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Physical Activity in Peri-Urban Communities: Testing Intentional and Implicit Processes within an Ecological Framework

Abstract

Background: Given the substantive health inequalities in peri-urban communities and the potential for physical activity to promote health in these communities, identifying modifiable physical activity determinants in this population is important. This study explored effects of the peri-urban environment and psychological constructs on physical activity intentions and behavioural automaticity guided by an integrated theoretical framework. **Methods:** Peri-urban Australians (*N*=271) completed self-report measures of environmental (i.e., physical/social-environment, and neighbourhood selection), motivational (i.e., autonomous motivation), and social cognition (i.e., attitudes, norms, and perceived behavioural control [PBC]) constructs, past behaviour, intentions, and automaticity. **Results:** A well-fitting path analytic model revealed that: autonomous motivation predicted all social cognition constructs; subjective norms and PBC, but not attitudes; autonomous motivation predicted intentions and automaticity; and subjective norms and PBC mediated effects of autonomous motivation on intentions. Of the environmental constructs, only neighbourhood selection was related to intentions, mediated by PBC. **Conclusions:** Autonomous motivation is an important correlate of physical activity intentions and automaticity, and subjective norms and PBC also related to intentions. Individuals perceiving a supportive environment were more likely to report positive PBC and intentions. Targeting change in autonomous motivation, and normative and control beliefs may help enhance physical activity intentions and automaticity in peri-urban communities.

Keywords: physical activity; intentions; automaticity; autonomous motivation; beliefs; integrated model

Physical Activity in Peri-Urban Communities: Testing Intentional and Implicit Processes within an Ecological Framework

The mission of the WHO Global Action Plan on Physical Activity 2018-2030 is "to ensure that all people have access to safe and enabling environments, and to diverse opportunities to be physically active in their daily lives, as a means of improving individual and community health and contributing to the social, cultural and economic development of all nations" (2018, p. 8). The plan aims to reduce physical inactivity globally by 15% by 2030 through the creation of active societies, environments, people, and systems. One strategy to achieve this goal is the introduction of programs for those who are least active. This necessitates identifying and targeting those who are at the greatest risk of inactivity.

In Australia, a population that is highly likely to be inactive are people living in inner-regional[1] or *peri-urban* communities. Peri-urban dwellers experience notable health inequalities compared to other Australians. Peri-urban Australians are more likely to suffer higher levels of psychological distress, blood pressure, and cholesterol, and to be diagnosed with respiratory and musculoskeletal diseases compared to city dwellers and people in more geographically remote areas (Torrens University Australia, 2017). In addition, 70% of people living in peri-urban communities participate in little or no physical activity (Australian Bureau of Statistics, 2015). More than 4.3 million people (18% of the total Australian population) live in peri-urban Australia (Australian Bureau of Statistics, 2018b), thus the health inequities experienced by this population represent a significant public health concern, which may be addressed through preventive health strategies aimed at increasing physical activity.

Research has demonstrated the importance of formative research and a theoretical basis for the development of effective behaviour-change interventions (Glanz & Bishop, 2010; Sheeran, Klein, & Rothman, 2017; Webb, Joseph, Yardley, & Michie, 2010). Consistent with

[1]Inner-regional Australia refers to a classification according to geographic remoteness specified within the Australian Statistical Geography Standard Remoteness Classification (ASGS-RS).

this evidence, developing means to increase physical activity participation among people living in peri-urban communities necessitates formative research identifying the determinants of inactivity in this population. Behavioural theories offer a systematic means to identify these determinants. A prominent approach to identify the determinants of physical activity has been to apply ecological theories. These theories posit that behaviour is a function of intrapersonal and interpersonal factors, the perceived environment, the characteristics of settings in which behaviour occurs, and policy-level factors (Sallis et al., 2006). Strategies designed to promote physical activity are likely to be most impactful if they account for these factors, and the processes by which they relate to behaviour (Bull, Eakin, Reeves, & Kimberly, 2006; Sallis, Owen, & Fisher, 2015).

Research aimed at identifying contextual characteristics that relate to physical activity from an ecological perspective has revealed that peri-urban dwellers perceive their neighbourhoods to be socially cohesive, aesthetically pleasing and safe, with good access to sports and recreational facilities, strong community support of local sporting teams, and activity-supportive social norms (Olson, March, Brownlow, Biddle, & Ireland, 2018). Such constructs have been also shown to be positively associated with physical activity in prior research (e.g., Ball et al., 2010; Foster et al., 2016; Kerr et al., 2016). In addition, distance from goods, services and facilities; poor pedestrian-mobility infrastructure; dangerous traffic conditions; and unfavourable weather have been identified as substantive as barriers to physical activity in peri-urban settings (Olson et al., 2018).

Beyond ecological correlates of physical activity in peri-urban communities, research has also aimed to identify the intrapersonal factors that determine physical activity participation from social-cognition theories. For example, research has provided some insight into the salient behavioural beliefs that relate to physical activity participation among people living in a peri-urban community (Olson, March, Clough, Biddle, & Ireland, 2019). Favourable outcome expectancies, varying normative beliefs among population sub-groups (e.g., people living on larger properties were perceived to be more active), and negative control beliefs (e.g., distance precluding walking as a means of transport and limited time available for recreational physical activity) were described as impacting physical activity participation. Notably, in environments that are defined by limited opportunities for social interaction, social interaction was reported as a favourable outcome of physical activity. However, it remains unclear whether these contextual characteristics and social-cognition factors are typical of the broader population of peri-urban Australians, and how intrapersonal factors, such as beliefs, relate to behaviour alongside other interpersonal and contextual factors. More broadly, although some studies have simultaneously examined effects of ecological and interpersonal constructs on physical activity intentions and behaviour (e.g., Lemieux & Godin, 2009; Panter, Griffin, Jones, Mackett, & Ogilvie, 2011; Thomas & Upton, 2014), such approaches are far from the norm and, bar a few notable exceptions (e.g., Shores, Moore, & Yin, 2010), there are virtually none in peri-urban and remote communities.

