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SCOTT, E. J., EVES, F. F., FRENCH, D. P. and HOPPE, R.

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Emma J. Scott *
University of Birmingham
Birmingham, U.K.

Frank F. Eves
University of Birmingham
Birmingham, U.K.

David P. French
University of Birmingham
Birmingham, U.K.

Roberta Hoppé
De Montfort University
Leicester, UK

* Corresponding Author:
Emma J Scott, M.Sci
Centre for Sport & Exercise Science
Sheffield Hallam University
Collegiate Crescent Campus
Sheffield, U.K.
S10 2BP
Tel: +44 (0)114 225 2524
Fax: +44 (0)114 225 4341
email: e.scott@shu.ac.uk

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ABSTRACT:

Objectives: This paper compares multiple measures of walking in two studies, and in the second study, compares how well Theory of Planned Behaviour (TPB) constructs perform in predicting these different measures.

Methods: In study one, forty-one participants wore a *New Lifestyles NL-2000* pedometer for one week. Subsequently, participants completed a questionnaire containing measures of the TPB constructs and two self-report measures of walking, followed by two interview measures of walking. For study two, 200 RAF trainee aircraftsmen wore pedometers for two weeks. At the end of each week participants completed the questionnaire and interview measures of walking.

Results: Both studies found no significant association between questionnaire measures of walking and pedometer measures. In study one, the interview measures produced significant, large correlations with the pedometer measure, but these relationships were markedly weaker in the second study. TPB variables were found to explain 22% of variance in intention to walk in study one and 45% of the variance in study two. In study two, prediction of subsequent measures of behaviour was found to be weak, except when using a single-item measure of walking.

Conclusions: Recall of walking is poor and accurate measurement by self-report is problematic. Although the TPB predicts intentions to walk well, it does not predict actual amount of walking, as assessed by pedometer. Possible reasons for these findings include the unique nature of walking as an activity primarily used to facilitate higher order goals. The use of single-item measures may exaggerate the effectiveness of the TPB model for walking, and possibly other forms of physical activity.

INTRODUCTION:

It is well-established that regular physical activity affords people multiple physiological and psychological health benefits. These benefits include reduced risk of coronary heart disease (British Heart Foundation, 2003), hypertension, type 2 diabetes, osteoporosis, obesity and some forms of cancer (Department of Health, 2004; U.S. Department of Health & Human Services [USDHHS] & Centers for Disease Control & Prevention [CDC], 1996). Regular physical activity also promotes musculoskeletal health and appears to relieve symptoms of depression and anxiety (USDHHS & CDC, 1996). Large numbers of the general population, however, do insufficient exercise to experience these advantages (Department of Health, 2004; USDHHS & CDC, 1996).

The American College of Sports Medicine (2000) currently promotes a two-stage approach to physical activity: In order to experience health benefits, such as those detailed above, every healthy adult should accumulate at least 30 minutes of moderate intensity physical activity on most days of the week (Pate et al., 1995). Those who wish to further improve cardiorespiratory and muscular fitness should aim for an additional 20 minutes of vigorous activity three times per week (Pollock et al, 1998). The first part of these recommendations has lead to a increased emphasis on 'active lifestyle' approaches to physical activity promotion, which means incorporating physical activity into daily life by making more active choices, e.g. taking the stairs rather than the elevator or selecting active pastimes such as gardening rather than sedentary ones such as watching television. This, in turn, has lead to increased interest in promoting walking as form of lifestyle physical activity.

Walking is unique in that it is a near-universally accessible and acceptable form of physical activity (Wimbush, MacGregor & Fraser, 1998). Further, walking at a self-selected moderate-to-brisk pace has been shown to fulfil the moderate intensity criterion (Murtagh, Boreham & Murphy, 2002). Walking is already the most frequently reported physical activity behaviour (Fox & Rickards, 2004) and is easy to accumulate. Few people, however, accumulate the recommended 30 minutes per day (Department of Health, 2004; USDHHS & CDC, 1996).

To effectively promote walking it is important to understand the factors determining walking behaviour. The most frequently used models for physical activity are the Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975) and it's successor, the Theory of Planned Behaviour (TPB; Ajzen, 1991). The TRA proposes that behaviour is determined by intention, which in turn is determined by attitudes and subjective norm. Attitudes towards performing a particular behaviour can be instrumental, i.e. the expected utility of the behaviour, and affective, i.e. anticipated feelings towards performing the behaviour (Ajzen & Driver, 1992; Eves, Hoppé & McLaren, 2003; French et al., 2005; Godin, 1987; Trafimow & Sheeran, 1998). Subjective norm is the perceived social pressure to perform the behaviour. The TPB extends this model with the addition of perceived behavioural control (PBC), which is the perceived ease or difficulty of performing the behaviour. PBC can influence both intention and behaviour and reflects the fact that external factors can influence a person's behaviour.

A recent meta-analysis confirmed that the TPB is superior to the TRA for the prediction of both physical activity intentions and actions (Hagger, Chatzisarantis & Biddle, 2002). Intention was found to be most strongly predicted by overall attitude with PBC also making a major contribution; subjective norm explained notably less variance (Symons Downs & Hausenblas, 2005; Hagger et al., 2002). Intention and PBC make unique contributions to the variance of physical activity behaviours

(Symons Downs & Hausenblas, 2005). Despite the success of the TPB for exercise, few studies attempted to predict specific physical activity behaviours, rather than the generic term “exercise”. Empirical evidence, however, illustrates that different TPB constructs are involved in the prediction of different forms of physical activity (Ajzen & Driver, 1992; Bryan & Rocheleau, 2002; Eves et al., 2003). Concerning walking, a recent study (Eves et al., 2003) found intentions and self-reported behaviour were predicted less well than a number of other specific types of exercise. Unlike all other physical activities, there was no contribution of affective attitude to the prediction of intention to walk.

