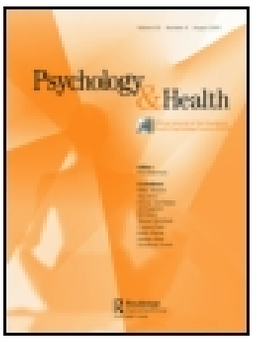

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Interpersonal effects of parents and adolescents on each other's health behaviours: a dyadic extension of the theory of planned behaviour

Keven Joyal-Desmarais[a], Richie L. Lenne[a], Mary E. Panos[a], Chloe O. Huelsnitz[a], Rachael E. Jones[a], Lisa A. Auster-Gussman[a], William F. Johnson[b], Jeffry A. Simpson[a] and Alexander J. Rothman[a]

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ABSTRACT

Objective: Interpersonal relationships are important predictors of health outcomes and interpersonal influences on behaviours may be key mechanisms underlying such effects. Most health behaviour theories focus on *intrapersonal* factors and may not adequately account for *interpersonal* influences. We evaluate a dyadic extension of the Theory of Planned Behaviour by examining whether parent and adolescent characteristics (attitudes, subjective norms, perceived behavioural control and intentions) are associated with not only their own but also each other's intentions/behaviours.

Design: Using the Actor-Partner Interdependence Model, we analyse responses from 1717 parent-adolescent dyads from the Family Life, Activity, Sun, Health, and Eating study.

Main Outcome Measures: Adolescents/parents completed self-reports of their fruit and vegetable consumption, junk food and sugary drinks consumption, engagement in physical activity, and engagement in screen time sedentary behaviours.

Results: Parent/adolescent characteristics are associated with each other's health-relevant intentions/behaviours above the effects of individuals' own characteristics on their own behaviours. Parent/adolescent characteristics covary with each other's outcomes with similar strength, but parent characteristics more strongly relate to adolescent *intentions*, whereas adolescent characteristics more strongly relate to parent *behaviours*.

Conclusions: Parents and adolescents may bidirectionally influence each other's health intentions/behaviours. This highlights the importance of dyadic models of health behaviour and suggests intervention targets.

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Theory of Planned Behaviour; interpersonal influence; parent-adolescent relationships; health behaviour; dyadic models; FLASHE

Introduction

People's close relationships are strong predictors of early mortality risk (Holt-Lunstad, Smith, & Layton, 2010), which has been attributed to the physiological consequences

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of social interactions (Hostinar, Sullivan, & Gunnar, 2014; Uchino, 2006). Yet close relationship partners also tend to engage in similar health practices (Meyler, Stimpson, & Peek, 2007; Pachucki, Jacques, & Christakis, 2011), likely because close others play an important role in changing and maintaining each other's behaviours (Jackson, Steptoe, & Wardle, 2015; Lewis & Butterfield, 2007; Martire & Helgeson, 2017). Research has recently begun to examine the specific psychological factors that underlie interpersonal effects on health behaviours (e.g. Howland et al., 2016; Guidetti, Cavazza, & Conner, 2016). The current study advances these efforts by evaluating a dyadic extension of the Theory of Planned Behaviour whereby the psychological characteristics (e.g. attitudes, subjective norms, perceived behavioural control) of parents and their adolescent children predict not only their *own* health intentions and behaviours but also *each other's* intentions and behaviours (see Figure 1). We further evaluate such effects across four behavioural domains (fruit and vegetable consumption; junk food and sugary drinks consumption; engagement in physical activity; engagement in screen time sedentary behaviours).

How well do health behaviour theories account for interpersonal influence?

Most psychological theories of health behaviour focus on *intrapersonal* explanations, such as how individuals' *own* characteristics relate to their *own* behaviours (Ajzen, 1991; Prochaska, Norcross, & DiClemente, 2013; Sheeran, Klein, & Rothman, 2017). For example, the Theory of Planned Behaviour (TPB; Ajzen, 1991; Armitage & Conner, 2001) maintains that people's *attitudes* (e.g. 'I think exercise is good'), *subjective norms* (e.g. 'I think others believe exercise is good') and *perceived behavioural control* (PBC; e.g. 'I'm confident in my ability to exercise') predict their *intentions* (e.g. 'I will exercise'), which in turn predict their *behaviours* (e.g. exercising). *Inter*personal explanations, which delineate how *other* people's characteristics affect a person's behaviour, have received less attention. The TPB and similar theories acknowledge the influence of other people on individuals' behaviours, but this effect is operationalised *through* intrapersonal channels (e.g. how alcohol consumption by adolescents' peers influence their own drinking by changing their subjective norms regarding alcohol).

Such accounts of interpersonal influence are insufficient for several reasons. First, if interpersonal factors (e.g. a friend's attitudes) exert influence through intrapersonal factors (e.g. one's own subjective norms), assessing *only* intrapersonal factors do not allow inferences regarding *which* interpersonal factors matter or how strongly each operate. Second, when only intrapersonal factors are assessed, one cannot rule out that interpersonal factors also contribute to a person's decisions and behaviour independent of the intrapersonal factors examined. This is important as studies using a dyadic approach to model health behaviours (i.e. assess the same beliefs and behaviours in both relational partners) find that the beliefs of relationship partners often predict each person's behaviour, even when accounting for people's own characteristics. For example, in a study of cancer screening, wives' and husbands' attitudes predicted both their own and each other's screening intentions (Manne, Kashy, Weinberg, Boscarino, & Bowen, 2012). Similarly, in parent-adolescent dyads, each person's