Whilst useful in providing an overview of the range of factors that contribute to health behaviour, ecological models do not specify the mechanisms by which these factors impact behaviour (Sallis, Owen, & Fisher, 2008). Researchers have called for the integration of ecological and social-cognition theories because they may offer enhanced, more comprehensive explanations of behaviour (e.g., Orbell, Szczepura, Weller, Gumber, & Hagger, 2017; Schüz, Li, Hardinge, McEachan, & Conner, 2017). Such calls are based on evidence that psychological factors from these theories mediate effects of social-demographic factors on behaviour (Orbell et al., 2017; Von Wagner, Good, Whitaker, & Wardle, 2011). This suggests that such constructs contribute to psychological states and beliefs which determine behaviour. In addition, recent advances in theories applied to predict and explain health behaviours like physical activity have sought to integrate components from multiple theories to facilitate more comprehensive explanations of behaviour, and the motivational and intentional processes involved.

One version of these integrated approaches was proposed by Hagger and Chatzisarantis (2009). The model integrates Ajzen's (1985) theory of planned behaviour (TPB) and Deci and Ryan's (1985) self-determination theory (SDT). The TPB identifies intentions as the most proximal predictor of participation in a given target behaviour, such as physical activity. Intentions, in turn, are predicted by beliefs relating to participating in that behaviour in future: attitudes, subjective norms, and perceived behavioural control (PBC). Consistent with the TPB, previous research has found that intentions explain a large proportion of variance in physical activity behaviour (e.g., Godin & Kok, 1996; Hagger, Chatzisarantis, & Biddle, 2002). In addition, interventions targeting change in the antecedents of intentions have demonstrated effective changes in in both intentions and behaviour (Sheeran et al., 2016; Steinmetz, Knappstein, Ajzen, Schmidt, & Kabst, 2016). According to SDT, qualitatively distinct forms of behavioural motivation drive behaviour. More autonomous forms of motivation reflect performing behaviours for self-endorsed reasons; and are positively associated with sustained participation in behaviours like physical activity (Teixeira, Carraça, Markland, Silva, & Ryan, 2012). In the integrated model, autonomous motivation is proposed to serve as a distal influence on intentions and behaviour mediated by the belief-based constructs from the TPB. Applying this process to physical activity, the model suggests that individuals with autonomous motives toward physical activity seek out future opportunities to participate in physical activity, and strategically form positive beliefs and intentions to do so.

While the integrated SDT and TPB model (Hagger & Chatzisarantis, 2009) demonstrates the importance of constructs representing motivational states and social cognition constructs in determining intentions, it does not incorporate effects of contextual factors. However, other integrated theoretical frameworks have simultaneously incorporated contextual factors alongside social-cognition determinants of physical activity participation, and specified the mechanisms by which these factors may relate to intentions and behaviour, consistent with calls to integrate ecological and social-cognition models (Orbell et al., 2017; Schüz et al., 2017). For example, Rhodes, Courneya, Blanchard, and Plotnikoff (2007) integrated personality, perceived environment, and planning, alongside constructs from the TPB to predict leisure-time walking. Results revealed that social-cognition constructs and ecological model constructs (i.e, aesthetics, infrastructure quality, and proximity to shops) explained 25% of the variance in physical activity behaviour. Consistent with previous finding (e.g., Orbell et al., 2017), statistically significant effects of both aesthetics and walking infrastructure on behaviour were observed, mediated by attitudes and intentions. Similarly, Maddison et al.'s (2009) integrated model of the perceived and built environment and TPB constructs on adolescent physical activity found that intentions had the strongest direct effects on physical activity, with direct effects of perceived environment and ownership of recreational equipment on self-reported physical activity. Taken together, these studies provide examples of how ecological and social-cognition models can be integrated to provide comprehensive explanations of the determinants of physical activity intentions and behaviour, and the processes involved.

Many of the studies integrating ecological and social-cognition determinants focus on intentions alone as the proximal determinant of behaviour. However, dual-process theories contend that behaviour is also driven by implicit processes, represented by the effects of constructs such as habit (Evans & Stanovich, 2013; Sheeran, Gollwitzer, & Bargh, 2013; Strack & Deutsch, 2004). Habits have been defined as "automatic responses to everyday contexts, learned through repeated performance in those contexts," and have been operationalised as 'automaticity,' that is, the experience of behaviours as automatically initiated on presentation of associated cues or contexts (Gardner, 2012, p. 32). For example, in the case of physical activity, repeated attendance at the gym after work may be 'triggered' (i.e., instigation of a learned behavioural response) by driving towards the gym when leaving work each day (i.e., repeated exposure to a behavioural cue in an everyday context). The construct of behavioural automaticity has typically been measured using self-report reflections of behaviours as controlled and experienced as 'automatically' initiated or enacted (Verplanken & Orbell, 2003).

Research has, therefore, expanded social-cognition theories that exclusively focus on intentional processes to integrate psychological constructs that represent implicit processes such as habit, as well as constructs from the environment. For example, Lemieux and Godin (2009) assessed the predictors of active commuting with a theoretical framework that incorporated constructs from the TPB, habit, environmental characteristics, and social-demographic factors. Collectively, past behaviour, PBC, attitudes, time to get to school/work, car accessibility, work status, social deprivation and habit explained substantive variance in active commuting. Thomas and Upton (2014) also adopted a model that incorporated constructs from the TPB, habit, and the environment to examine the predictors of physical activity in children. Gender, environmental variables, the TPB variables and habit strength predicted physical activity behaviour. Taken together, these studies suggest considerable promise for theories that integrate constructs representing contextual factors, intentional and implicit processes, such as habit, in accounting for substantive variance in physical activity intentions and behaviour.

