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Does parental support moderate the effect of children's motivation and self-efficacy on physical activity and sedentary behaviour?

F.B. Gillison [a, *], M. Standage [a], S.P. Cumming [a], J. Zakrzewski-Fruer [a], P.C. Rouse [a], P.T. Katzmarzyk [b]

[a] Department for Health, University of Bath, Bath, BA2 7AY, UK
[b] Pennington Biomedical Research Centre, Baton Rouge, LA 70808, USA

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ABSTRACT

Objectives: 1) To test whether parental support moderates the direct effects of children's motivation and self-efficacy on objectively measured moderate-vigorous physical activity (MVPA) and sedentary time. 2) To explore differences in the relationships between boys and girls.
Design: Cross-sectional observational study.
Method: Data were collected from 430 9–11 year old UK children and their parents; parents self-reported on the support they provided to their children to be active (through providing transport, encouragement, watching, or taking part with their child), and children self-reported their motivation and self-efficacy towards exercise. MVPA and sedentary time were measured using accelerometers.
Results: Both parent- and child-level factors were largely positively associated with children's MVPA and negatively related to sedentary time. There was no evidence of a moderation effect of parental support on MVPA or sedentary time in boys. Parental provision of transport moderated the effect of girls' motivation on week-day MVPA; more motivated girls were less active when transport was provided. Transport and exercising with one's child moderated the effect of motivation and self-efficacy on girls' sedentary time at weekends; more motivated girls, and those with higher self-efficacy were less sedentary when parents provided more frequent transportation or took part in physical activity with them.
Conclusions: The results largely supported a model of the independent effects of parent and child determinants for moderate-to-vigorous physical activity, but there was evidence that some types of parent support can moderate sedentary time in girls. Further research is needed to explore the causal pathways between the observed cross-sectional results.

1. Introduction

The lack of physical activity in childhood is associated with obesity, precursors of chronic disease (Ekelund et al., 2004), and threats to future health and wellbeing such as diabetes and cardiovascular disease in adulthood (Barton, 2012). Physical activity is, however, a complex set of behaviours with multiple determinants operating at numerous levels as is predicted by a socio-ecological model (Butland et al., 2007); for example, cultural (e.g., expectations of children and opportunities for active play), neighbourhood (e.g., safety, and urban/rural setting), school (e.g., resources, and scheduling) and individual differences (e.g., preferences and ability) have all been significantly associated with physical activity behaviour in childhood (Sallis, Prochaska, & Taylor, 2000). Most research compares the effects of these different influences either individually or in parallel, rarely considering how these factors may interact. The aim of this study is to consider the interaction between two sets of factors that have been consistently shown to predict children's physical activity behaviour; 1) a child's motivation and self-efficacy towards physical activity, and 2) the support children receive from parents. Specifically, we aim to determine whether parental support moderates the relationship between child-level factors and physical activity behaviour.

Past work from a self-determination theory (SDT; Ryan & Deci, 2017) perspective has shown children's autonomous motivation to be consistently and positively associated with physical activity

* Corresponding author.
E-mail address: f.b.gillison@bath.ac.uk (F.B. Gillison).

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and exercise (Lonsdale, Sabiston, Raedeke, Ha, & Sum, 2009; Sebire, Jago, Fox, Edwards, & Thompson, 2013; Standage, Gillison, Ntoumanis, & Treasure, 2012). SDT differentiates between motivational regulations that are autonomous or controlled (Deci & Ryan, 2008). Autonomous motivation refers to when people engage in activities for reasons such as enjoyment (termed intrinsic motivation) or as they have personal meaning and relevance (termed identified regulation). Controlled motivation refer to when activities are undertaken purely to gain rewards or avoid punishment (termed external regulation), or to gain approval or avoid feeling guilt or shame (termed introjected regulation) (Deci & Ryan, 2008). In contrast to the positive impact of autonomous motivation, controlled motivation has been shown to have weak negative associations with physical activity (Owen, Smith, Lubans, Ng, & Lonsdale, 2014). Thus, it is the quality rather than absolute quantity of motivation that is important to consider.

While SDT takes account of the influence of a person's assessment of their capability to carry out an activity, and to demonstrate one's competence while undertaking it (i.e., the satisfaction of their need for competence), people's expectation of their capability prior to taking part (i.e., self-efficacy) can also have a strong influence on whether or not they choose to do so. Self-efficacy is also frequently studied as a predictor of physical activity behaviour (Sterdt, Liersch, & Walter, 2014), and high self-efficacy is consistently associated with higher levels of participation (Sallis et al., 2000). It is a key component of many behaviour change theories, including social-cognitive theory (SCT; Bandura, 1998), and the transtheoretical model and the theory of planned behaviour (Prochaska & Diclemente, 1984). Applications of such theories suggest that children who feel more able to complete an activity are more likely to seek out opportunities to do so, and to take part for longer (Bauman et al., 2012; Trost, Kerr, Ward, & Pate, 2001).