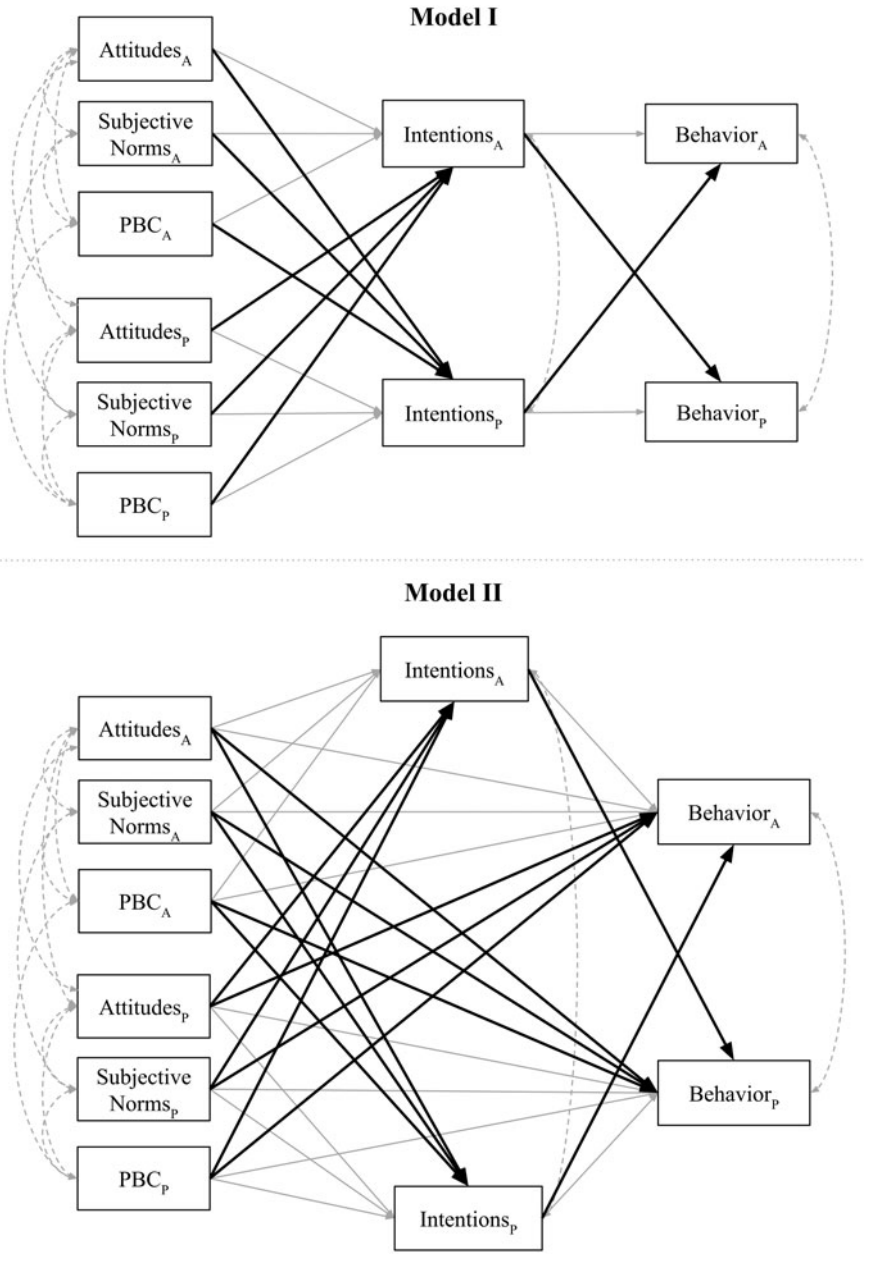

Figure 1. Subscripts denote Adolescent (A) and Parent (P) variables. PBC, perceived behavioural control. Bold unidirectional paths represent interpersonal (partner) effects. Grey unidirectional paths represent intrapersonal (actor) effects. Grey dashed paths represent correlations that account for interdependence between dyad members (i.e. correlations between all equivalent variables between persons), and similarity in item responses within person (e.g. correlations between adolescent attitudes, subjective norms, and PBC). Correlations between different belief types across persons are not included (e.g. between adolescent attitudes and parent PBC).

autonomous motivation to consume fruits/vegetables also predicted their own and each other's eating behaviour (Dwyer et al., 2017). These findings reinforce calls to test dyadic health behaviour models that specify both intrapersonal and interpersonal factors (Howland et al., 2016; Karney et al., 2010).

Developing a dyadic extension of the theory of planned behaviour

One way to develop dyadic models of health behaviour is to extend current theories by adding interpersonal effects that mirror intrapersonal effects. For example, the TPB posits that a person's attitudes, subjective norms and PBC predict their intentions. A dyadic extension can incorporate the effects of a *close other's* attitudes, subjective norms and PBC on her or his own intentions (*intrapersonal* effects), along with the effects of the close other's own attitudes, subjective norms and PBC on her or his partner's intentions (*interpersonal effects*; Karney et al., 2010). Dyadic models also account for within-dyad similarity by modelling the correlation between partners' characteristics and outcomes (e.g. between their attitudes; Kenny, Kashy, & Cook, 2006). Howland et al. (2016), for example, evaluated whether romantic partners' beliefs (attitudes, subjective norms and PBC) were associated with each other's physical activity *intentions* and found interpersonal effects for each person's PBC. Their model, however, was only a partial extension of the TPB because they did not examine associations with *behaviour*.