Research in this area may also be limited by the outcome measures used. TPB studies most often employ simple, single item self-report measures of behaviour (Armitage & Conner, 2001; Symons Downs & Hausenblas, 2005), although the theory does not require this and alternative methods may give more accurate measures of behaviour (Armitage & Conner, 2001). Pedometers are small devices worn on the hip that count steps taken, and hence provide an objective measure of walking. Pedometers are accurate and reliable at different walking speeds (Bassett et al., 1996; Crouter, Schneider, Karabulut & Bassett, 2003), on a variety of terrains (Bassett et al., 1996) and in diverse population groups (Cyarto, Myers & Tudor-Locke, 2004; Stanish, 2004; Wilde, Corbin & Le Masurier, 2004), with the *New Lifestyles NL-2000* identified as the best performing model in tests (Crouter et al., 2003; Schneider, Crouter & Bassett, 2004). It must be acknowledged that no measurement tool is ever entirely free from error (Johnston, French, Bonetti & Johnston, 2004) and even pedometers do not produce a perfect measure of walking, the primary source of invalidity being human error, e.g. forgetting to wear the monitor, and accumulation of steps from alternative activities, e.g. running..

In contrast with the objective measure of walking offered by the pedometer are subjective measures. These can be divided into questionnaires using global rating scales and interviews, which require respondents to recall specific episodes of physical activity. Whilst many of these measures have been validated, most self-report measures do not provide an accurate estimate of total physical activity (Sallis & Saelens, 2000). Further, the validity is greater for vigorous than moderate intensity activities (Sallis & Saelens, 2000). To the best of our knowledge, none of these measures have been independently validated for walking. Self-report, however, remains the assessment method of choice for many large scale walking studies (Eyler, Brownson, Bacak & Houseman, 2003; Hallal et al., 2005; Simpson et al., 2003), despite the chronic underestimations of self-reported walking compared to pedometer counts (Bassett, Cureton & Ainsworth, 2000).

A measurement issue of particular relevance to the TPB is that of compatibility. The principle of compatibility states that in order to maximise predictive validity the predictor and criterion variables should be compatible, that is, they should be measured at the same level of specificity with regards to the target, action, context and time elements of the behaviour (Ajzen, 1988). Courneya (1994) has since suggested that predictive power could be further improved by ensuring that the scales, as well as the wording of the items, correspond. For repeated behaviours it is also recommended that these scales should be continuous rather than dichotomous (Courneya, 1994). In practice, intention measured on a one to seven scale is matched with a corresponding one to seven scale for behaviour. For physical activity, however, the behaviour may not occur at all and hence a zero to seven scale for behavioural frequency is often employed (e.g. Eves et al., 2003). Considering the repeated encouragement to ensure scale correspondence between the measures of constructs and behaviour used (e.g. Courneya, 1994; Symons Downs & Hausenblas, 2005; Sutton, 1998), it is perhaps not surprising that many researchers have chosen simple, single-item self-report measures of behaviour presented in the same format as the construct measures.

Set against the simplicity of single item measures of behaviour suitable for the TPB is the more complex structured interview of the 7-day Physical Activity Recall (PAR: Blair, 1985; Sallis et al., 1985). The PAR interview is often considered the best self-report measure, given its validation with objective indices of participation (Montoye, Kemper, Saris, & Washburn, 1996). During the interview participants itemize all episodes of physical activity over the previous seven days, specifying duration and intensity. The participant works backwards from the current day aided by interviewer prompts. This more detailed approach based on prompted recall should improve accuracy of reporting of physical activity. Recent research, however, has demonstrated that the PAR produces less accurate reports of low intensity physical activity than high (Richardson, Ainsworth, Jacobs, & Leon, 2001; Sallis et al., 1985), suggesting that it may not be well suited to measuring walking.

This paper presents two studies investigating which of several self-report measures of walking behaviour are most highly associated with the assessments of walking yielded by pedometer. The second study also explores the effect of different methods of measuring walking on the ability of the TPB constructs to predict the behaviour.

STUDY 1:

The first study compared four commonly used self-report measures of walking with an objective measure of the behaviour. Two questionnaire measures were employed, one using a simple, single item measure of the type commonly employed in TPB research on physical activity, the other a composite measure requesting both the time spent walking for recreation and the time walking as part of daily living. Time spent walking as part of daily living reflects the current emphasis on accumulation of activity throughout the day (Pate et al., 1995). Two interview measures were also used: the 7-day PAR (Sallis et al., 1985) and an active transport interview. Due to the more detailed retrospection encouraged by the interview techniques, it was hypothesised that the two interview measures would be more closely related to the pedometer-recorded step count than the questionnaire measures. Similarly, regarding the questionnaire measures, the more detailed composite measure was expected to produce a measure of walking that better related to step count than the single item measure. Furthermore, it was anticipated that the active transport interview would provide a more accurate measure by focussing specifically on walking as transport.