The Present Study

Based on previous research integrating SDT and TPB constructs (Hagger & Chatzisarantis, 2009), and research integrating constructs representing reasoned (e.g., social-cognition constructs), ecological, and automatic (e.g., behavioural automaticity), the present research aims to test the effectiveness of an integrated model incorporating these constructs to predict physical activity intentions and habits among people living in peri-urban communities in Australia. The proposed model adopts constructs from theories of motivation (i.e., autonomous motivation from SDT) and social cognition (i.e., belief-based constructs and intentions from the TPB), dual-process models (i.e., behavioural automaticity), and ecological models (i.e., perceived features of the physical and social environment) . The model proposes that physical activity-related intentions and the experience of physical activity as ‘automatic’ or habitual are a function of motivational constructs and characteristics of the physical and social environment. Next, we outline hypothesised relations among constructs of the proposed integrated model that relate to the environmental, intentional and implicit components. The relations are illustrated in Figure 1.[2]

INSERT FIGURE 1 ABOUT HERE

Consistent with research that has integrated SDT with TPB (Hagger & Chatzisarantis, 2009), it was hypothesised that autonomous motivation would predict physical activity intentions mediated by attitudes, subjective norms, and PBC. Furthermore, consistent with research integrating ecological models with social cognition and motivational theories (e.g., Lemieux & Godin, 2009; Orbell et al., 2017; Thomas & Upton, 2014), features of the social and physical environment and drivers of neighbourhood selection were hypothesised to positively predict physical activity intentions mediated by attitudes, subjective norms, and PBC.

Consistent with research integrating constructs representing implicit determinants of behaviour (e.g., Hamilton, Kirkpatrick, Rebar, & Hagger, 2017), such as behavioural automaticity, alongside motivational and social cognition constructs, it was hypothesised that past physical activity participation would be a direct predictor of autonomous motivation. In addition, it was also hypothesised that autonomous motivation would predict automaticity. This is based on research suggesting that individuals with autonomous motivation are likely to persist on tasks that are personally meaningful and, therefore, develop adaptive habits to do so, which obviate the need for intentional processing (Gardner & Lally, 2013). It was also expected that autonomous motivation would moderate the relationship between past physical activity and automaticity, such that individuals with autonomous motivation are more likely to persist with the behaviour over time. The relationship between past physical activity and automaticity was, therefore, expected to be stronger with higher levels of autonomous motivation.

Finally, as environmental behavioural constructs are likely to represent important stable determinants of activity and maintain the development of healthy habits (Wood & Rünger,

[2] A detailed list of hypotheses is presented in Appendix A (supplemental materials).

2016), it was hypothesised that these constructs would also predict automaticity. Finally, it was further hypothesised that past physical activity participation would predict all modelled psychological constructs, consistent with previous research, but that model predictions would remain (e.g., Albarracin, Johnson, Fishbein, & Muellerleile, 2001; Hagger, Polet, & Lintunen, 2018).

Method

Participants, design and procedure

The present study adopted a cross-sectional correlational design. Participants were recruited via social media platforms (Facebook, Instagram, LinkedIn, and Twitter). The ‘audience-selection’ tool for publication of paid advertisements on Facebook and Instagram was utilised to specifically target adults (> 18 years) residing in peri-urban communities in Australia. Australians living outside these target regions were not excluded from participating, however, their data were not used in the current analysis. Status as a resident of peri-urban Australia was assessed by matching residential postcodes to AGSG-RS categories, using AGSG correspondences (Australian Bureau of Statistics, 2011). A total of 722 participants completed the online questionnaire, 271 of which were classified as living in peri-urban localities. Participants were aged between 18 and 76 years (M = 46.47, SD = 13.78), and the majority were female (79.3%). According to body mass index (BMI), two thirds of participants were obese (33.6%) or overweight (33.2%), with the remainder classified within the normal (30.6%) and underweight (1.5%) weight ranges. On average, participants reported 325.95 minutes of moderate and vigorous physical activity (MVPA) in the previous week (SD = 318.91), with 59% reporting ‘sufficient’ physical activity, in accordance with the Australian Government guidelines for physical activity (2014). Over half of the sample (51.3%) held a Bachelor degree or higher, and 36% reported an annual income of over AUD$93,600. Conversely, 9.2% did not complete the final year of high school, and 18.7% reported earning less than AUD$36,400 per annum. Participation was voluntary, and a prize draw to win one of two $50 prepaid Visa cards was conducted as an incentive for participation. Approval was attained from the host institutions' human research ethics committee, and participants provided informed consent prior to completing the online questionnaire.

Measures

The online questionnaire included measures to assess constructs representing intentional and implicit processes, past physical activity participation, characteristics of the physical and social environment, drivers of neighbourhood selection, and health-related and demographic characteristics of participants. The measures are summarised below, and a complete list of items is available in Appendix B (supplemental materials).

Autonomous motivation. Autonomous motivation towards physical activity was measured using the 24-item Behavioural Regulation in Exercise Questionnaire – 3 (Markland & Tobin, 2004; Wilson, Rodgers, Loitz, & Scime, 2006). Items are statements reflecting thoughts and feelings about performing physical exercise (e.g., "I think it is important to make the effort to exercise regularly.") Responses were recorded on 5-point scales (0 = *not true for me* and 4 = *very true for me*). A relative autonomy index was computed for each participant, as recommended by Markland (2014), with weights assigned to each subscale (i.e., Amotivation * -3, External Regulation * -2, Introjected Regulation * -1, Identified Regulation * 1, Integrated Regulation * 2, and Intrinsic Regulation * 3), and then the sum of the weighted subscales was calculated. Higher scores reflect higher levels of autonomous motivation.

Theory of Planned Behaviour. Development of items relevant to the TPB constructs, including intentions, attitudes, subjective norms, and PBC were guided by procedures outlined by Ajzen (2006). Intentions were measured on three items (e.g., "I will try to be physically active for at least 30 minutes on most days in the forthcoming week"). Responses were measured on 10-point scales (1 = *definitely true* and 10 = *definitely false*). Attitudes were measured on five items sharing a common stem: "For me, being physically active for at least 30 minutes on most days …" Responses were provided on 10-point scales (e.g., 1 = *harmful* and 10 = *beneficial*).