Parents also play a key role in determining children's physical activity levels (Sallis et al., 2000). Positive associations of a medium effect size (Adkins, Sherwood, Story, & Davis, 2004; Sallis, Calfas, Alcaraz, Gehrman, & Johnson, 1999) have been consistently reported between parental support and leisure-time physical activity through the provision of both direct, tangible support (e.g., providing transport, enrolling children in sports clubs, watching children take part), and intangible support (e.g., through verbal encouragement, and attitudes towards physical activity) (Beets, Cardinal, & Alderman, 2010; Edwardson & Gorely, 2010). Recent systematic reviews also suggest that the involvement of family may lead to greater efficacy of school-based interventions (Vasques, Magalhães, Cortinhas, Mota, Leitão, & Lopes, 2014), suggesting that parents' influence reaches beyond the home environment and may be important wherever interventions are based. However, we know very little about how parental influences operate; none of the studies included in the available systematic reviews of children's physical activity interventions consider the interactive effects of children's psychosocial determinants alongside parental support (Adkins et al., 2004; Sallis et al., 1999), and thus the relative importance of parent- versus child-level influences on children's physical activity levels, and the potential interactive or moderating effects are unknown. A clearer understanding of whether parental support and children's own motivation act in parallel, or whether they have an interactive effect could greatly help us to better specify and target childhood physical activity interventions, to maximize their efficacy.

There are two additional limitations of past work that the present study seeks to address. First, in terms of measurement as the use of objective versus subjective (self-report) measures has been shown to be related to study outcomes (Yao & Rhodes, 2015). That is, far fewer studies report on objectively assessed physical activity outcomes than do self-report (Edwardson & Gorely, 2010), and thus the confirmation of previous findings using objective means is warranted. The second limitation of past research relates to the degree to which children's broad activity profile is considered, rather solely focusing on moderate-to-vigorous activity levels. The time that children spend being sedentary has been linked to health risks independently of moderate to vigorous physical activity levels (Owen et al., 2014) and as such is not simply the opposite end of the physical activity continuum but a behaviour in its own right (Pate, O'Neill, & Lobelo, 2008). The use of objective measurement tools such as accelerometers, allows for the more accurate assessment of sedentary time alongside time spent in physical activity of different levels of intensity. In an era in which attractive sedentary pursuits including the use of computers, on-demand television, tablets and smart phones are increasingly available to young children, an understanding of whether and how the factors influencing physical activity can influence, or fail to influence, sedentary time is important, yet there is little reliable information about the correlates of sedentary behaviour in children (Van der Horst, Paw, Twisk, & Van Mechelen, 2007).

Thus, this study aimed to address the limitations of past work incurred by using objective measures of physical activity and sedentary time, and assessing the interaction between parental and child influences on motivation. In Hypothesis 1, we predicted that autonomous motivation and self-efficacy would be positively associated with objectively measured moderate-to-vigorous physical activity (MVPA) and negatively associated with sedentary time; controlled motivation was predicted to have a negative association with MVPA and a positive association with sedentary time. In Hypothesis 2, we predicted that parents' social support for physical activity would be positively associated with MVPA and negatively with sedentary time. In Hypothesis 3, we predicted that parental social support would moderate the relationship between a child's self-efficacy and motivation towards exercise and the time spent in MVPA and sedentary behaviour. Specifically, we hypothesised that a) children with high autonomous motivation and self-efficacy but unsupportive parents will be less physically active and more sedentary than equally motivated children with supportive parents (i.e., less able to enact their natural tendencies towards activity), and b) that children with low autonomous motivation and self-efficacy but highly supportive parents will be more physically active and less sedentary than children with similarly low motivation but less supportive parents.

In order to control for additional factors known to influence children's physical activity levels and/or parental support, we included the covariates of gender, BMI, and biological maturation (Beets, Vogel, Chapman, Pitetti, & Cardinal, 2007). Previous research has consistently reported girls to be less active (Biddle, Atkin, Cavill, & Foster, 2011; Sterdt et al., 2014) and to receive less parental encouragement (Fredricks & Eccles, 2005) than boys. A higher body weight is associated with lower activity levels in both genders (Ekelund et al., 2004). Biological maturity is consistently associated with physical activity levels, with early maturing girls engaging in less physical activity than their on-time or late maturing peers, and an association in the opposite direction for boys (Cumming, Standage, Gillison, & Malina, 2008; Ekelund et al., 2004). While most children in primary school have yet to reach puberty, as girls reach maturity ahead of boys, early maturing girls may have already begun to experience the changes associated with reduced physical activity levels. Finally, as children have different opportunities to be active and spend time with parents during the week compared with weekends, we considered week days and weekend days separately in line with past work (Beets et al., 2007).

2. Methods

2.1. Design

Data were collected in the south west of the UK as part of the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE) using a standardised data collection protocol reported in detail elsewhere (Katzmarzyk et al., 2013). The same measures were used in all countries. Overarching ethical approval for the ISCOLE protocol was provided by the Pennington Biomedical Research Center Institutional Review Board, and local ethical approval was also obtained for the UK site by the Institutional research ethics committee.