METHODS:

Participants

Forty-one free-living participants (18 male) aged 20.9 ± 3.1 years were recruited via University noticeboards. Before beginning, participants received an information sheet, were made aware that they could withdraw at any time, and signed informed consent forms. The University of Birmingham Safety and Ethics Committee approved this study.

Procedure

Participants were issued with a *New Lifestyles NL-2000* (New Lifestyles Inc., Kansas City, MO.) pedometer and instructed in its correct usage. The pedometers were sealed shut so that the step count display was not visible and, to reduce deviation from their usual walking behaviour, participants were informed that the device would record all forms of physical activity. Previous studies that have investigated walking using self-report measures have not notified participants in advance that they will be required to report their behaviour (e.g. Hallal et al, 2005). Had participants in the present study known that their step count was being monitored, this may have resulted in an increased awareness of walking behaviour during the monitoring period, thus contaminating the later self-reports. Participants were asked to wear the pedometer during all waking hours for one week and to keep a diary detailing the times they actually wore it each day and any reasons for removal, e.g. swimming or showering. The purpose of the diary was to act as a memory aid in an effort to minimise the amount of missing data and to allow adherence to be assessed. Participants who indicated that they had not worn the pedometer for at least 12 hours each day were excluded from the analysis. Similarly, any participant who recorded less than 500 steps on one or more days was excluded as this was deemed to be suggestive of non-adherence.

Pedometers and diaries were returned during the second visit and the data downloaded. Participants completed the questionnaire, containing TPB construct measures and both the single item and composite measures of walking, and the interviews for physical activity (PAR) and active transport. In all cases the questionnaire was completed before the interviews to prevent the more detailed, prompted recall of the interview influencing the unprompted recall targeted by the questionnaire. Participants were then debriefed.

Measures

The *New Lifestyles NL-2000* is a small, lightweight pedometer that clips onto the belt or waistband and records steps taken. It resets at midnight and stores data for the previous seven days whilst recording the current day. All monitors were subjected to preliminary calibration to ensure step count accuracy: First, the number of steps recorded by each pedometer was compared to a manual step count over a distance of 1000m. Pairs of pedometers were then worn simultaneously for a 24-hour period and their records compared. This was done to ensure accuracy in a free-living situation and was repeated until each pedometer had been paired with at least two others. Those producing error rates greater than 1% in either part of the calibration procedure were excluded from this study, resulting in the removal of 2 out of 50 pedometers tested.

The TPB variables were measured using questionnaire items with seven point response scales, anchored at each end only with descriptive labels. These questionnaire items were developed for a previous exercise behaviour study that included walking and was conducted using a sample drawn from the same population as the present study (Eves et al, 2003). They show high internal consistency in both the original and present study.

As walking can be composed of multiple short episodes (USDHHS & CDC, 1996), the phrase *walking regularly* was used and was defined as "walking for any reason for at least 30 minutes a day in total (i.e. time spent on each bout added together, this includes walking to work etc.)". The value of 30 minutes per day was chosen to accord with the current physical activity recommendations (Pate et al., 1995).

Intention was measured using two items: “I plan to walk regularly during the next week” and “I intend to walk regularly during the next week”, each anchored with *definitely do* and *definitely do not* (Cronbach’s alpha = 0.97). Affective and instrumental attitudes were assessed separately, both using the stem: “Walking regularly during the next week would be…”. The semantic differentials used to measure affective attitude (Cronbach’s alpha = 0.88) were *interesting* - *boring, enjoyable* - *unenjoyable* and *pleasant* - *unpleasant* and those measuring instrumental attitudes (Cronbach’s alpha = 0.87) were *beneficial* - *harmful, healthy* - *unhealthy* and *wise* - *foolish.* A single item, scaled from *strongly agree* to *strongly disagree,* measured subjective norm: “Most people who are important to me would approve of me walking regularly during the next week”. Two items, each anchored with *strongly agree* and *strongly disagree,* measured PBC: “I am confident that I could walk regularly during the next week if I wanted to” and “I am sure I can walk regularly during the next week” (Cronbach’s alpha = 0.85). For each construct the mean score across items was calculated for analysis.

Similar to these measures of the TPB constructs was the single item measure of walking, which asked ‘How often you have been *walking regularly* in the last week’ on a 9-point scale ranging from ‘not at all’ (scored as 0) to ‘more than once a day’ (scored as 8), as shown in Box 1. The response indicated was taken to be the frequency of walking for at least 30 minutes per day (as earlier defined) over the previous week. Thus, the frequency score was multiplied by the minimum time of 30 minutes to produce an estimation of the total number of minutes spent walking in the last week.

The composite measure constituted two questions to cover recreational and non-recreational participation. Participants indicated (a) the number of times they had walked for recreation during the last seven days and the average duration of the episodes; (b) the time spent walking *'each day in the last 7 days, other than for recreation. For example, going to work, to the shops, to the pub, to visit friends.'* on a scale with 10 minute increments from *'none'* to *'over 180 minutes'* (See box 1). For the composite measure, the total number of minutes recreational walking reported (frequency multiplied by average duration) was added to seven times the average daily duration of non-recreational walking.

Insert Box 1 about here

The interview consisted of two parts: a 7-day PAR (Sallis et al., 1985) and an adapted version of the 7-day recall that focussed on active transport. During the initial 7-day PAR, participants were asked to recall what they had done, whether they would categorize it as physical activity and, if so, at what intensity. Definitions of moderate, hard and very hard physical activity were provided. All walking reported, irrespective of intensity, was extracted for each day.