Subjective norms were measured with six items (e.g., "Most people who are important to me are physically active on most days each week"). Responses were provided on 10-point scales (e.g., 1 = *completely true* and 10 = *completely false*). PBC was measured on four items (e.g., "For me to be physically active for at least 30 minutes on most days in the forthcoming week would be…"). Responses were provided on 10-point scales (1 = *impossible* and 10 = *possible*).

Automaticity. Habitual instigation of physical activity was assessed on the four item Self-Report Behavioural Automaticity Index (SRBAI), which has been assessed as a reliable and valid measure of behavioural automaticity (Gardner, Abraham, Lally, & de Bruijn, 2012). Items were preceded with the common stem: "Deciding to do physical activity is something I do," concluding with actions such as "without thinking" and "automatically". Responses were given on a 7-point scales (1 = *strongly disagree* and 7 = *strongly agree*).

Past physical activity. Self-reported physical activity over the past week was measured on the Active Australia Questionnaire (AAQ; Australian Institute of Health and Welfare, 2003). The questionnaire comprises nine items assessing minutes and instances of walking, moderate, and vigorous leisure-time physical activity (e.g., "In the last week, how many times have you walked continuously, for at least 10 minutes, for recreation, exercise or to get to or from places?"). Reported minutes walking and performing moderate and vigorous physical activity were summed, with vigorous activity weighted by two, to determine MVPA. In accordance with the survey manual for implementation, analysis and reporting, to avoid over-reporting responses greater than 840 minutes for any specific activity were truncated to 840 minutes and total times greater than 1680 minutes were truncated to 1680 (Australian Institute of Health and Welfare, 2003).

Physical environment. Characteristics of the physical environment were measured on items adapted from four subscales of the abbreviated Neighbourhood Environment Walkability Scale (NEWS-A), including aesthetics, traffic hazards, crime and safety, and infrastructure and safety for walking (Cerin, Saelens, Sallis, & Frank, 2006). Burton et al. (2009) adapted the instrument for use in metropolitan Brisbane, Australia. These adaptations were further revised for the present study, to ensure items were contextually appropriate for peri-urban Australia, based on our preliminary work (MASKED). Aesthetics was measured with seven items relating to the attractiveness of the built and natural environment in the local neighbourhood (e.g., “There are many interesting things to look at in my neighbourhood”). Higher scores indicated perceptions of more aesthetically pleasing neighbourhood environments. Crime and safety was assessed with eight items (e.g., “There is a lot of crime in my neighbourhood”). Two items were reverse scored, and higher scores indicated greater levels of perceived crime. Traffic hazards were assessed with six items (e.g., “In my neighbourhood, there is usually a lot of traffic on the local streets”). Two items were reverse scored, and higher scores indicated perceptions of more dangerous traffic conditions. Infrastructure and safety for walking was assessed on nine items (e.g., “There are footpaths on most of the streets in my neighbourhood”). Two items were reverse scored, with higher scores indicating more walkable neighbourhoods. Responses for all items were recorded on five-point Likert scales (1 = *strongly disagree* and 7 = *strongly agree*).

Social environment. Social cohesion was measured on five items developed by Buckner (1988). For example, “I am good friends with many people in my neighbourhood.” Responses were recorded on five-point scales (1 = *strongly disagree* and 5 = *strongly agree*). Two items were reverse scored. Higher scores indicate greater levels of social cohesion.

Community participation was measured on a single item asking “In what ways do you get involved with your local community?” Participants were able to select an option reporting no community participation (scored as 0). Alternatively, participants could indicate community participation through volunteer work, formal clubs, informal interest groups, and ‘other,’ that were provided as multiple choice options allowing multiple responses to be selected. For those who reported some community participation, the number of options indicating active community participation was summed. Thus overall scores ranged from 0, indicating no community participation to 4, indicating the greatest level of self-reported participation.

Neighbourhood selection. Eighteen items assessing drivers of neighbourhood selection were included. Participants were asked: "How important were each of the following in your decision to move to your current neighbourhood." Seventeen items based on those used by Burton et al. (2009) were included (e.g., "ease of walking to places"). An additional item, ("country lifestyle") was added based on our prior research (MASKED). Responses were collected on 5-point scales (1 = *not important at all* and 5 = *very important*).

Self-rated health

Self-rated health was assessed on a single item: "In general, would you say your health is …" Responses were provided on a 5-point scale (1 = *poor* and 5 = *excellent*). In order to assess BMI, participants were asked to provide their height in centimetres or feet and inches, and their weight in kilograms, stones or pounds. BMI was calculated as weight in kilograms divided by height in metres, squared.

Demographic and remoteness variables

Items were included to assess known demographic correlates of physical activity including age, gender, education, and income. A single item assessing whether participants lived within a town or outside of a town was also included. Responses for this item were collected on a 10-point scale (1 = *I live in town* and 10 = *I live out of town*).

Data analysis

Preliminary analyses to assess the internal consistency of the proposed measures and zero-order correlations among the mean average scores of the scales were computed using SPSS Statistics v.24. Alpha reliability coefficients used to assess the internal consistency of measures, with alphas greater than .70 considered acceptable (Ponterotto & Ruckdeschel, 2007). A principal components analysis with oblique rotation was conducted on the items from the neighbourhood selection scale to determine drivers of neighbourhood selection among peri-urban dwellers. Correlations between demographic and health correlates of physical activity and model constructs were examined to determine which demographic variables should be included in the model. A path analysis was conducted to test the hypothesised model using Mplus v.6.12 with the robust maximum likelihood estimator, which provides robust estimates for data with distributions that deviate moderately from a normal distribution (Asparouhov & Muthen, 2006). Sample size justification was based on the number of paths in the proposed model, with at least 10 participants for each estimated pathway. Missing data were handled using the full-information maximum likelihood (FIML) estimation procedure. Model goodness-of-fit indices included the model chi-square value (with a conservative α level set at < .01), root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker-Lewis Index (TLI). A non-significant chi-square test and values < .06 for the RMSEA and ≥.95 for the CFI and TLI indicate 'good fit;' CFI and TLI values > .90 will be taken to represent 'adequate fit' (Hu & Bentler, 1999). In addition to the direct and indirect pathways specified in the hypothesised model, attitudes, subjective norms and PBC were allowed to co-vary in the path analysis, as were the modelled contextual variables. Automaticity and intentions were also set to co-vary[3].