2.2. Participants

A full list of primary schools within two education authority areas in the south west of England was obtained, and schools were stratified according to student socio-economic status (SES) (based on levels of entitlement to free school meals; high, mid, low) and weighted by size (large, small). Schools were then selected at random using the probability proportional to size approach, and head teachers were invited to take part. The recruitment approach was not intended to result in a nationally representative sample, but to maximize variability. All children in Year 6 (aged 9–11) in participating schools were eligible to take part. The sample generated is the dataset for the UK ISCOLE site. To be included in the analytical sample for the present study, participants had to provide qualifying accelerometry data (minimum of 4 days, including 1 weekend day) and their parents must have returned the parent-completed questionnaire containing parent social support items. 541 participants provided initial consent, of whom 525 took part (i.e., completed initial measures); 46 were excluded for not providing sufficient accelerometry data, and a further 49 were excluded as parents did not return the questionnaire pack. The final analytical sample was 430 children (M age 10.4 years, 57% female, 87% white; Table 2). Seventy-seven percent of participants were of a normal weight for their age and height, 13% were overweight and 7% obese (based on WHO cut-points; Onis et al., 2007). Descriptive statistics were computed and compared for children included and excluded from the analysis using independent samples t-tests for continuous variables (age, BMI) and $\chi2$ tests for categorical data (gender, socio-economic group, living with both parents); there was a significantly higher proportion of boys in the excluded (55%) than included (43%) sample, but no other significant differences were found.

2.3. Measures

2.3.1. Physical activity

Physical activity was assessed objectively using Actigraph GT3X + accelerometers (ActiGraph, Pensacola, FL, USA) (Katzmarzyk et al., 2013). Accelerometers were worn on an elasticised waist-belt (at the right mid-axillary line) for 24 h/day for 7 consecutive days plus an initial familiarisation day, removing only for washing or water-based activities. Only children providing at least 4 days (including at least 1 weekend day) of at least 10 h of wear time per day were included in the analysis. Data were collected at a sampling rate of 80 Hz, downloaded in 1-s epochs, and aggregated to 15-s epochs for analysis (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008). The Evenson cut-points validated for children (Trost, Loprinzi, Moore, & Pfeiffer, 2011) were used to determine MVPA ($\geq$574 counts per 15 s) and sedentary time ($\leq$25 counts per 15 s) (Evenson et al., 2008; Tudor-Locke, Barreira, Schuna, Mire, & Katzmarzyk, 2013).

2.3.2. BMI

Standing height was measured to the nearest 0.1 cm without shoes with the participant's head in the Frankfort Plane and at the end of a deep inhalation using a Seca 213 portable stadiometer (Seca, Hamburg, Germany). Body mass was measured to the nearest 0.1 kg using a portable Tanita SC- 240 Body Composition Analyzer (Tanita, Arlington Heights, USA). Subsequently, Body Mass Index (BMI; body mass (kg)/height (m2)) and BMI z-score according to World Health Organization (Onis et al., 2007) were calculated.

2.3.3. Parental support for physical activity

Parent support was self-assessed through the four items of the ‘Friends and Family’ scale of the Neighborhood Impact on Kids (NIK) study survey (Saelens et al., 2012); how often in the last week parents had 1) watched, 2) encouraged, 3) provided transport for their child to play sport/engage in physical activity, and 4) how often they had taken part with them. Parents rated each item on a scale of 1 (never) to 5 (every day). Systematic reviews of parental social support have previously demonstrated that such support can be differentiated into different types of support; i) tangible, which can be further categorised as instrumental (e.g., proving transport) or conditional (e.g., exercising together) or ii) intangible which can be further categorised as motivational (e.g., encouragement) or information (e.g., discussing benefits). These different types of support are not conceptually equivalent, and may operate through theoretically distinct mechanisms (Beets et al., 2010). As the four items of the support measure used in the present study map to different categories of support, in line with these arguments, they were thus considered separately in the analysis.

2.3.4. Child self-report measures

Self-efficacy for physical activity was assessed using an eight-item self-efficacy questionnaire developed with and for school-aged children (Motl et al., 2000). The scale has been demonstrated to have good factorial validity and invariance over time when tested with a large sample of adolescent girls (Motl et al., 2000), and showed measurement invariance in children of both genders of the age of the present sample (Dishman, Dowda, McIver, Saunders, & Pate, 2017).

Motivation towards exercise was assessed using five items taken from the Behavioural Regulation of Exercise Questionnaire (BREQ-2; Markland & Tobin, 2004) which has been since reliably used in child samples (Owen et al., 2014). Given the length of the existing ISCOLE child-completion questionnaire, the BREQ-2 was reduced from a 19 to a 5-item measure by selecting the item loading most strongly onto each subscale (intrinsic motivation, identified,

Table 1
Pattern of simplex correlations between abbreviated scale indicators.

	Amotivation	Extrinsic regulation	Introjected regulation	Identified regulation
Extrinsic regulation	0.24***	–	–	–
Introjected regulation	0.02	0.23***	–	–
Identified regulation	−0.31***	−0.03	0.28***	–
Intrinsic motivation	−0.34***	−0.13***	0.17***	0.55***

Table 2
Sample characteristics.