The second part of the interview addressed active transport, focusing on walking. Working back in a similar style to the 7-day PAR, participants recalled where they had been and their method of transport. Participants who reported walking for all or part of a journey were then asked to estimate the time spent walking on that occasion. Again the amount of walking was extracted directly from the interview record.

Analysis

Pearson Product Moment Correlation Coefficients were calculated for each measure of walking to estimate the degree of association between them. A series of hierarchical linear regression analyses were carried out with intention to walk as the dependent variable. The TPB constructs of affective and instrumental attitudes, subjective norm and PBC were entered at the first step. Previous research has suggested that past behaviour can influence future behaviour indirectly through intentions to perform the behaviour (Hagger et al., 2002), thus making it a potential predictor of intentions. Past behaviour was therefore entered into the regression analyses on the second step, with separate analyses being carried out for each measure of walking behaviour obtained.

RESULTS:

All participants in this sample provided complete data. The pedometers recorded a daily average of 10634 ± 3510 steps per participant. Table 1 contains the descriptive statistics for each measure. The pedometer data and the self-reports of walking generated by both the composite questionnaire measure and the transport interview were normally distributed. The single item measure of walking was negatively skewed, in contrast to the data from the PAR interview, which was positively skewed. Although the amount of walking reported during both interviews was comparable, the questionnaire measures produced notably higher (composite) and lower (single item) mean values relative to those obtained from the interviews.

The correlation matrix for the five measures of walking used in this study is presented in table 2. Spearman’s Rank Correlation Coefficients were also calculated, and produced comparable results to those shown in table 2. The two interview measures demonstrated large, significant correlations with both the objective pedometer measure of walking and with each other. Both questionnaire measures, however, yielded non-significant correlations with the objective measure, interview measures and each other. The correlations of the interview measures with the pedometer counts were greater than the equivalent correlations for the questionnaire measures (all $t_{38} > 2.08$, $p < .05$).

Insert Tables 1 & 2 about here

The TPB constructs (affective and instrumental attitudes, subjective norm, PBC) explained 21.7% of the variance in reported intentions to walk during the coming week, with PBC the only unique predictor (ß = .44, $p = .04$). Addition of the single item measure of past behaviour in step 2 significantly improved the model, explaining 50.0% variance in walking intentions, with past behaviour the only significant contributor (ß = .21, $p < .001$). Replacing the single item measure of past behaviour with each of the other four measures in each case reduced the adjusted amount of variance explained to less than the 21.7% achieved in step 1 by the original TPB constructs (Composite measure: adjusted $R^2 = .203$; PAR: adjusted $R^2 = .193$; Transport interview: adjusted $R^2 = .196$; Step count: adjusted $R^2 = .193$). In all of these cases, PBC remained the only significant contributor (all $\beta = .45$, all $p < .05$).

DISCUSSION:

In summary, this study suggests that structured interviews can provide a self-report measure of walking behaviour that is associated with an objective measure, whereas commonly used questionnaire measures cannot. The positive skew seen in the single item measure suggests a ceiling effect, possibly due to the method by which the time spent walking was calculated. All responses of ‘more than once a day’ were scored as a frequency value of eight before being multiplied by the minimum required time of 30 minutes. There are two ways in which this could have created a ceiling effect on the data: participants may have walked for 30 minutes more than eight times, alternatively participants may have walked for more that 30 minutes on each occasion. The questionnaire does not give participants the opportunity to express either of these situations.

The pattern of contribution from PBC but not affective attitude, and amount of variance explained are similar to a previous application of the TPB to walking that explained 17.5% of intentions (Eves et al, 2003). In addition, the data suggest that a single item measure of past behaviour made an appreciable contribution to intentions whereas the more detailed information available from the structured interview accounted for no additional variance in the model. Given the small sample, these results must be considered provisional.

STUDY 2:

The first study explored the use of different methods of measuring walking behaviour within a small sample of students. The second extended this by investigating the performance of the self-report measures relative to the objective measure within a much larger, non-university population. For self-report of walking, the single item measure and the PAR interview were retained, with additional transport questions added at the end of questioning about each day’s behaviour. It was predicted that walking reported using the PAR interview measure would be more closely related to the pedometer determined step count than the single item questionnaire measure.

Also, examination of the predictive utility of the TPB in the first study was limited to predictions of intention as behaviour was not measured after completion of the TPB questionnaire. To investigate whether the TPB can effectively predict walking behaviour, the duration of the study was extended to two weeks. This allowed measures of both past and future behaviour relative to the administration of the questionnaire assessing TPB constructs to be obtained. The participants in this study were RAF trainee aircraftsmen. During the first week of they were living off-base, i.e. in a free-living situation, whereas the second week of monitoring was performed when they returned to base. Thus, assessment was performed in two different contexts. It was hypothesised that the TPB constructs would predict walking behaviour in line with previous research on physical activity (Hagger et al., 2002)

METHODS:

Participants:

Two hundred Royal Air Force trainee aircraftsmen (77.0% male, age 20.1 ± 3.72 years) were recruited from two bases in the United Kingdom. Participants received an information sheet and brief presentation about the study, which included making them aware that they could withdraw at any time, before completing a consent form. The University of Birmingham Safety and Ethics Committee approved this study.