The current study tests a more complete dyadic extension of the TPB by examining whether and how both relationship partners' attitudes, subjective norms, PBC and intentions are associated with each other's health intentions *and* behaviours. We analyse data from a U.S. national survey of 1717 parent-adolescent dyads (Nebeling et al., 2017) that assessed health beliefs and behaviours for both dyad members across four domains: fruit and vegetable consumption (FV), junk food and sugary drinks consumption (JF), engagement in physical activity (PA) and engagement in screen time sedentary behaviours (SB). To date, dyadic studies of health behaviour have focused on romantic relationships (e.g. Howland et al., 2016; Martire & Helgeson, 2012) but there is growing interest in parent–adolescent relationships (e.g. Guidetti, Cavazza, & Graziani, 2014; Guidetti et al., 2016), the dynamics of which differ substantially from romantic relationships. For instance, parents can use their power to obtain acquiescence from their adolescents (Henry, Wilson, & Peterson, 1989) in ways that romantic partners cannot. Because adolescence is a time in which children seek greater autonomy and relative power (Koepke & Denissen, 2012), adolescents may also exert influence on their parents (e.g. by playing an active role in grocery shopping). Dyadic models can provide insights into these dynamics by explicitly modelling the interpersonal effects of parents on adolescents and of adolescents on parents.

We examine two alternative conceptualisations of a dyadic extension of the constructs identified by the TPB (see Figure 1). Model I is grounded on the assumption that all influences on people's behaviour (intrapersonal and interpersonal) occur *indirectly* through intentions. Model II allows these effects to occur either through intentions or *directly* on behaviour. According to the TPB, PBC can directly affect people's *own* behaviour, but it is unclear whether PBC and *only* PBC has a direct effect on

another person's behaviour. Because we cannot rule out any interpersonal pathway *a priori*, Models I and II offer contrasts to determine whether any given belief has indirect and/or direct interpersonal associations with behaviours.

We had several *a priori* expectations. First, consistent with intrapersonal tests of the TPB, we expected individuals with stronger attitudes, subjective norms and PBC regarding a given behaviour (FV, JF, PA or SB) to have stronger intentions to engage in that behaviour. Such intentions were expected to be associated with higher rates of that behaviour (Figure 1, grey paths). Second, we expected interpersonal effects (Figure 1, black paths) would emerge, above and beyond the intrapersonal effects in each model. We expected parents' (adolescents') attitudes, subjective norms and PBC for each behaviour to be associated with their adolescents' (parents') intentions, and parents' (adolescents') intentions to be associated with their adolescents' (parents') behaviour. We did not expect *all* interpersonal paths to be significant but did anticipate interpersonal effects would emerge for each behavioural domain.

Method

The FLASHE parent sample was recruited by the Ipsos Consumer Opinion Panel in all regions of the U.S. in 2014 (Oh et al., 2017; Pachucki, Jacques, & Christakis, 2017). Eligible parents (aged 18 years or older) lived with at least one adolescent (aged 12–17 years). For each household, one adolescent was randomly selected to participate with their parent. Five thousand and twenty-seven dyads were invited to participate and 1945 enrolled. Participants responded to two surveys that assessed diet (e.g. FV and JF beliefs and behaviours) and physical activity (e.g. PA and SB beliefs and behaviours). We analysed the data from all dyads that completed the diet ($N = 1646$) and/or the physical activity ($N = 1644$) surveys – 1717 dyads in all. Our adolescent sample was 50% female and 50% male, whereas parents were predominantly female (74%). Respondents predominantly identified as non-Hispanic White (70% of parents; 64% of adolescents), followed by non-Hispanic Black (17% of either parents/adolescents) and Hispanic (7% parents; 10% adolescents). Additional demographic information is available in Table S1 in the supplemental materials, and further details on FLASHE's methods/recruitment are available elsewhere (Mâsse & Lytle, 2017; Oh et al., 2017; Pachucki et al., 2017). Data were downloaded 4 April 2017 and can be obtained at https://cancercontrol.cancer.gov/brp/hbrb/flashe.html.

Preregistration

Our study protocol was preregistered prior to accessing FLASHE data (osf.io/zvzke) and our analysis code is available online (osf.io/x3jav). We followed our preregistration, with two exceptions. First, we did not preregister an intentions measure, but added it later to better capture the TPB. Analyses excluding intentions are consistent with the results here. Second, we did not preregister analyses for the SB domain, but applied the protocol specified for the other domains. We also preregistered moderation analyses, but report them elsewhere (Lenne et al., 2018).

Measures

Beliefs and intentions

Although FLASHE was not designed to assess TPB variables formally, it contained items that can be used to operationalise the four key constructs identified by the TPB. Attitudes, subjective norms, PBC and intentions were assessed separately for adolescents and parents for each behavioural domain using 5-point Likert-type response formats (1 = 'strongly disagree'; 5 = 'strongly agree'). Items assessing beliefs/intentions for FV and PA focused on engaging in these behaviours, whereas JF and SB items generally focused on limiting the behaviours. To facilitate comparisons across the four domains, items on limiting behaviours were reverse-scored, such that higher scores indicated more positive beliefs/intentions towards engaging in the behaviour. When multiple items assessed a construct, the mean was used. The unstandardised means and standard deviations are available in Table S2 in the supplemental materials.

Attitudes towards each behaviour were assessed with a single item, 'I would [engage in behaviour] because it's an important thing for me to do' (e.g. 'I would eat fruits and vegetables every day because it's an important thing for me to do'). Two additional items were used to assess attitudes towards PA ('If I were to be physically active most days of the week, it would be fun' and 'I don't like to exercise' [reverse-coded]; standardised coefficient alphas [α_s] were .67 for parents, and .65 for adolescents). Two items measured *subjective norms* for adolescents. The first assessed adolescents' perception of their peers' behaviours (i.e. a descriptive norm; 'My friends [engage in behaviour] most days of the week') and the second assessed their perception of how peers would react if they engaged in a certain behaviour (i.e. an injunctive norm; 'I would [engage in behaviour] because others would be upset with me if I didn't'). The two items were discrepant (α_s= .10, -.08, .27 and -.18 for FV, JF, PA and SB, respectively); this is typical as injunctive and descriptive norms are independent aspects of subjective norms (Rivis & Sheeran, 2003). Parents completed only the item assessing the injunctive norm. *PBC* was assessed using one item asking about parents' and adolescents' confidence in their ability to enact each health behaviour ('I feel confident in my ability to [engage in behaviour]'). Finally, parent and adolescent *intentions* to enact each behaviour were assessed with one item: 'I would [engage in behaviour] because I have thought about it and decided that I want to [engage in behaviour]'.