	Full Sample (N = 430) Mean (SD) range	Girls (N = 244) Mean (SD)	Boys (N = 186) Mean (SD)
Age (years)	10.4 (0.53) 9–11	10.4 (0.53)	10.4 (0.53)
BMI (kg/m^2)	18.4 (2.98) 13–29	18.7 (3.20)	18.1 (2.63)
Hours video/computer game use on a school day	2.67 (1.40) 1–7	2.30 (1.17)	3.15 (1.53)
Hours spent outside after school, before bedtime	2.71 (1.35) 1–4	2.68 (1.41)	2.74 (1.26)
Hours spent watching TV	3.39 (1.28) 1–7	3.38 (1.20)	3.40 (1.39)
MVPA week day (minutes/day)	66.80 (23.24) 13–156	59.02 (18.71)	77.02 (24.64)
MVPA weekend (minutes/day)	57.61 (30.23) 6–168	50.08 (25.38)	67.49 (33.17)
Sedentary time weekday (minutes/day)	501.45 (59.99) 309–691	506.37 (57.58)	495.00 (62.57)
Sedentary time weekend (minutes/day)	476.34 (88.86) 228–813	468.71 (87.04)	486.35 (90.44)
Weight status (% overweight or obese)	20.2%	21.3%	18.8%
Household income (% <£20,000)	24.4%	23.8	25.3

Notes: MVPA – moderate to vigorous physical activity.

introjected, and extrinsic regulations, and amotivation) using previous datasets comprising 1512 UK adolescents (Gillison, Standage, & Skevington, 2006; Standage & Gillison, 2007). To test the validity of the abbreviated scale, we calculated the simplex correlation matrix consistent with the full scale within the UK sample (Table 1). The items representative of each subscale showed the expected valence of effect when correlated with MVPA in the present sample (Supplementary Table 1), and a simplex pattern of correlations similar to those found in research with adolescents using the full instrument (Verloigne et al., 2011).

2.3.5. Maturation

Biological maturation was assessed using the Khamis-Roche method, which computes the percentage of predicted adult stature attained at the time of measurement, based on parent self-reported heights (corrected for over-estimation) (Khamis & Roche, 1994).

2.4. Analysis

All data were analysed using SPSS version 20. In order to control for known correlates of children's physical activity levels we included gender (Standage & Gillison, 2007; Trost et al., 2001; Van der Horst et al., 2007), BMI (Ekelund et al., 2004), and maturation status (Cumming et al., 2008) as adjustment variables (covariates) in our analyses. Moderation was assessed through regression analysis (Hayes, 2013). The moderation analyses were conducted separately for each of the dependent variables, time spent in MVPA, and time spent in sedentary behaviour. All independent variables (covariates, parent support, and child psychosocial variables) and interaction terms (child psychosocial x parent variables) were included simultaneously. Moderation is demonstrated if the interaction term adds significant explanatory variance to the regression model (Helm & Mark, 2012). All analyses were conducted separately for week and weekend day data.

3. Results

3.1. Descriptive analyses

Girls engaged in 18.0 fewer minutes of MVPA than boys per weekday (SE = 2.1, $p < 0.001$), and 17.4 fewer minutes on weekend days (SE = 2.8; $p < 0.001$). Girls were marginally more sedentary than boys during the week (M difference = 11 min/day, SE = 5.9, $p = 0.05$), but boys were more sedentary during the weekend (M difference = 17.6, SE = 8.6, $p = 0.04$). Intra-class correlations (ICC) demonstrated that there was a negligible effect of school on primary variables (ICC self-efficacy = 0.06, autonomous motivation = 0.02, parental support = 0.02), so the analyses were conducted at an individual level. All variables met the assumptions of regression analyses.

Initial correlation analyses confirmed that the predicted covariates of gender, BMI and maturation status were significantly associated with the outcome variables (Supplementary Table 1). A higher BMI was associated with lower MVPA and greater time spent in sedentary behaviour. Maturation status was only associated with weekend physical activity in girls; during the weekends more mature girls were less active and more sedentary than less mature girls. Controlled motivation was not significantly associated with any of the accelerometry outcomes, and therefore was not included in the main analyses.

Hypothesis 1. The model predicting MVPA from child-level psychosocial variables (controlling for gender, BMI, and maturation status) was significant with a moderate to large effect on both weekdays $R^2 = 0.18$, $p < 0.001$, and weekends $R^2 = 0.14$, $p < 0.001$ (Table 3). Significant independent indicators were gender (MVPA was greater in boys) and self-efficacy (higher self-efficacy was associated with greater MVPA); the negative effect of BMI approached significance on weekdays only. Weekday sedentary time was not predicted by the model, yet there was a significant albeit weak effect at the weekend ($R^2 = 0.05$, $p = 0.001$) indicating that sedentary time was greater in boys and children with a more advanced maturity status.

Given the significant effect of gender, the analyses were repeated for girls and boys separately. The model was predictive of MVPA during the week and at weekends for both genders, although of small effect size (weekday MVPA; boys $R^2 = 0.06$, $p < 0.05$; girls $R^2 = 0.04$, $p < 0.05$; weekend MVPA; boys $R^2 = 0.10$, $p = 0.001$; girls $R^2 = 0.05$, $p = 0.01$). During the week, no variables were independently predictive of outcomes for boys, but BMI was negatively associated with MVPA for girls ($\beta = -0.17$, $p < 0.05$). At the

Table 3
Model comparison statistics for the child vs parent models.