Procedure:

During the initial visit participants provided basic demographic information before being issued with a *New Lifestyles NL-2000* pedometer and instructed in its correct usage. Similar to the first study participants were lead to believe that they were wearing a monitor designed to measure all forms of physical activity and were instructed not to wear the monitor when swimming, showering or performing in other 'wet' activities and to remove the monitor before playing contact sport. Participants were provided with a diary and asked to note the times at which they wore the pedometer and reasons for removal (e.g. showering, going to bed).

One week later, 180 participants (77.5% male, age 20.2 ± 3.95 years) returned to complete a questionnaire, containing measures of the TPB constructs and measures of walking during the previous week, plus the PAR interview. One hundred and thirty-nine participants (76.5% male, age 20.4 ± 4.34 years) returned a further seven days later to complete the second questionnaire and interview measures of behaviour. Comparison of the sample that completed all measures (69.5% recruited participants) with those who only completed week one (90.0% recruited participants) revealed no differences between samples on any measure (all p > .22). Again the questionnaire was completed before the interview in all cases.

Measures

This study employed the same TPB construct measures and single item measure of walking used in the first study, with one minor alteration. The figure of 30 minutes walking per day was replaced by 90 minutes. This value was generated from pilot work using pedometers to measure walking in RAF aircraftsmen that estimated the average daily amount of walking to be 95.4 ± 21.8 minutes. All TPB measures achieved Cronbach's alphas of 0.85 or greater in this sample.

The interview protocol was also slightly modified. Rather than completing two interviews that elicited largely overlapping reports of walking, participants completed one standard PAR interview with additional active transport questions. After recalling their physical activity for each day participants were asked whether they remembered using any form of active transport, such as walking or cycling, which they had not already reported. If a positive response was received then the interviewer asked where they had been, what form of transport had been used and how long the journey had taken. The walking reported as physical activity and as transport was then summed to give a total for each day.

RESULTS:

Different measures of behaviour

For the comparison of self-report measures of walking with the pedometer counts only those participants with complete pedometer records, as defined in study 1, were included in the analysis. This resulted in the exclusion of thirty-seven participants (20.6%) from the first week and sixteen (11.5%) from the second week.

During the first week of the study the pedometers recorded a participant average of 67580 ± 21100 steps, which increased significantly to 78362 ± 24533 steps in the second week (t_{135} = 4.97, p < .001). The descriptive statistics for the various measures of walking are shown in Table 3. It was noted during the course of the PAR interviews that many participants in this population reported both walking and marching. Both of these methods of transport contribute to step count and they are presented as separate elements in the following analysis. Further, running can also contribute to step count and reports of running were extracted from the PAR interview reports for inclusion in table 3.

Insert Table 3 about here

The pedometer recorded step counts were normally distributed for weeks 1 and 2 of the study, whereas the single item measure was negatively skewed for both weeks. The walking component of the PAR measure was normally distributed in both weeks whereas the marching and running components were positively skewed for the first week and more evenly distributed in the second.

Both the single item and PAR measures of behaviour demonstrated much weaker relationships with step counts than in the previous study. As Table 3 shows, there was no association between step counts and self-reports of walking obtained using either the single item measure or the PAR interview in either the first or second week of this study. In contrast, during both weeks the PAR measures of marching and running demonstrated significant associations with step count. As both marching and running contributed to step counts, residualised scores were computed to remove the contribution of marching and running. In subsequent analyses of pedometer counts, both the raw step counts and residualised scores were tested.

Predicting intentions to walk and walking behaviour using TPB Variables

The relationships between the predictor and outcome variables are shown in table 4. A strong association was present between all TPB constructs. Intention correlated well with all three measures of past behaviour. While the two self-report outcome measures also showed some correlation with the underlying TPB constructs, step count is not related to any of the TPB constructs either as a raw score (shown) or as a residualised count. As one would expect, past and predicted behaviour were highly correlated when measured using the same instrument. Interestingly, there was also a correlation between the single item and PAR measures of walking at each time points.

Insert table 4 about here

A hierarchical linear regression analysis investigated the contribution of the TPB variables (affective and instrumental attitudes, subjective norm, PBC) and past (i.e. week one) behaviour to intentions to walk (in week two). TPB variables were entered in step one and past behaviour in step two. The analysis was repeated using each measure of past behaviour (single item, PAR, step count) in the second step (see table 5). Note that due to the reduced sample with complete pedometer data separate analyses were run. The initial model explained 45.3% variance in intentions with unique contributions from subjective norm and PBC. Adding the single item measure of past behaviour to the model significantly improved predictions of intention, with past behaviour becoming an additional unique predictor. There were, however, no significant changes in the model with the inclusion of either PAR reported walking or the objective measure of step count. There were no differences between analyses that employed the raw data or the residualised step counts that removed the influence of marching and running. Although PBC makes the greatest contribution in all models, it is interesting to note that subjective norm demonstrates a consistent, unique negative contribution.

Insert tables 5 & 6 about here

Following the prediction of intention to walk, further hierarchical regression analyses explored the role of TPB predictors of behaviour (intention, PBC) and different measures of past behaviour in predicting future behaviour. Table 6 summarises these results. In the models of behaviour using only traditional TPB predictors, intention and PBC were significant predictors of only the single item measure of walking, offering no unique contribution towards explaining either PAR reported or pedometer recorded walking. In all cases, adding past behaviour to the models resulted in a significant increase in the amount of behavioural variance explained. The single item measure of walking was the one best explained by both the traditional TPB constructs and by the TPB constructs plus past behaviour. Indeed, the amount of explained variance of the single item measure contrasted with moderate amounts of variance explained for the other measures of behaviour. As before, there were no differences between models using the raw pedometer counts or the residualised scores.