Results

Preliminary analyses

Alpha coefficients indicated acceptable internal consistency for the TPB, autonomous motivation, automaticity, social cohesion, and neighbourhood aesthetics variables. Adjustments were made to the crime and safety, infrastructure for safety and walking, and traffic hazards variables to improve internal consistency. The results and scale adjustments to maximise alpha are reported in Appendix C (supplemental materials). Principal components analysis of neighbourhood selection variables resulted in the extraction of two factors, accounting for 41.16% of the variance in the 16 included items. The first factor included six items representing neighbourhood selection driven by a desire for close access to shops, work, city, transport, main roads, and destinations within walking distance. This factor was named 'proximity,' and

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[3]Data files and analysis output for the Mplus analyses are available online: https://osf.io/8kf37/?view_only=800c2c93694f4e7f86c2d519c328cec5

explained 26.87% of the variance in the items, with all factor loadings greater than .466. The second factor included four items representing neighbourhood selection driven by the appeal of a 'country lifestyle' and sense of community. This factor was named 'lifestyle and community,' and explained 14.29% of the variance in the items, with all factor loadings greater than .661. Descriptive statistics and zero-order correlations among study variables are presented in Appendix D (supplemental materials). Correlations between the psychological variables and past physical activity variables were statistically significant. Small-to-medium significant associations were found for intentions with community participation, aesthetics, and neighbourhood selection for lifestyle and community, and for automaticity with social cohesion and neighbourhood selection. The remaining contextual variables were not significantly correlated with intentions or automaticity and were excluded from further analysis. Education, self-rated health, and BMI were significantly correlated with intentions and automaticity. In order to control for effects of these socio-demographic and health-related variables in the proposed model, and to reduce model parameterisation, we computed unstandardised residual scores for the variables to be used in the model by regressing each variable on the set of demographic variables. Finally, a preliminary check using the Hayes Process macro in SPSS (Hayes, 2012) revealed no moderation effect of autonomous motivation on the relationship between past physical activity and automaticity, so this pathway was omitted from the final model.

Model effects

Overall model fit was acceptable according to the multiple criteria adopted (χ^2 (15) = 28.87, p = .017; RMSEA = .058, CFI = .968, TLI = .905). The model explained 46.2% of the variance in intentions, and 24.9% of the variance in behavioural automaticity. Standardised parameter estimates of the modelled direct and indirect pathways are presented in Table 1. Direct effects are also illustrated in Figure 2.[4] [5]

INSERT TABLE 1 ABOUT HERE

INSERT FIGURE 2 ABOUT HERE

Based on the integrated model, it was hypothesised that autonomous motivation would predict physical activity intentions mediated by the social cognition constructs from the TPB variables. As predicted, autonomous motivation had statistically significant and positive direct effects on attitudes, subjective norms, PBC, and intentions. Further, subjective norms and PBC had significant and positive direct effects on intentions. However, contrary to hypotheses, there was no effect of attitudes on intentions. As predicted, there were significant indirect effects of autonomous motivation on intentions, mediated by subjective norms and PBC, but not by attitudes. In addition, past physical activity had significant and positive direct effects on autonomous motivation, attitudes, subjective norms, PBC, and intentions, as expected. However, there were no indirect effects of past physical activity on intentions through autonomous motivation, attitudes, subjective norms, or PBC.

As hypothesised, autonomous motivation and past physical activity had statistically significant and positive direct effects on behavioural automaticity. Although not predicted, there was also a significant indirect effect of past physical activity on automaticity, mediated by autonomous motivation.

As hypothesised, neighbourhood selection for lifestyle and community had a statistically significant direct effect on PBC. However, there was no effect of neighbourhood selection for lifestyle and community on attitudes, subjective norms, or automaticity, resulting in the rejection

[4]Error covariances are presented in Appendix E and a figure depicting the significant indirect effects is presented in Appendix F.

[5] Although not a specific aim of the research, an additional multi-group analysis was conducted to compare model effects in inner-regional and major city populations of Australia. The results of this analysis and a brief discussion related to its findings are presented in Appendix G. The corresponding data files and analysis output are available online: https://osf.io/8kf37/?view_only=800c2c93694f4e7f86c2d519c328cec5

of these hypotheses. As predicted, significant indirect effects were observed between neighbourhood selection for lifestyle and community on intentions mediated by PBC. However, attitudes and subjective norms did not mediate this relationship. Contrary to predictions, there were no significant direct or indirect effects of any of the other constructs from the ecological model on intentions, or its determinants from the TPB.

Discussion

In the present study, we used an integrated model comprising constructs from motivational and social cognition-theories of behaviour, dual-process theories, and ecological frameworks to identify the predictors of physical activity intentions and behavioural automaticity in a sample of peri-urban dwelling Australians. Results indicated that autonomous motivation, subjective norms, PBC, and past behaviour were significant predictors of intentions to participate in physical activity in the future, and autonomous motivation and past behaviour were significant predictors of behavioural automaticity. Of the ecological constructs, only neighbourhood selection for lifestyle and community predicted intentions, mediated by perceived behavioural control. There were no effects of aesthetics, social cohesion, and community participation on intentions and behavioural automaticity. Together, constructs from the proposed model explained substantive variance in physical activity intentions and automaticity in this sample, although the effects of the social cognition and motivational variables were most pervasive.

The rationale for applying psychological and motivational models within an overarching ecological framework was based on the assumption that features of the physical and social environment would shape psychological beliefs that relate to physical activity participation (Orbell et al., 2017; Von Wagner et al., 2011). Consistent with predictions, there was a significant indirect effect of neighbourhood selection on intentions, mediated by PBC. This indicates that the selection of residential location for lifestyle and community (i.e., a desire to be near to greenspace/bushland, open spaces, a country lifestyle and strong sense of community) was linked to favourable perceptions over the ease of performing physical activity, which was in turn, linked to intentions to perform physical activity.