Behavioural assessments

Items assessing FV, JF, PA and SB were selected following NCI's recommendations and standard practice, ensuring that parents/adolescents completed age-appropriate measures. Each construct was coded such that higher scores indicated more engagement in each behaviour.

Fruit/vegetable and junk food/sugary drinks consumption (FV/JF). To assess FV/JF, FLASHE employed items from the Dietary Screener Questionnaire used in the 2009–2010 *National Health and Nutrition Examination Survey* (NHANES; Epidemiology & Genomics Research Program, National Cancer Institute, 2016) and the *National Youth Physical Activity and Nutrition Survey* (Centers for Disease Control and Prevention, 2010). Items were modified to be age-appropriate. Six-point scales assessed the frequency with which participants consumed various foods over the prior seven days (1 = not having

consumed the food; 6 = 3 or more times per day). Following Dwyer et al. (2017), six items assessed FV consumption (e.g. apple, bananas, green salad) and 16 items assessed JF consumption (e.g. candy or chocolate, ice cream or other frozen desserts, potato chips, corn chips, cheese puffs). Adolescents and parents completed the same items, and mean scores were calculated for each variable (FV, JF). The NHANES dietary screener was validated against a 24-hour recall of diet in several studies (e.g. Thompson, Midthune, Kahle, & Dodd, 2017). Additional information about FLASHE's dietary screener is available (Sparks & Guthrie, 2017).

Physical activity/Screen time sedentary behaviour (PA/SB). Adolescent PA was assessed using the Youth Activity Profile (YAP; Saint-Maurice & Welk, 2017; Saint-Maurice & Welk, 2015). We used eight items from the YAP, excluding items assessing activities that took place in school. Example items asked adolescents to 'summarize [their] level of activity last week' (1= 'I did not do any physical activity in my free time'; 5 = 'I very often [7 or more times] did physical activity in my free time') or to indicate the number of days during the week they walked/biked to or from school (0 = '0 days [never]'; 4 = '4-5 days [most every day]'). Items were scaled from zero to one, and a mean was calculated. Parent PA was assessed with the International Physical Activity Questionnaire (IPAQ) Short Form (Craig et al., 2003), which asked them to indicate the number of days during the prior week they engaged in at least 10 minutes of walking, moderate activity, or vigorous activity, and the usual amount of time spent in those activities each day. The IPAQ was scored in units of metabolic equivalent task (MET) minutes following recommended protocol (The IPAQ Group, 2016). The YAP and IPAQ have been validated against accelerometer data (Craig et al., 2003; Saint-Maurice & Welk, 2017; Saint-Maurice & Welk, 2015).

For adolescent SB, we used the mean of four items from the YAP (Saint-Maurice & Welk, 2017; Saint-Maurice & Welk, 2015) that assessed average free time per day spent using the computer or a cell phone, watching TV, and playing videogames during the preceding 7 days (1= 'I didn't really use [device] at all'; 5 = 'I used [device] more than 3 hours'). For parent SB, we used six items from the Project Eat Surveys (Taverno Ross, Larson, Graham, & Neumark-Sztainer, 2014), the Growing Up Today Study (Falbe et al., 2013) and the TREC Idea Study (Lytle, 2009), some of which were modified for FLASHE. Items were similar to the adolescent items and assessed time per day spent using the computer or a cell phone, watching TV, playing handheld/console videogames, or using electronic readers (1= not at all; 6 = 6+ hours). We calculated mean scores for each parent but truncated 20 outliers such that scores reflect engaging in SB for no more than 18 hours a day; this decision did not affect our conclusions.

Statistical analyses

We conducted analyses using the Actor-Partner Interdependence Model (APIM; Koepke & Denissen, 2006). The APIM uses nested structures to test the independent contribution of *actor* effects (i.e. intrapersonal effects, such as adolescent attitudes on adolescent behaviour) and *partner* effects (i.e. interpersonal effects, such as parent attitudes on adolescent behaviour). Following APIM procedures, we examined Models I and II using structural equation modelling with the lavaan package (Rosseel, 2012) in R (R

Core Team, 2017). Models were specified according to the path diagrams in Figure 1, using full information maximum likelihood estimation to handle missing data. Prior to analyses, we applied log-transformations on skewed variables (adolescent JF behaviour; parent JF and PA behaviours) and standardised variables to ease comparisons.

Results

We present the actor effects followed by summaries of the partner effects. We compare the average partner effects for (1) adolescent-to-parent versus parent-to-adolescent and (2) intention versus behaviour outcomes. Bivariate correlations are presented in Table S3–S6 of the supplemental files. Table 1 presents the fit indices for Models I and II for each behavioural domain. Model I explained a medium-to-large proportion of the variance in parent and adolescent behavioural intentions (33.3–52.5%) but explained less variance in parent and adolescent behaviour (0.3–16.4%). Model II consistently accounted for more variance in behaviour (2.9–31.2%) than Model I and almost always yielded better fit indices.