	MVPA		Minutes/day sedentary time	
	Week days	Weekends	Week days	Weekends
Child-level model	R^2 = 0.18, p < 0.001	R^2 = 0.14, p < 0.001	R^2 = 0.02, p = 0.07	R^2 = 0.05, p = 0.001
Gender	**β = −0.42, p < 0.001**	**β = −0.20, p = 0.03**	–	**β = −0.30, p = 0.001**
BMI	β = −0.10, p = 0.06	β = −0.09, p = 0.11	–	β = 0.05, p = 0.36
Maturation offset	β = 0.06, p = 0.60	β = −0.09, p = 0.36	–	**β = 0.24, p = 0.02**
Autonomous motivation	β = 0.00, p = 0.98	β = 0.08, p = 0.15	–	β = −0.04, p = 0.43
Self-efficacy	**β = 0.14, p = 0.008**	β = 0.14, p = 0.01	–	β = −0.04, p = 0.43
Parent-level model	R^2 = 0.18, p < 0.001	R^2 = 0.13, p < 0.001	R^2 = 0.04, p = 0.007	R^2 = 0.07, p < 0.001
Gender	**β = −0.40, p < 0.001**	**β = −0.18, p = 0.045**	β = 0.3, p = 0.73	**β = −0.32, p = 0.01**
BMI	**β = −0.13, p = 0.02**	**β = −0.11, p = 0.04**	β = 0.05, p = 0.40	β = 0.04, p = 0.45
Maturation offset	β = 0.05, p = 0.60	**β = −0.13, p = 0.02**	β = 0.06, p = 0.54	**β = 0.26, p = 0.01**
Watch child	β = 0.04, p = 0.73	β = 0.07, p = 0.21	β = −0.03, p = 0.63	β = 0.002, p = 0.97
Encourage child	**β = 0.12, p = 0.02**	**β = 0.16, p = 0.002**	β = −0.04, p = 0.49	**β = −0.11, p = 0.04**
Provide transport	β = −0.10, p = 0.07	β = −0.05, p = 0.39	β = −0.06, p = 0.33	β = −0.08, p = 0.17
Active with child	β = 0.07, p = 0.17	β = −0.001, p = 0.98	**β = −0.12, p = 0.02**	β = −0.04, p = 0.45

Notes: standardised beta weights presented, bold type indicates independent significant predictors. R^2 represents the amount of variance in the dependent variable explained by the model, with 0.01 considered a small effect size, 0.09 medium and 0.25 large.

weekend, autonomous motivation was positively associated with MVPA in boys (β = 0.19, p < 0.05), whereas self-efficacy was positively associated with MVPA in girls (β = 0.17, p < 0.05). Time spent in sedentary behaviour during the week was not significantly predicted by the model for either gender. At the weekend, boys' sedentary time was inversely associated with autonomous motivation (R^2 = 0.09, p < 0.01; β = −0.28, p = 0.001), whereas girls' sedentary time was positively associated with maturity status (R^2 = 0.06, p < 0.01; β = 0.20, p = 0.008) and autonomous motivation towards physical activity (β = 0.15, p = 0.04). That is, autonomous motivation had opposite associations with the sedentary behaviour of girls compared to that observed in boys.

Hypothesis 2. Regression analyses controlling for child gender, BMI and maturation status indicated that both weekday and weekend MVPA was predicted by a model of parent-level effects (Table 3). Girls' weekday MVPA was significantly predicted by the parent-level model (R^2 = 0.11, p < 0.001; moderate effect size) through a significant positive association with parental encouragement (β = 0.25, p = 0.001), and negative associations with BMI (β = −0.19, p = 0.01) and provision of transport (β = −0.20, p < 0.05). The association with parents taking part with their child also approached significance (β = 0.13, p = 0.06). Boys' weekday MVPA was not significantly predicted by the parent-support model (R^2 = 0.03, p = 0.51; small effect size).

At the weekends, MVPA was significantly predicted by the model for both genders (boys R^2 = 0.07, p < 0.5; girls R^2 = 0.06, p < 0.05), although the amount of variance each explained was small (<10%) and the only independent predictor was parental encouragement, and only for boys (β = 0.20, p < 0.05; girls β = 0.12, p = 0.10). Sedentary behaviour was not predicted by parent-level effects for either gender during the week (boys R^2 = 0.06, p = 0.08; girls R^2 = 0.04, p = 0.14). While the full model was significantly predictive for both genders at the weekend (boys R^2 = 0.07, p < 0.05; girls R^2 = 0.07, p < 0.01), the only significant association was with maturation status for girls, indicative that more mature girls were more sedentary (girls β = 0.20, p < 0.01; boys β = 0.04, p = 0.68). Thus, overall the hypothesised effects of parent support on MVPA were weak but in the expected directions, but there was little evidence that parental support is independently associated with lower sedentary time.

Hypothesis 3. Given the differences in the significant correlates of physical activity between boys and girls, Hypothesis 3 was tested separately for each gender. All interaction effects for which p < 0.1 are explored given the number of variables in each analysis, and the limited power of interaction models. There were no significant moderation effects of parent-level factors in predicting MVPA or sedentary behaviour for boys (Table 4). For girls, interactions were significant (or neared significance) in relation to two aspects of parent support; the provision of transport, and taking part in physical activity with one's child. In line with predictions, when transport provision was low, more motivated girls undertook more MVPA on weekdays than their less motivated peers. However, when transport was provided more frequently, more motivated girls reported *less* MVPA than both their less motivated peers, and girls with similar levels of motivation but *less* transport from parents (Fig. 1a). The remaining interaction terms showed associations with girls' weekend sedentary time only; when transport provision was frequent, there was little difference in sedentary time between girls with high or low motivation, but when transport was infrequent, girls with higher autonomous motivation tended to be more sedentary than their less motivated peers (Fig. 1b). Both interactions between parental transport and motivation (Fig. 1a and b) thus demonstrate findings in opposition to our predictions. However, the effects of interactions with support in the form of taking part with a child were in line with expectations; when participation was frequent, girls with high motivation (Fig. 1c) and high self-efficacy (Fig. 1d) were less sedentary than their less motivated or confident peers. There was little difference in sedentary time according to girls' motivation or self-efficacy when participation was infrequent.