Conversely, although aesthetics, social cohesion, and community participation were correlated with physical activity-related intentions and automaticity, they did not have unique effects in the model. This finding contrasts with previous studies that have found that constructs from the TPB mediated relationships between environmental constructs and physical activity behaviour (e.g., Fleig et al., 2016; Rhodes, Brown, & McIntyre, 2006; van der Horst, Oenema, te Velde, & Brug, 2010). However, these studies were conducted in heavily-populated and highly-walkable metropolitan areas, with highly active participants. Rhodes et al. (2006) concluded that environmental constructs may be antecedents of physical activity-related motivation and may not exert direct effects on behaviour independent of motivation. This may be the case in highly walkable environments that do not present actual barriers to physical activity. It may not be the case, however, in environments with low walkability and considerable barriers to physical activity, as have been described in peri-urban regions of Australia (Olson et al., 2018). In such cases, features of the environment may have a direct influence on health behaviours bypassing intentions, although this hypothesis could not be tested in the current study (Fishbein, 2000). To speculate, given the significant effects of neighbourhood selection on PBC in the current study, it is possible that this construct may influence behaviour via PBC, in cases where PBC serves as a proxy for actual control, consistent with the TPB (Ajzen, 1985). For example, distance to shops may preclude walking as a viable means of transport, regardless of intentions to be active, and would be beyond the control of the individual.

Another potential pathway through which the environment may impact health behaviour is by moderating the intention-behaviour relationship, consistent with research that has demonstrated moderating effects of socio-demographic factors on relations in the TPB, such as the intention-behaviour relationship (Schüz et al., 2017). For example, land-use mix has been found to moderate the relationship between intentions and walking behaviour; with the relationship being stronger among those who perceived more proximal access to recreational facilities (Rhodes et al., 2006; Rhodes et al., 2007). Thus, it is possible that features of the environment in peri-urban settings are moderating the relationship between intentions and behaviour (e.g., the intention-behaviour relationship could be stronger among peri-urban Australians who live in more walkable environments, suggesting that higher walkability fosters the conversion of intentions into action). However, the present research design precludes investigation of this possibility.

In the present study the correlations of the contextual constructs with intentions and automaticity were small in size. Therefore, it is possible that their effects on intentions were rendered relatively trivial alongside the belief-based predictors. These smaller correlations are consistent with previous research that has shown that individual and social factors exert a stronger influence upon physical activity, relative to environmental factors (Giles-Corti & Donovan, 2002; Lemieux & Godin, 2009). Maddison et al. (2009) also noted that social cognition variables were better predictors of physical activity compared to characteristics of the perceived and built environment. However, the smaller effect of contextual variables relative to social cognition constructs does not mean that the influence of the environment on physical activity behaviour is not of practical significance. Ecological models indicate that efforts to effect behaviour change will be most successful when targeting multiple levels of influence on behaviour (Sallis et al., 2015), and health behaviour may be viewed as a product of motivation, capability, and supportive environments (Michie, van Stralen, & West, 2011).

It is also possible that measures of the ecological constructs included in the study were too general and did not adequately represent the specific nature of environmental cues that drive physical activity in this community. Moreover, correspondence between measures of the social cognition constructs and the measure of intentions was high (e.g., in terms of action, target, context and time, consistent with Ajzen's recommendations), while the correspondence between the intention measure and the measures of the social environmental variables was low. The weaker effects observed for the ecological constructs relative to the psychological constructs may, therefore, be an artefact of measurement. Future research should seek to measure the ecological variables using objective means. It would also be important to include a measure of physical activity participation, preferably by objective rather than self-report means, in order to examine the unique effects of the psychological and ecological constructs on behaviour.

Focusing on effects of motivational and social-cognition constructs in the integrated model, we found that participants with autonomous motives were more likely to report positive beliefs with respect to future participation in physical activity. The findings also suggest that the relationship between autonomous motivation and the development of intentions to undertake physical activity is facilitated by beliefs that significant others endorse physical activity participation, and the perceived ease of performing physical activity. This is consistent with the integrated model (Hagger & Chatzisarantis, 2009, 2016), as well as the predictions of self-determination theory (Deci & Ryan, 1985), suggesting that autonomously motivated individuals will tend to align their beliefs with their motives in order to initiate future behaviours that are likely to be experienced as autonomous.

Contrary to predictions, however, we found no effect of attitudes on intentions. This finding is inconsistent with previous research that typically shows small-to-medium sizes effects of attitudes on physical activity intentions (Hagger et al., 2002). This finding, however, seems congruent with research in which peri-urban participants reported largely inactive lifestyles despite describing positive physical activity-related outcome expectancies (Olson et al., 2019). However, the most likely reason for the small, trivial effect of attitudes on intentions is the large zero-order correlations of attitudes with both autonomous motivation and subjective norms ($r >$ .50). As attitudes and these variables were significantly correlated with intention as well, it is possible that any effect of attitudes on intentions in the context of the path model may have been subsumed by the effects of these variables. This likely illustrates substantive overlap these constructs in this context for this population – for example, the distinction between attitudes, which reflect positive appraisal of physical activity, and subjective norms, which reflect perceived approval of significant others may not have been readily apparent. This may be the case when the beliefs underpinning the two constructs are identical (e.g., participants may have viewed social approval as a salient outcome of participating in physical activity in itself).

The small, non-significant effect of attitudes meant that subjective norms and PBC were the dominant predictors of intentions. This is somewhat inconsistent with previous research applying social-cognition theories (Hagger et al., 2002), and integrated models (Hagger & Chatzisarantis, 2009) in health behaviour which found larger effects for attitudes and PBC, and modest effects for subjective norms. To speculate, the effect of normative beliefs may be more salient in peri-urban communities because people living in smaller communities experience a strong sense of neighbourliness and community spirit (Eley, Bush, & Brown, 2014; Olson et al., 2018). Further, it is also possible that individuals' estimates of perceived control over the behaviour in the current sample may have been an accurate reflection of actual control over the behaviour, in which case it should directly predict behaviour consistent with Ajzen (1991) predictions. The absence of a follow-up measure of physical activity in the present study, however, precluded analysis of direct effects of PBC on physical activity.

