compared to averages for this age group (Inchley et al., 2016).

Willingness measures showed good face validity and internal reliability, yet there is debate about whether explicit measures, requiring conscious deliberation, can accurately capture impulsive willingness to engage in behaviour that is neither planned nor entirely unconscious (Fishbein, 2008). An alternative approach might be to use a reaction-time task, in which participants quickly provide yes/no answers (Comello & Slater, 2011).

Conclusions

Our study is the first to explore whether prototype perceptions explain variance in young adolescents' daily physical activity over and above reasoned action variables. These results offer initial evidence that identifying as an active type of person, and having low favourability towards inactive types, is associated with more daily activity. Further research should explore how to target active images in interventions.

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