4. Discussion

In this sample of 9–11 year old UK children, children's motivation and self-efficacy towards exercise, and parental support for physical activity, were generally positively associated with objectively measured MVPA and negatively associated with sedentary time. Gender-specific analyses indicated that the associations between children's autonomous motivation and self-efficacy and MVPA were more closely aligned during the weekend than during the week (Hypothesis 1). Boys' weekend MVPA was most strongly predicted by autonomous motivation, whereas girls' was most strongly predicted by self-efficacy, but it was of note that neither construct was independently predictive of week day MVPA. A similar week/weekend split was observed for sedentary time, with neither boys' nor girls' sedentary time predicted by psychosocial constructs during the week. However, at weekends autonomous motivation appeared to have a contrasting effect on boys and girls; autonomous motivation for exercise negatively predicted boys'

Table 4
Combined model of potential moderation effects of parent support on children's MVPA and sedentary time.

	Minutes/day MVPA		Minutes/day sedentary time	
	Week days	Weekends	Week days	Weekends
Girls				
	$R^2 = 0.15$, $p < 0.001$	$R^2 = 0.11$, $p = 0.06$	$R^2 = 0.06$, $p = 0.50$	$R^2 = 0.14$, $p = 0.003$
Child motivation	β = −0.34, p = 0.15	−0.33, p = 0.18	0.31, p = 0.21	0.59, p = 0.01
Child self-efficacy	β = 0.16, p = 0.51	0.15, p = 0.57	−0.01, p = 0.98	−0.20, p = 0.42
Parent support – watching	β = −0.29, p = 0.53	0.42, p = 0.38	−0.44, p = 0.37	−0.13, p = 0.78
Parent support – encouragement	β = −0.34, p = 0.39	−0.31, p = 0.46	0.13, p = 0.76	−0.35, p = 0.39
Parent support – transport	β = −0.02, p = 0.96	−0.55, p = 0.29	0.58, p = 0.28	0.82, p = 0.11
Parent support – participation	β = 0.43, p = 0.26	0.14, p = 0.72	0.24, p = 0.54	0.24, p = 0.53
Interaction terms (where p = 0.2)	Motivation x transport; β = −0.87, p = 0.08	Self-efficacy x participation; β = 0.63, p = 0.19 Motivation x transport; β = −0.76, p = 0.11 Self-efficacy x transport; β = 0.84, p = 0.13	–	Motivation x participation; β = −1.00, p = 0.04 Self-efficacy x participation; β = −0.77, p = 0.10 Motivation x transport; β = −1.15, p = 0.03
Boys				
	$R^2 = 0.10$, $p = 0.29$	$R^2 = 0.16$, $p = 0.02$	$R^2 = 0.14$, $p = 0.04$	$R^2 = 0.14$, $p = 0.045$
Child motivation	β = −0.16, p = 0.63	−0.24, p = 0.44	−0.39, p = 0.22	−0.39, p = 0.22
Child self-efficacy	β = −0.13, p = 0.71	−0.04, p = 0.91	0.51, p = 0.14	0.62, p = 0.07
Parent support – watching	β = 0.12, p = 0.83	0.03, p = 0.96	−0.52, p = 0.34	−0.18, p = 0.75
Parent support – encouragement	β = −0.23, p = 0.58	−0.40, p = 0.44	0.58, p = 0.16	0.05, p = 0.91
Parent support – transport	β = −0.87, p = 0.11	−0.40, p = 0.88	0.92, p = 0.08	0.61, p = 0.25
Parent support – participation	β = 0.00, p = 0.99	−0.12, p = 0.80	−1.09, p = 0.02	0.10, p = 0.83
Interaction terms (where p = 0.2)	–	Self-efficacy x transport; β = 6.35, p = 0.14	Self-efficacy x participation; β = − 0.70, p = 0.15 Motivation x watching β = 1.06, p = 0.12	–

Notes: All models were controlled for BMI and maturation offset. R^2 represents the amount of variance in the dependent variable explained by the model, with 0.01 considered a small effect size, 0.09 medium and 0.25 large.

sedentary time (as expected by a substitution hypothesis), but positively predicted sedentary time for girls. This unexpected positive association in girls warrants further investigation.