DISCUSSION:

The self-report measures of walking ranged widely in the degree to which they shared variance with objectively measured walking behaviour, as assessed by pedometer. While the interview measures correlated reasonably well with step counts within the university population, neither of the questionnaire measures were associated with the objective measure. For the RAF population, however, neither the questionnaire nor the interview measure was associated with step counts. The data from these studies confirm previous findings that recall of walking is poor (Ainsworth, Leon, Richardson, Jacobs & Paffenbarger, 1993; Richardson, Leon, Jacobs, Ainsworth & Serfass, 1994) and that accurate measurement of walking by self-report remains elusive (Bassett et al., 2000; Eves et al., 2003; Tudor-Locke & Myers, 2001).

The lack of observed relationship between self-reported and objective measures suggests that participants are largely unaware of their walking behaviour and thus, are unable to accurately report it. This may be due to the incidental nature of a large portion of the walking undertaken, a factor apparent in interview responses. In study one, the PAR interview correlated better with step count than the questionnaire-based TPB measure, suggesting that more detailed prompting can elicit better recall. This is in line with previous research suggesting that stronger motivation to accurately recall walking, in our case the presence of the interviewer, may generate more accurate responses (Johnson-Kozlow & Matt, 2004). Nonetheless, the substantial relationship between the interview and pedometer counts in the university sample was not replicated in the larger RAF sample. As the latter may engage in more work-related activity, it is possible that walking becomes a less salient activity in keeping with its primary purpose of transport. Set against this, walking was measured both in a free-living context and when constrained by activity on the base; neither context revealed any relationship between self-reported walking and the objective measure.

RAF trainee aircraftsmen reported regular bouts of marching and running as well as walking in the interview, with these activities contributing to the recorded step count. Despite these additional contributors, residualised scores that removed the influence of marching and running revealed the same lack of relationship between the objective measure and self-reports of walking. Indeed, PAR reported marching and running were better correlated with step count than walking. There are three possible reasons for this: firstly, marching and running are of a higher intensity than walking, which may make them easier to recall (Eves et al., 2003; Richardson et al., 2001), thereby facilitating more accurate self-report. Secondly, participants could more easily calculate how much marching they have done. Whilst on duty, trainee aircraftsmen are required to march when moving around the air base. Therefore by recalling the major time-consuming tasks that they were assigned to, they could work out where they had been and approximately how long it would take them to travel between these locations. This is an easier task than trying to recall which minor errands were run on any given day or how many times the journey was made between one's own room and a friend's room in another barrack block. Finally, marching and running may be easier to recall due their more structured and purposeful nature; marching is non-volitional with aircraftsmen instructed to report to a specific location or to attend to a job. Running is mainly a planned activity requiring some preparation for its completion. Thus, as the activity is consciously initiated it may leave a stronger memory (Eves et al., 2003).

The TPB variables explained over 45% of the variance in walking intentions during the following week. In common with Eves et al (2003), the present study found no significant contribution of attitude to intention, with PBC being the major contributor. Part of this may reflect the definition employed in the present study of regular walking as lifestyle accumulation; it seems likely that intention to walk specifically for leisure would be influenced by attitude. Nonetheless, the absence of any effects of attitude underscores the unusual nature of lifestyle walking in contrast to other forms of physical activity. The strongest predictor of intention is attitude for both the generic term exercise (Hagger et al., 2002) and for most specific types of physical activity behaviours (Eves et al., 2003).

Concerning the single item measure of walking, it was notable that substantial amounts of its variance could be predicted by intention and PBC. One could argue that the better prediction relative to the interview or objective measures reflect the fact that behaviour and its psychological precursors were measured on similar scales as required by the TPB. Critically, however, there was little evidence in either study reported here that the single item measure was associated with the underlying behaviour. Hence the prediction of behaviour (as assessed using the single item measure) may be at least partly an artefact of shared method variance (c.f. Sutton, 1998).

When participants are unable to accurately recall a given behaviour they typically employ availability heuristics to generate an estimate (Aarts & Dijsterhuis, 1999; Johnson-Kozlow et al., 2004). Previously reported intention and PBC may function as heuristics for the estimate of behaviour here. Our attempt to measure a behaviour for which there is poor recall, has highlighted one possible pitfall of single item scales. This finding may have wider implications for researchers using the TPB. Where accuracy of self-report may be compromised, for example by the passage of time or the routine nature of the behaviour (Aarts, Paulussen, & Schaalma, 1997), use of single item scales could inflate the apparent ability to predict that behaviour. This relates to the observation that the TPB predicts self-reports of behaviour much better than objectively measured behaviour (Armitage & Conner, 2001).