Actor effects within a dyadic extension of the TPB

Table 2 presents the actor effects for Models I and II for each behavioural domain. According to the TPB, people's attitudes, subjective norms and PBC should be positively associated with their intentions, and their intentions should be positively associated with their behaviour. Among the 32 actor effects representing these pathways in Model I, 31 were significant and positive. Of the same 32 effects in Model II, 28 were significant and positive. Model II also allowed us to test direct effects of PBC on each of the four health behaviours. These effects were significant and positive for three of the four behaviours. This pattern of results is consistent with traditional TPB hypotheses and reveals that these effects generally remain significant even when controlling for the TPB beliefs/intentions of close others.

Table 1. Model I and Model II: APIM fit statistics and R^2.

	Model I				Model II			
	FV	JF	PA	SB	FV	JF	PA	SB
CFI	0.920	0.948	0.826	0.944	0.981	0.989	0.962	0.966
RMSEA	0.102	0.074	0.165	0.083	0.086	0.058	0.133	0.112
SRMR	0.073	0.046	0.118	0.064	0.050	0.029	0.088	0.058
R^2 for intentions								
Parent	0.330	0.424	0.373	0.523	0.330	0.424	0.373	0.523
Adolescent	0.386	0.368	0.347	0.431	0.386	0.368	0.347	0.431
R^2 for behaviour								
Parent	0.158	0.036	0.089	0.003	0.201	0.093	0.218	0.034
Adolescent	0.164	0.029	0.117	0.004	0.234	0.06	0.312	0.029

Notes: Model II's coefficients of determination (R^2) for intentions (lighter grey) are equivalent to those for Model I. APIM = Actor-Partner Interdependence Model; FV = fruit and vegetable consumption; JF = junk food and sugary drinks consumption; PA = physical activity; PBC = perceived behavioural control; SB = screen time sedentary behaviour. Ideal model fit was defined as a CFI close to or higher than .95, a RMSEA close to or less than .06, and a SRMR close to or lower than .08 (Hu & Bentler, 1999). Most models had good fits, approaching or surpassing the CFI and SRMR thresholds most of the time, but RMSEA tended to be higher than .06. RMSEA values were not interpreted as problematic, given that this index can be a poor indicator of fit for complex models (Iacobucci, 2010).

Table 2. Standardised intrapersonal (actor) effect estimates from APIM models in Figure 1.

				Model I				Model II[a]			
Actor	Outcome	~	Predictor	FV	JF	PA	SB	FV	JF	PA	SB
Parent											
	Intention	~	Attitudes	0.471***	0.587***	0.486***	0.601***	0.472***	0.587***	0.487***	0.601***
		~	Norms	0.082***	0.079***	0.125***	0.184***	0.082**	0.079***	0.125***	0.184***
		~	PBC	0.188***	0.150***	0.166***	0.113***	0.189***	0.149***	0.165***	0.112***
	Behaviour	~	Intentions	0.325***	0.183***	0.268***	0.041	0.218***	0.119***	0.018	0.065[t]
		~	Attitudes	–	–	–	–	0.054*	0.064*	0.050*	0.000
		~	Norms	–	–	–	–	0.042[t]	–0.16***	0.208***	−0.116***
		~	PBC	–	–	–	–	0.198***	0.156***	0.032	0.12***
Adolescent											
	Intention	~	Attitudes	0.377***	0.463***	0.446***	0.482***	0.377***	0.463***	0.446***	0.482***
		~	Norms	0.066**	0.049*	0.094***	0.171***	0.066**	0.049*	0.094***	0.171***
		~	PBC	0.320***	0.259***	0.124***	0.200***	0.320***	0.259***	0.124***	0.199***
	Behaviour	~	Intentions	0.367***	0.159***	0.333***	0.061*	0.197***	0.105***	0.022	−0.011
		~	Attitudes	–	–	–	–	0.009	0.019	0.301***	−0.002
		~	Norms	–	–	–	–	0.114***	0.102***	0.131***	0.115***
		~	PBC	–	–	–	–	0.245***	0.098***	0.244***	0.106***

Notes: APIM = Actor-Partner Interdependence Model; FV = fruit and vegetable consumption; JF = junk food and sugary drinks consumption; PA = physical activity; PBC = perceived behavioural control; SB = screen time sedentary behaviour.

[a]Because the modelling of intentions is identical across Models I and II, estimates for Model II are presented in lighter grey font.

***$p < .001$;

**$p < .01$;

*$p < .05$;

[t]$p < .10$.

Model II also examined whether attitudes and subjective norms were directly associated with behaviour over the association between intentions and behaviour. Attitudes typically were positively associated with behaviour for parents (3 significant paths of 4), but not for adolescents (1 significant path of 4). Subjective norms were related to behaviour for both parents and adolescents (7 significant paths of 8). Unexpectedly, parents' subjective norms were negatively associated with their JF and SB behaviours, whereas all adolescent actor effects were positive.

Partner effects within a dyadic extension of the TPB

Table 3 presents all estimated partner effects for Models I and II for each behavioural domain. Significant partner effects emerged for every model (see columns of Table 4); 13 significant partner effects were found for Model I, and 21 were found for Model II. Table 4 presents the average absolute (i.e. non-directional) *magnitude* of all partner effects, broken down by type of partner effect (i.e. regressing adolescent outcomes on parent variables versus parent outcomes on adolescent variables) and type of outcome (i.e. partner effects on intentions versus behaviours). Using the information in Tables 3 and 4, we describe the *frequency* with which partner effects were significant and the average *magnitude* of each effect type. Across the four behavioural domains, there were slightly fewer adolescent-to-parent than parent-to-adolescent partner effects (Model I: 5 vs. 8 significant effects; Model II: 10 vs. 11 significant effects). However, the average magnitude of partner effects was similar between adolescent-to-parent and parent-to-adolescent effects (see Table 4). The results from Models I and II are equivalent when accounting for *intentions*. Overall, adolescent-to-parent partner effects were less frequently significant than parent-to-adolescent partner effects (3 vs. 6 significant effects) and were smaller in average magnitude (.023 vs. .039). When accounting for *behaviours*, adolescent-to-parent partner effects were slightly more frequently significant than parent-to-adolescent partner effects in Model II (7 vs. 5 significant effects), but not Model I (2 vs. 2 significant effects). However, in both Models, the average magnitude of adolescent-to-parent partner effects was greater than that of parent-to-adolescent partner effects (Model I: .088 vs. .060; Model II: .063 vs. .039).