Hypothesis 2 was also largely supported, and further suggested that providing encouragement was more beneficial than other forms of more tangible parental support for children of this age. However, parental support for physical activity did not appear to be protective of sedentary time for either gender. There was also an unexpected negative association between parental provision of transport and week-day MVPA in girls, which was a reversal of the direction of effects reported in simple bivariate correlations and in contrast to the positive associations between instrumental support (transport) and MVPA reported in past work (Edwardson & Gorely, 2010; Hoefer, McKenzie, Sallis, Marshall, & Conway, 2001; Sallis et al., 1999). The moderation analysis suggested that this effect was largely due to girls with high autonomous motivation towards exercise engaging in less MVPA when transport was more vs less frequently available. It is possible that this is a measurement effect if the frequency of providing transport is a proxy for some other factor, for example if the activities requiring transport require less activities than those for which no transport is needed (e.g., informal activities around the home, or activities undertaken after school requiring no additional trips). Providing girls with transport could have a negative effect by substituting a sedentary activity (being driven) for more energetic active travel options. Some past work indicates that children tend to take part in active recreational pursuits *or* recreational active travel but not both, on a given day (Copperman & Bhat, 2007). However, in our own sample, there was no association between the provision of transport and time spent in sedentary behaviour to support this suggestion.

A future direction for research would be to explore the social context in which this type of support is offered (i.e., whether or not the support is offered in an autonomy supportive or coercive manner) which has the potential to negatively impact engagement in physical activity once 'delivered' to a physical activity facility (Standage & Ryan, 2012). While further work may be useful in helping to explore this anomaly, the finding raises a wider issue related to the use of composite measures of parental support; if we had included a composite scale of parental support, the transport item would have operated as a suppressor variable (Preacher & Hayes, 2004), and no effect of parental support would have been found. Many studies do not separate out the effect of transport provision from other supportive actions (e.g., Hoefer et al., 2001), which could in part account for some contrasting findings in past studies.

The primary purpose of the study was to investigate whether parental support moderates the effects of children's motivation and self-efficacy towards exercise (Hypothesis 3). Given that the analysis of moderation effects through regression modelling generally has low power to detect significant interactions, all interaction effects that neared significance (i.e., $p \leq 0.10$) were explored. The finding that there were no interaction effects predicting MVPA that neared significance for boys, and only one for girls (on week days only, as discussed previously), suggests that parental support and a child's own motivation towards physical activity may have largely independent effects. There is evidence in similar settings that parents' provision of support and evaluations of their child's physical abilities differ according to gender (e.g., Davison, Cutting, & Birch, 2003; Edwardson & Gorely, 2010), which in turn predicts increased physical activity such as participation in sport (Fredricks & Eccles, 2005). Our findings largely suggest that despite these differences, there is little to no moderation of children's MVPA by parent provision of support; encouragement is facilitative for MVPA for both boys and girls, regardless of their level of self-efficacy or motivation.

Greater evidence of a moderating effect was seen for parental support on the association between children's motivation for activity and their sedentary time, but only in girls. These interactions suggested that girls with higher levels of motivation and self-efficacy are more responsive to parent support in the form of transport provision and co-participation with parents. That is, these two forms of support enable girls who are more motivated to avoid