The present findings may also have implications for research investigating physical activity using the TPB, which typically employ the generic term exercise; investigations of the TPB contribution for individual types of exercise are rare (Ajzen & Driver, 1992; Bryan & Rochleleau, 2002; Eves et al., 2003). For the generic term, participants are expected to recall episodes of different types of physical activity to produce a composite estimate of their exercise behaviour. Further, use of a single item to measure the behaviour is commonplace, and using scale-compatible measures is recommended. To produce a single item measure of generic exercise, participants must aggregate across separate episodes of different types of behaviour, often without any prompting cues; this is quite a complex recall task. In contrast, measures of individual types of exercise can be considered instances of prompted recall of the behaviour not unlike the prompting that occurs in an interview. In essence the task for participants is to recognise whether they have performed the behaviour. It is possible that under the suboptimal conditions of recall of the generic composite, measures of the underlying behaviour may also be subject to heuristic biases. Put another way, use of single item measures may have elevated the apparent ability of the TPB to predict the behaviour.

In contrast to the single item measure, the prediction of walking assessed using the PAR and the pedometer was poor. This may be because the TPB was designed to model *planned*, or goal-directed, behaviour and walking is a largely unplanned method of transport; the higher order goal of the destination is the planned part of the behaviour, e.g. going to the shops. More generally, the present results suggest that the TPB may not be applied as successfully to behaviours which do not constitute goals in themselves, although further empirical work is needed to test this possibility.

There are two limitations to the present study, one concerning scale construction and the other concerning contributors to the step counts relevant to the above discussion. First, the principles of scale correspondence and compatibility were violated in this study. Whereas behaviour was measured on a continuous scale, intention and PBC used dichotomous graded scales (Courneya, 1994). This lack of correspondence between the TPB constructs and the behaviour would have reduced the relationship between the predictor and outcome variables. Hence part of the failure to predict the PAR measure of walking and step counts may reflect a lack of scale correspondence. It should be noted, however, that any attenuation resulting from imperfect correspondence means that the apparent prediction of the single item measure represents an underestimation of the effect. Concerning violation of scale compatibility, the target behaviour for intention was ‘walking regularly, i.e. for 30 minutes’ and hence a compatible behavioural measure would have involved a dichotomous yes/no response to the question ‘Did you walk regularly?’ rather than the continuous measures used. Ideally, the objective measure of step counts would have been matched with TPB constructs defined in terms of step counts though there would be obvious problems for participants if asked about their TPB constructs in relation to the unfamiliar behaviour of step counts. More realistically, minutes of walking rather than walking regularly could have been used as the target behaviour. Once again, violation of scale compatibility may have attenuated the relationship between intention and the measures of behaviour, particularly in the case of step counts. Hence this study may have underestimated the ability of the TPB to predict walking. Only further research can clarify the issue.

Turning to contributors to the objective measure, step count would be influenced by all locomotor behaviour, a point underscored by contributions from both marching and running to step count in the RAF sample. Nonetheless, when the contributions of running and marching were removed statistically by using residualised scores, the results were unaltered. Further, while self-reports of marching and running correlated with the objective measure, self-reports of walking did not. These data confirm that self-reports of walking may be problematic.

Durante and Ainsworth (1996) suggest that poor recall of behaviour can be attributed to four primary cognitive sources: comprehension, retrieval, decision-making and response generation. The fact that walking itself requires minimal cognitive involvement will lead to weak encoding of the activity in memory and subsequently poor recall (Schacter, 1999). Hence retrieval appears the most likely cause of the problems with measurement. Walking is unique in that it can be a planned leisure activity but occurs most often as an incidental lifestyle activity without active planning. There are brief episodes throughout the day such as fetching something from another room, travelling to a new location or simply transport subservient to other lifestyle activities, such as gardening. Recommendations citing 10,000 steps per day as a physical activity target include these forms of walking within that total (Hatano, 1993) underlining the importance of their inclusion in any measurement of daily walking. Neither interview nor questionnaire could be expected to retrieve all of these brief episodes. It is likely, however, that the interviews may sometimes perform better due to the more detailed introspection they encourage, as demonstrated in the university population.

A (potential) limitation of the present study is that the pedometers counted number of steps taken, whereas the questionnaire and interview measures assessed the amount of time spent walking. It could be argued that walking behaviour and stepping behaviour are two different activities. Participants, however, only completed one set of questionnaire items assessing the TPB constructs and these items all referred to ‘walking regularly’, measuring the behaviour in minutes. Thus the TPB constructs may not have been suitable for modelling step behaviour. Collecting a second set of construct measures enquiring about the average number of steps participants intended to take over the coming week and their beliefs about taking a given number of steps may have addressed this issue and improved the predictive validity of the resulting model. Most people, however, have very little idea how many steps they take in an average day. Therefore asking people how many steps they took in the last week, expect to take in the coming week or their beliefs about taking a certain number of steps per day would be unlikely to generate accurate, considered responses. Furthermore, assuming that stepping and walking are two different behaviours and that this is the reason for the poor performance of the TPB for modelling pedometer determined walking behaviour, does not explain the low predictive utility of the TPB when applied to the PAR measure of behaviour.

These studies illustrate the current difficulties in measuring, modelling and explaining walking behaviour and emphasise the need for further research into this unique physical activity behaviour. New methods of exploring and predicting walking need to be investigated, particularly considering the current interest in the behaviour. Walking presents as an ideal activity for public health promotion campaigns. Until the behaviour is better understood, however, the most efficient way to encourage it will remain elusive.

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<u>BOX 1: Questionnaire items measuring walking during the previous week</u>

Single item measure:

Please indicate how often you have been walking regularly in the <u>last</u> week?

Not At all	one time	two times	three times	four times	five times	six times	once a day	more than once a day

On average, how long did you walk for each time? ………………………………..