Discussion

Evidence of intrapersonal effects delineated by the TPB

The intrapersonal paths specified by the traditional TPB – both in Models I and II – were statistically significant in the theorised direction, with only a few exceptions. This is noteworthy because these intrapersonal effects controlled for their interpersonal counterparts, resulting in greater precision. Estimating only intrapersonal effects when partners are non-independent (e.g. when their attitudes are correlated) can lead to overestimation, and similar biasing can arise when interpersonal effects are estimated without controlling for intrapersonal effects. Dyadic models improve inferences by modelling both types of effects explicitly (Koepke & Denissen, 2006).

Table 3. Standardised interpersonal (partner) effect estimates from APIM Models in Figure 1.

			Model I				Model II[b]			
Effect type and outcome	~	Predictor[a]	FV	JF	PA	SB	FV	JF	PA	SB
Adolescent-to-parent effects										
Parent intention	~	Attitudes	0.039^{t}	0.047*	0.004	0.017	0.039^{t}	0.047*	0.004	0.018
	~	Norms	0.053*	0.047*	−0.001	0.021	0.053*	0.047*	−0.002	0.021
	~	PBC	0.013	−0.008	0.021	0.005	0.012	−0.008	0.022	0.005
Parent behaviour	~	Intentions	0.180***	0.030	0.100***	−0.040	0.112***	0.047	0.298***	−0.005
	~	Attitudes	–	–	–	–	−0.005	−0.054^{t}	−0.008	−0.055^{t}
	~	Norms	–	–	–	–	0.089***	0.084***	0.070**	0.052^{t}
	~	PBC	–	–	–	–	0.055*	0.008	−0.005	−0.057*
Parent-to-adolescent effects										
Adolescent intention	~	Attitudes	0.023	0.016	0.074**	0.052*	0.023	0.016	0.074**	0.052*
	~	Norms	0.071***	0.067***	0.014	0.048*	0.071***	0.067***	0.014	0.049*
	~	PBC	0.019	0.045*	0.018	0.015	0.018	0.045*	0.018	0.014
Adolescent behaviour	~	Intentions	0.122***	0.043^{t}	0.056*	0.020	0.081**	0.017	−0.006	0.047
	~	Attitudes	–	–	–	–	−0.008	0.036	0.003	−0.018
	~	Norms	–	–	–	–	0.077***	−0.121***	0.005	−0.066*
	~	PBC	–	–	–	–	0.063**	0.026	0.01	0.035

Notes: APIM = Actor-Partner Interdependence Model; FV = fruit and vegetable consumption; JF = junk food and sugary drinks consumption; PA = physical activity; PBC = perceived behavioural control; SB = screen time sedentary behaviour.

[a]Predictors are characteristics of the partner (i.e. parent outcomes are predicted by adolescent characteristics; adolescent outcomes are predicted by parent characteristics).

[b]Because the modelling of intentions is identical across Models I and II, estimates for Model II are presented in lighter grey font.

***$p < .001$;

**$p < .01$;

*$p < .05$;

$^{t}p < .10$.

Table 4. Summary of interpersonal (partner) effect patterns across behaviours.

	Model I mean effect sizes						Model II mean effect sizes[a]					
Partner effect type	Paths in model	FV	JF	PA	SB	All domains	Paths in model	FV	JF	PA	SB	All domains
Partner effects on *all outcomes*												
Adolescent-to-parent effects	4	0.071	0.033	0.032	0.021	0.039	7	0.059	0.042	0.058	0.030	0.047
Parent-to-adolescent effects	4	0.059	0.043	0.041	0.034	0.044	7	0.049	0.047	0.019	0.040	0.039
Partner effects on *intentions*												
Adolescent-to-parent effects	3	0.035	0.034	0.009	0.014	0.023	3	0.035	0.034	0.009	0.015	0.023
Parent-to-adolescent effects	3	0.038	0.043	0.035	0.038	0.039	3	0.037	0.043	0.035	0.038	0.038
Partner effects on *behaviours*												
Adolescent-to-parent effects	1	0.180	0.030	0.100	0.040	0.088	4	0.065	0.048	0.095	0.042	0.063
Parent-to-adolescent effects	1	0.122	0.043	0.056	0.020	0.060	4	0.057	0.050	0.006	0.042	0.039

Notes: Means are of the absolute, non-directional effect sizes. FV = fruit and vegetable consumption; JF = junk food and sugary drinks consumption; PA = physical activity; SB = screen time sedentary behaviour.

[a]Because the modelling of intentions is identical across Models I and II, estimates for Model II are presented in lighter grey font.

Evidence of interpersonal effects in the dyadic extension of the TPB

We found statistically significant partner effects for Models I and II in *each* behavioural domain (FV, JF, PA and SB) and on *both* intentions and behaviours. Partner effects made significant contributions above actor effects in both models. This suggests it is unlikely that partners exert their influence solely through changes in actors' own beliefs, as such effects were accounted for by modelling correlations among each corresponding TPB variable between parents and adolescents. Since intrapersonally oriented TPB intervention strategies can elicit change in behaviours (Simpson, Farrell, Oriña, & Rothman, 2016), there is value in determining whether eliciting change in partners' beliefs is also effective. Findings from future longitudinal and experimental research will also determine whether the partner effects observed in this correlational study are causal.