We also found that both past physical activity and autonomous motivation predicted automaticity. This is consistent with other research that has found that self-determined motives are more strongly associated with behavioural automaticity (Gardner & Lally, 2013; Radel, Pelletier, Pjevac, & Cheval, 2017). Together, these findings indicate that experiencing physical activity as automatic is a function of previous experience and motivation style. These findings are unsurprising. Past behaviour was measured using frequency of past participation in physical activity, so likely captures the repetition of the behaviour in stable contexts, a primary determinant of habit formation, of which automaticity is a key component. In addition, individuals with autonomous motivation are likely to seek out regular participation in behaviours that provide opportunities to experience autonomy – such behaviours are, therefore, likely to become highly automated.

We found no evidence that autonomous motivation moderated the relationship between past behaviour and automaticity. Instead it seems that autonomous motivation may be partly responsible for the development of automaticity. Given that individuals holding autonomous motives toward physical activity tend to persist with physical activities over time, they are more likely to experience repeated bouts of physical activities in stable contexts and, as a consequence, develop adaptive habits and experience the activities as automatically, rather than intentionally, controlled.

Strengths, limitations, and recommendations for future research and practice

The current study is unique in that it applied an integrated model comprising factors from multiple theoretical perspectives (motivation and social cognition, dual process, and ecological models) to predict physical activity in peri-urban contexts, a seldom studied population. Given that ecological models are not explicit on the process by which environmental determinants relate to health behaviour, the integration of these constructs alongside theoretical frameworks that focus on the intentional and implicit psychological processes that relate to physical activity participation enabled us to test some potential mechanisms. However, there are a number of limitations which should be taken into account. First, the direction of the relationships among model constructs were based on established theoretical frameworks, but the correlational design precluded causal inferences. Future research may consider longitudinal or panel designs, which may enable modelling of stability and reciprocal effects. Importantly, adoption of experimental designs, in which key constructs are manipulated and their effects on outcomes tested, would provide stronger evidence to infer causal links. Second, a prospective measure of physical activity participation was not included. Therefore, the degree to which intentions and automaticity predict subsequent physical activity participation has yet to be determined. This limitation also precluded further exploratory investigation of additional mechanisms through which contextual features of peri-urban settings might impact physical activity (i.e., whether such features impact behaviour via PBC, rather than intentional processes; or whether such factors moderate the intention-behaviour relationship). Third, the use of self-report data represents a further limitation of the study design. Self-report measures are subject to response bias but may also introduce common method variance into the data, which may affect relations among constructs. Future research should include prospective measures of behaviour, to enable behavioural prediction, and consider the adoption of objective measures of physical activity using devices such as accelerometers. Finally, we used convenience sampling, and participant education and income levels were higher than Australian national averages (Australian Bureau of Statistics, 2018a; Torrens University Australia, 2017). The current sample should, therefore, not be considered representative of the general peri-urban population and should impose limits on the extent to which current findings can be generalized. We look to future studies to explore the effects of the gamut of determinants from our integrated model on physical activity in a representative sample of peri-urban dwellers, recruited using random, stratified methods.

Current findings may assist in providing preliminary evidence of potential targets for behaviour-change interventions. Strategies that target change in subjective norms and perceived control to foster positive intentions toward physical activity may, for example, be appropriate for this sample. Intervention strategies might include persuasive communications highlighting the importance of social support and negating barriers, as well as providing experiences of success with activities. In addition, fostering autonomous motives for physical activity by enhancing enjoyment and providing experiences of mastery of activities may encourage the development of intentions to perform physical activity and promote physical activity habits. Further, broader community-based strategies such as enhancing the ‘sense of community’ and ‘country lifestyle’ within peri-urban communities may be effective in influencing intentions to participate in future physical activity in the current sample. However, tangible means to do this remain elusive. Affecting change in the motivational and social-cognition constructs may be more viable.

However, it is important to note that given the preliminary nature of the findings, and the limitations outlined previously, the current evidence should not form the basis of definitive advice on intervention strategy.

Conclusion

The aims of this research were to estimate effects of features of the physical and social neighbourhood environment, and motivational and social-cognition constructs, on physical activity-related intentions and automaticity among peri-urban Australians. Only neighbourhood selection for lifestyle and community, together with autonomous motivation and social cognition constructs, explained substantive variance in intentions. Autonomous motivation and past behaviour were the only correlates of automaticity. Overall, current results suggest that contextual features of peri-urban settings may not play a substantive role in determining physical activity intentions. Based on this preliminary evidence, fostering autonomous motivation (e.g., by enhancing enjoyment) and favourable normative and control beliefs (e.g., by encouraging social support and reducing barriers to physical activity) may be possible strategies interventionists could adopt to encourage physical activity among inactive peri-urban Australians.

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Table 1
Standardised Direct, Indirect, and Total Effects of Modelled Pathways

Effect	β	*p*
Direct effects		
Autonomous motivation→attitudes	.403	<.001
Autonomous motivation→subjective norms	.201	<.001
Autonomous motivation→PBC	.231	<.001
Autonomous motivation→intentions	.258	<.001
Attitudes→intentions	.102	.090
Subjective norms→intentions	.241	<.001
PBC→intentions	.167	.001
Past physical activity→autonomous motivation	.322	<.001
Past physical activity→attitudes	.050	.427
Past physical activity→subjective norms	.214	.001
Past physical activity→PBC	.160	.007
Past physical activity→intentions	.249	<.001
Autonomous motivation→automaticity	.391	<.001
Past physical activity→automaticity	.190	<.001
Aesthetics→automaticity	-.074	.144
Aesthetics→attitudes	-.040	.555
Aesthetics→subjective norms	.061	.328
Aesthetics→PBC	-.042	.471
Social cohesion→automaticity	.089	.167
Social cohesion→attitudes	.084	.205
Social cohesion→subjective norms	.060	.354
Social cohesion→PBC	-.068	.288
Community participation→automaticity	-.033	.535
Community participation→attitudes	.019	.750
Community participation→subjective norms	-.088	.146
Community participation→PBC	-.007	.915
Neighbourhood selection→automaticity	.037	.547
Neighbourhood selection→attitudes	.043	.532
Neighbourhood selection→subjective norms	.057	.383
Neighbourhood selection→PBC	.211	<.001
Indirect effects		
Autonomous motivation→attitudes→intentions	.041	.107
Autonomous motivation→subjective norms→intentions	.048	.009
Autonomous motivation→PBC→intentions	.038	.010
Autonomous motivation→attitudes/subjective norms/PBC→intentions[a]	.128	<.001
Past physical activity→autonomous motivation→intentions	.083	<.001
Past physical activity→autonomous motivation→attitudes	.130	<.001