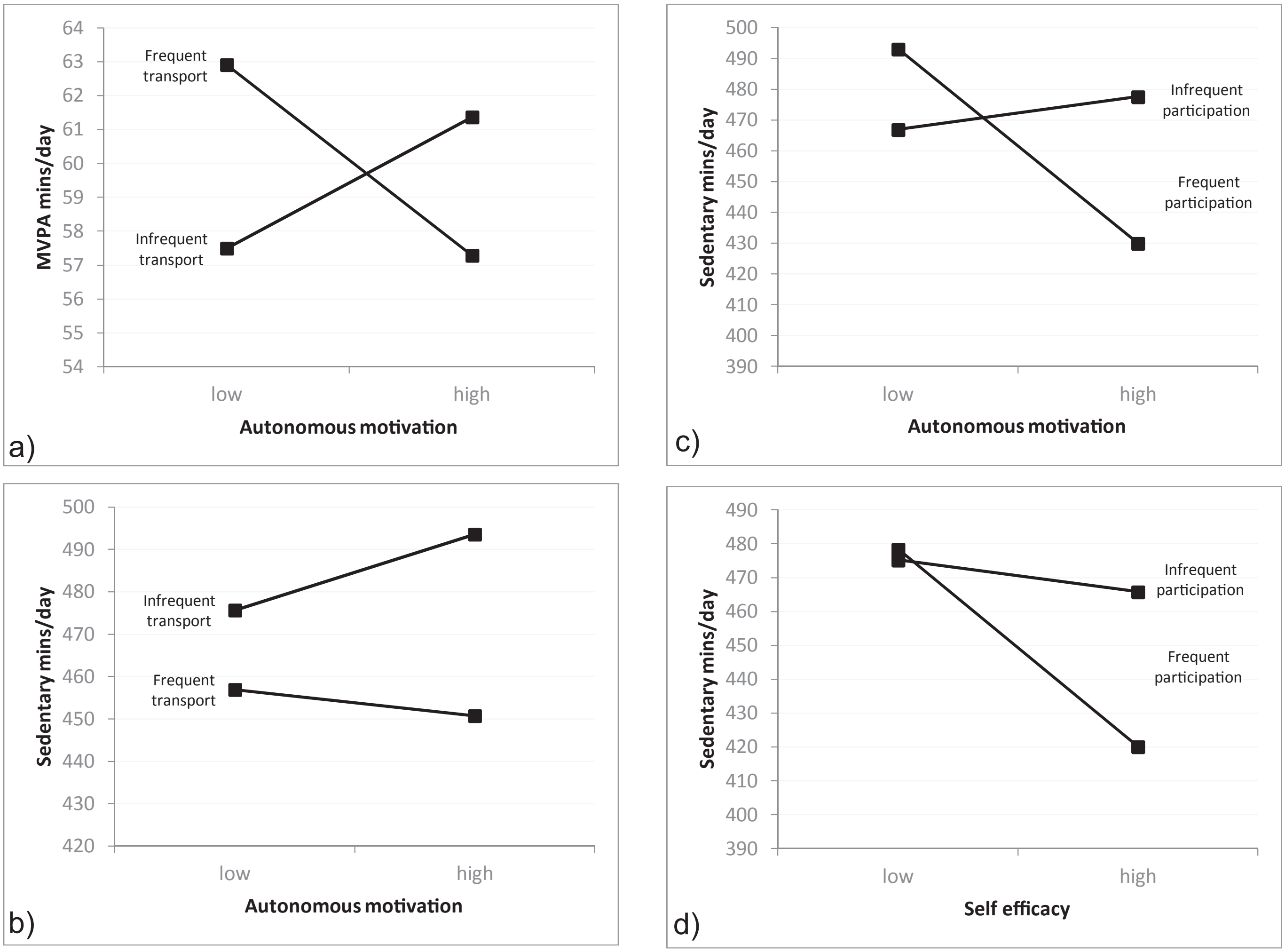

Fig. 1. Interaction effects predicting MVPA and sedentary time in girls. **a)** Weekday MVPA: interactions with motivation and transport. **b)** Weekend Sedentary time: interactions with motivation and transport. **c)** Weekend Sedentary time: interactions with motivation and participation. **d)** Weekend Sedentary time: interactions with self-efficacy and participation.

being sedentary, even if the activity they do take in its place does not reach the level of MVPA. Past work has shown that lower sedentary time tends to be associated with higher MVPA (Springer, Kelder, & Hoelscher, 2006), so it may be that our results differ from previous findings due to the simultaneous negative impact of providing transport on MVPA (as discussed previously). This moderation effect appears logical if considering the quality of engagement from an SDT perspective (Standage & Ryan, 2012). Girls who are more motivated towards physical activity would be likely to show greater engagement and persistence, and thus spend more time in non-sedentary pursuits when provided the opportunity by their parents (i.e., for the same frequency of opportunity, time engaged in the activity will be greater).

It would be informative to study other potential relationships between these factors using longitudinal data, for example whether (i) children's motivation towards exercise influences parent encouragement (in that parents do not have the opportunity to watch, provide transport to, or take part in physical activity with their child, if he or she does not want to get involved), (ii) whether the opposite may be true in that parental encouragement fosters self-efficacy and motivation, or (iii) whether there is a reciprocal relationship. The potential for parent support to influence motivation and self-efficacy is certainly consistent with theoretical frameworks. Within SDT, important others such as parents can help to shape physical activity experiences to the extent they provide support for their child's basic psychological needs (autonomy, competence, and relatedness) (Deci, Eghrari, Patrick, & Leone, 1994), and consequently autonomous motivation (see Standage & Ryan, 2012). Self-efficacy can also be promoted by verbal persuasion (or implicit communication of belief in one's abilities) if the person providing the persuasion is considered to be sufficiently expert (Trost et al., 2003).

4.1. Strengths and limitations

The present study advances our understanding of the multifaceted predictors of children's physical activity levels in the UK, by providing an analysis of the interactive effects of parent support with children's motivation and self-efficacy, and via the use of objectively measured physical activity and sedentary behaviour. However, the use of cross-sectional data limits the extrapolation of these findings as causal effects cannot be inferred. In addition, other research has shown a wider set of parental influences to promote MVPA in children than were studied here, namely modelling, attitudes, and parents' own physical activity levels (Beets et al., 2007; Edwardson & Gorely, 2010; Verloigne et al., 2011). Similarly, factors such as parenting style and rules have been shown to have significant associations with sedentary time

(He, Harris, Piche, & Beynon, 2009), so studies with a specific focus on understanding the determinants of sedentary behaviour may benefit from extending the range of parent-level factors to include such parenting practices.

The present study is also limited to some degree by the measures used. Specifically, due to the large number of questionnaires that parents and children were asked to complete in ISCOLE a brief measure of parent support was selected with each domain measured by a single, self-report item, and an abbreviated version of the BREQ-2 was used, comprising only one single item for each motivational regulation. Despite the range of measures included, the size of effects reported in the hypothesised models were relatively small. This indicates that there are other factors not included in the model that are important in driving children's physical activity. The lack of significant interaction effects could also be due to a lack of power; the sample size was calculated to provide sufficient power for the wider multi-site analysis predicting obesity across 12 countries, and not for within-country interaction effects.

4.2. Conclusions

Parental support for physical activity does not appear to moderate the association between children's motivation and self-efficacy towards exercise and their objectively measured physical activity, beyond a single negative effect found for providing transport to exercise facilities for highly motivated girls. However, parental support, and in particular providing encouragement, may be independently associated with greater levels of MVPA, although the strength of this association may differ between genders, and between week and weekend days. Parental support did appear to have a moderating effect on sedentary time for girls; for girls who have a high self-efficacy and are motivated to be active, providing transport, and being active alongside one's child was associated with a reduction in sedentary time at weekends.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.psychsport.2017.07.004.

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