Bidirectional influence

Overall, the direct partner effects from adolescent-to-parent and from parent-to-adolescent were comparable in frequency and magnitude, suggesting that interpersonal influences may often be bidirectional. Other studies also find bidirectional partner effects between children and parents (Coesens, De Mol, De Bourdeaudhuij, & Buysse, 2010; Dwyer et al., 2017). However, research on similarity in parent–child behaviour typically emphasises parental influence on their children's behaviours (Guidetti, Conner, Prestwich, & Cavazza, 2012; Golan & Crow, 2004; Lewis & Butterfield, 2007) without considering the influence of children on their parents. Given that children can influence their parents' decisions (e.g. affecting purchases; Wilson & Wood, 2004), future interventions might examine the effects of strategies that target *both* influence channels. For example, do nutrition campaigns that target adolescent characteristics also elicit changes in parental eating behaviour? Could interventions leverage adolescent-to-parent and parent-to-adolescent influence channels synergistically to promote behaviour maintenance? Further developments in dyadic theories of health behaviour could inform such efforts.

Intentions versus behaviours

On average, parent characteristics were more strongly associated with adolescent *intentions* than were adolescent characteristics with parent intentions. However, adolescent characteristics were more strongly associated with parent *behaviours* than were parent characteristics with adolescent behaviours. Additionally, parent characteristics were similarly associated with adolescent intentions *and* behaviours, but adolescent characteristics were more strongly associated with parent behaviours than intentions. What might account for these patterns? Some of these differences may arise from qualities unique to the social roles played by parents and children. For example, parents tend to have more power than adolescents, and power affects the ways in which individuals influence one another (Simpson, Farrell, Oriña, & Rothman, 2015). Parents typically have greater authority and credibility, which helps them persuade their adolescents to change their *intentions* (Pornpitakpan, 2004). Adolescents may have more difficulty changing their parents' *intentions*, but may persist in

requesting an outcome (e.g. eating pizza) until their parents give in (e.g. McDermott, O'Sullivan, Stead, & Hastings, 2006). Such concessions do not require parents to change their general intentions towards a behaviour. For example, parents may intend to avoid a behaviour (e.g. JF/SB), but find themselves occasionally capitulating, creating discrepancies between their intentions and behaviours.

Another difference in social roles is that parents are expected to support their children more than the reverse. Parents may accommodate their children by changing their behaviours (e.g. bike or play video games with their children to support a new interest), without requiring a change in their intentions to enact the behaviour for its own sake. Children, however, may be less likely to alter their behaviours simply for their parents' sake. Future research should delineate whether, when and why parents and children exert differential influence on each other's health-relevant intentions and behaviours. When addressing such questions, a developmental approach may prove insightful. For example, parents may exert greater influence on younger children's eating behaviours (e.g. by controlling their home food environment; Larsen et al., 2015) than on adolescents' eating behaviours, especially as they spend more time outside the home. In contrast, children's influence on their parents may increase over time as they learn how to better influence their parents through practice, and gain greater credibility and relative power as they age.

Comparing findings across attitudes, subjective norms and PBC

Of the three TPB belief variables, subjective norms had the largest number of partner effects on both intentions and behaviours. Attitudes had several significant associations with partner intentions, but they were not directly associated with partner behaviours, whereas PBC had several significant associations with partner behaviours, but fewer with partner intentions. These patterns differ from Howland et al. (2016), who found that PBC, but not attitudes or subjective norms, were associated with partner intentions. This may reflect differences between parent-adolescent and romantic relationships. However, there are too few dyadic health studies and models to interpret these differences meaningfully, and the possibility remains that these differences reflect methodological rather than psychosocial factors. Future research needs to establish which constructs are most likely to generate partner effects, how strong each effect is, and whether or how their operations vary across different types of relationships.

Additionally, the present study focused on the impact of *interpersonal* factors on parent and adolescent behaviours. Future research should examine *dyadic* or 'relationship-level' factors – characteristics that describe the dyad itself rather than either partner. These might include assessments of the overall quality of the relationship or engagement in joint planning activities (i.e. dyadic planning; Burkert, Scholz, Gralla, Roigas, & Knoll, 2011). Dyadic factors could be incorporated into future models as predictors or mediators of interpersonal effects (e.g. how dyadic planning predicts physical activity), or as moderators of interpersonal effects (e.g. relationship quality may moderate the magnitude of interpersonal effects; Howland et al., 2016).

Comparing findings across Model I and Model II

Model II offers a more complete but less parsimonious evaluation of interpersonal effects than Model I. Given that Model II fit indices outperformed Model I and many significant partner effects were observed between beliefs and behaviours, future studies should continue to examine the full set of pathways specified in Model II. Because some interpersonal paths may contribute less than others (e.g. we found no significant direct partner effect from attitudes to behaviour), future work should establish the reliability and usefulness of each pathway in Model II.

Comparing findings across behavioural domains

The degree to which TPB constructs account for intentions/behaviours varies across different behaviours (Meyler, Stimpson, & Peek, 2016). We extend research documenting variation in intrapersonal effects by examining how *interpersonal* effects also vary across behaviours.

Healthy versus unhealthy behaviours

Intentions more strongly covaried with healthy (FV and PA) than unhealthy (JF and SB) behaviours with respect to both intrapersonal and interpersonal effects. This may be because unhealthy behaviours, relative to healthy ones, are more responsive to contextual/impulsive factors (e.g. craving junk food and impulsively buying some) than to deliberate plans (e.g. a person may be less likely to plan to be sedentary; Hofmann, Friese, & Wiers, 2008). This distinction is reflected in how constructs were measured in the FLASHE survey. FV and PA items were framed around active engagement in a behaviour, whereas JF and SB items were framed in terms of limiting one's engagement in a behaviour. Given that cognitions about limiting a behaviour are distinct from those about doing a behaviour (Richetin, Conner & Perugini, 2011), future work should address this distinction.