Past physical activity→autonomous motivation→subjective norms	.065	.003
Past physical activity→autonomous motivation→PBC	.074	.001
Past physical activity→attitudes→intentions	.005	.478
Past physical activity→subjective norms→intentions	.052	.012
Past physical activity→PBC→intentions	.027	.025
Past physical activity→autonomous motivation→automaticity	.126	<.001
Aesthetics→attitudes→intentions	-.004	.585
Aesthetics→subjective norms→intentions	.015	.337
Aesthetics→PBC→intentions	-.007	.477
Aesthetics→attitudes/subjective norms/PBC→intentions[a]	.003	.881
Social cohesion→attitudes→intentions	.009	.243
Social cohesion→subjective norms→intentions	.015	.364
Social cohesion→PBC→intentions	-.011	.324
Social cohesion→attitudes/subjective norms/PBC→intentions[a]	.012	.613
Community participation→attitudes→intentions	.002	.756
Community participation→subjective norms→intentions	-.021	.156
Community participation→PBC→intentions	-.001	.915
Community participation→attitudes/subjective norms/PBC→intentions[a]	-.020	.426
Neighbourhood selection→attitudes→intentions	.004	.572
Neighbourhood selection→subjective norms→intentions	.014	.392
Neighbourhood selection→PBC→intentions	.035	.012
Neighbourhood selection→attitudes/subjective norms/PBC→intentions[a]	.053	.033
Total effects		
Autonomous motivation→automaticity	.391	<.001
Past physical activity→automaticity	.316	<.001
Aesthetics→automaticity	-.074	.144
Community participation→automaticity	-.033	.535
Neighbourhood selection→automaticity	.037	.547
Social cohesion→automaticity	.089	.167
Autonomous motivation→intentions	.386	<.001
Past physical activity→intentions	.457	<.001
Attitude→intentions	.102	.090
Subjective norms→intentions	.241	<.001
PBC→intentions	.167	<.001
Aesthetics→intentions	.003	.881
Community participation→intentions	-.020	.426
Neighbourhood selection→intentions	.053	.033
Social cohesion→intentions	.012	.613

Note. PBC = Perceived behavioural control; [a]Total indirect effects.

Figure 1. Hypothesised framework for the prediction of physical activity-related automaticity and intentions. Features of the social environment comprised social cohesion and community participation, features of the physical environment included aesthetics, crime, infrastructure for safety and walking, and traffic hazards. Drivers of neighbourhood selection were selected by factor analysis and comprised lifestyle and community, and proximity. Only variables from these factors that were significantly correlated with social cognition and motivational constructs were included in the final model. PBC = Perceived behavioural control.

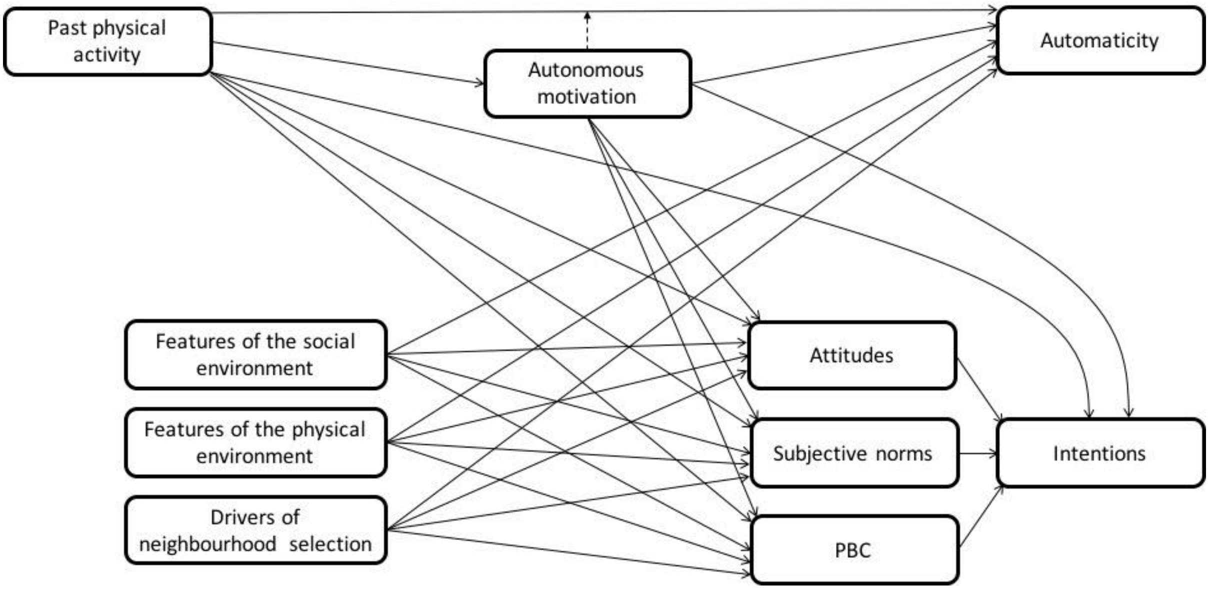

Figure 2. Parameter estimates for statistically significant paths in the proposed model with explained variance in dependent variables. Feint lines represent paths with non-significant parameter estimates. PBC = Perceived behavioural control.