Another difference between healthy and unhealthy behaviours was that parent (but not adolescent) subjective norms were negatively related to parent/adolescent behaviour for JF/SB. This was unexpected and all other significant associations with parent/adolescent subjective norms were positive. This may reflect the differential operation of doing versus limiting a behaviour (Rivis & Sheeran, 2011), but also of injunctive versus descriptive norms (Rivis & Sheeran, 2003), as our measure of subjective norms differed between parents/adolescents. Unfortunately, we cannot tease apart these explanations without a measure of parent descriptive norms. Future work should examine the reliability of these effects to ascertain that they are not methodological artefacts.

Eating versus physical activity behaviours

Adopting a dyadic, relational focus may reveal other meaningful distinctions between behavioural domains. There are certain behaviours that parents and adolescents may be more likely to engage in while in one another's presence. For example, eating behaviours may be more coordinated than physical activity behaviours and, if so, one might expect stronger patterns of interpersonal influence on eating behaviours. We found evidence consistent with this pattern, but differences in effect size were smaller

than between promoting healthy versus limiting unhealthy behaviours. Research has examined how parents influence their children/adolescents' physical activity (Beets, Cardinal, & Alderman, 2010) and eating behaviours (Wang, Beydoun, Li, Liu, & Moreno, 2011), but studies generally do not compare influences across domains (with some exceptions; e.g. Berge, Wall, Loth, & Neumark-Sztainer, 2010). Fewer studies, if any, take a dyadic perspective to consider how children/adolescents may influence their parents differentially across behavioural domains.

A critical need for longitudinal dyadic research

Although the FLASHE data are dyadic, they are also cross-sectional. Thus, the direction of our estimated effects cannot be ascertained. For instance, differences in behaviour may account for differences in intention (e.g. via social modelling), rather than the reverse (see Weinstein, 2007, on limitations of cross-sectional tests of health behaviour theories). Further, belief and intention items were framed in terms of future behaviour, or behaviour in general (i.e. without a time-frame), but participants reported *recent* patterns of behaviour. Though modelling behaviour as an outcome is common when working with cross-sectional data, doing so assumes that concurrently measured predictors are reflective of their status *preceding* the behaviour. If this assumption is false, it may make sense to model behaviour as a predictor of intention. Following a reviewer's suggestion, we tested an Alternative Model in which behaviour and the three TPB beliefs predict intention (see Figure S1 and Tables S7–S9 of the supplemental files). The results were congruent with those from Models I and II and supported the premise that interpersonal associations can be observed over and above intrapersonal ones. However, it remains that no inferences can be made regarding the temporal ordering of these effects. It is critical that future research efforts prioritise the collection of longitudinal dyadic data sets.

Limitations and strengths

The current study has several limitations and strengths. Although the interpersonal results were robust across the four behavioural domains, they should be viewed as preliminary evidence of partner effects. First, as discussed above, the FLASHE data are cross-sectional. Second, some TPB constructs were assessed with one or two items, limiting their reliability. Third, FLASHE was not formally designed to test the TPB, meaning that some items were operationalised slightly differently from traditional assessments used in TPB research. For example, intention items were framed in terms of wanting/deciding rather than intending, and an attitude item asked about the importance of the behaviour for *oneself*, possibly creating overlap with self-identity factors (Sparks & Guthrie, 1998). These deviations preclude us from drawing strong conclusions regarding each specific TPB predictor and underscore the value of replicating our findings with better assessments. That said, constructs used across health behaviour theories often overlap (Sheeran et al., 2017), and the items we used replicated prior intrapersonal TPB findings (Armitage & Conner, 2001; Meyler et al., 2016). Although we are limited in our ability to draw inferences about a given predictor, our

observation of interpersonal effects *across* predictors supports our claim that dyadic extensions to social-cognitive theories hold value.

Fourth, our behavioural measures consisted of self-reports and, therefore, relied on participants' ability to recall their behaviours. The IPAQ, YAP and NHANES dietary screener have each been validated against external measures (Craig et al., 2003; Saint-Maurice & Welk, 2017; Wang et al., 2017), but direct measures of behaviour remain the gold standard. Self-reports are prone to response biases, but they may affect estimates of intrapersonal effects more than interpersonal effects, given that the latter involve responses from two individuals.

There are also strengths. FLASHE was designed to evaluate dyadic models via the inclusion of many identical measures answered by both parents and their adolescents. Our analyses also involved 1717 dyads (3434 individuals), whereas many dyadic studies have much smaller sample sizes. FLASHE was designed to maximise sample similarity to many U.S. demographic variables (Oh et al., 2017; Pachucki et al., 2017). The effects, however, may not generalise to different types of relationships (e.g. romantic partners, friends) or to different regional/cultural contexts. Finally, the concurrent assessments of FV, JF, PA and SB allowed us to replicate findings across four distinct domains, increasing confidence in our results.

Conclusion

In this research, we evaluated a dyadic extension of the Theory of Planned Behaviour that modelled patterns of associations between parents and adolescents across four health behaviours. We obtained consistent evidence of interpersonal effects; each individual's characteristics were significantly associated with the other person's health-relevant intentions/behaviours, accounting for the effect of each individual's characteristics on their own intentions/behaviours. We observed stronger effects from parents-to-adolescents on adolescent *intentions*, and stronger effects from adolescents-to-parents on parent *behaviours*. These results underscore the importance of measuring and modelling dyadic influence on health behaviours.

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