Composite measure:

Please indicate how many times you have been walking <u>for recreation</u> during the last *7 days* ………………..

On average, for how long did you walk each time? …………………………………..

Please circle the number of minutes you have spent walking each day in the last *7 days*, <u>other than for recreation? For example, going to work, to the shops, to the pub, to visit friends.</u>

None

About 10 minutes	about 20 minutes	about 30 minutes	about 40 minutes	about 50 minutes	about 60 minutes
About 70 minutes	about 80 minutes	about 90 minutes	about 100 minutes	about 110 minutes	about 120 minutes
About 130 minutes	about 140 minutes	about 150 minutes	about 160 minutes	about 170 minutes	over 170 minutes

Table 1: Descriptive statistics for the five measures of walking obtained in Study 1

	Mean ± standard deviation	Median	Range
Pedometer recorded step count (steps per day)	10634 ± 3510	10109	13703
Single item measure (minutes per day)	28.22 ± 7.72	30.00	26
Composite measure (minutes per day)	98.78 ± 64.03	98.57	226
PAR (minutes per day)	69.33 ± 47.15	60.00	188
Transport interview (minutes per day)	59.82 ± 29.16	63.75	116

Table 2: Correlation matrix of the measures of walking obtained in Study 1

	Pedometer recorded step count	Single item	Composite	PAR
Single item measure	r = .217, p = .173 C.I.: -.097 to .492			
Composite measure	r = .149, p = .351 C.I.: -.166 to .437	r = .301, p = .056 C.I.: -.007 to .557		
PAR	r = .573, p < .001 C.I.: .322 to .749	r = .240, p = .131 C.I.: -.073 to .510	r = .285, p = .071 C.I.: -.025 to .545	
Transport interview	r = .564, p < .001 C.I.: .310 to .748	r = .273, p = .084 C.I.:-.038 to .536	r = .159, p = .319 C.I.: -.156 to .445	r = .675, p < .001 C.I.: .464 to .814

Table 3: Descriptive statistics for the measures of walking, marching and running used in Study 2 and the correlation between the self-report measures and the pedometer count for each week

	Week 1				*Week 2*			
	Mean ± sd	Median	Range	*R*	Mean ± sd	Median	Range	*R*
Step count (steps per day)	9789 ± 3000	9724	13333		11382 ± 3174	11483	17684	
Single item (mins per day)	86.65 ± 88.89	60.00	480.0	.06 C.I.: -.109 to .225	68.24 ± 53.21	60.00	270.0	.05 C.I.: -.119 to .216
PAR – walking (mins per day)	61.28 ± 52.62	49.29	325.7	.02 C.I.: -.148 to .187	41.06 ± 37.63	30.35	222.8	.05 C.I.: -.119 to .216
PAR – marching (mins per day)	7.21 ± 11.57	2.40	60.0	.21* C.I.: .049 to .365	20.25 ± 20.86	14.65	85.7	.26** C.I.: .096 to .410
PAR – running (mins per day)	7.23 ± 8.29	4.29	38.6	.26** C.I.: .096 to .410	13.44 ± 12.20	10.25	42.8	.50*** C.I.: .363 to .616

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 4: Pearson correlation coefficients for the TPB constructs and measures of behaviour used in Study 2

						Measures of Past behaviour			Outcome measures		
		Affective Attitude	Instrumental Attitude	Subjective Norm	PBC	Step count	Single item	PAR total	Step count	Single item	PAR total
	Intention	.329***	.164*	.299***	.567***	.180*	.267**	.190**	.050	.248**	.179*
	Aff. Att.		.525***	.473***	.289***	.069	.107	.192**	-.006	.210*	.215**
	Inst. Att.			.374***	.313***	.129	.126	.116	.070	.144	.075
	Sub. Norm				.411***	.099	.219**	.159*	-.037	.124	.132
	PBC					.137	.237**	.181*	.046	.243**	.162
Past Behaviour	Step count						-.037	.021	.333***	-.067	.038
	Single item							.595**	.069	.461***	.242**
	PAR total								.003	.509***	.465***
Outcome measures	Step count									-.047	.180*
	Single item										.336**

*** *p* < .05, ** *p* < .01, *** *p* < .001**

Table 5: Prediction of intentions to walk from TPB variables and the different measures of past behaviour

Measure of past behaviour	*Affective attitude*	*Instrumental attitude*	*Subjective norm*	*PBC*	*Past behaviour*	*Change in R^2*
Single item (n=180)	.07	-.02	-.18*	.73***	-	.453***
	.05	.01	-.15*	.62***	.24***	.045*
PAR (n=180)	.07	-.02	-.18*	.73***	-	.453***
	.06	-.02	-.18**	.72***	.09	.005
Step count (n=137)	.07	.04	-.19*	.69***	-	.416***
	.07	.03	-.19*	.68***	.10	.006

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 6: Summary of regression analyses showing prediction of week two walking behaviour from TPB variables and past (i.e. week one) behaviour

Measure of Behaviour	*Intention*	*PBC*	*Past Behaviour*	*Adjusted R^2*
Single item (n=139)	.48***	.19*	-	.358***
	.19*	.15*	.51***	.516[a]
PAR (n=139)	.07	.20	-	.050*
	.01	.16	.38***	.180[a]
Pedometer (n= 114)	.01	-.02	-	.000
	.03	-.02	.36***	.110[a]

* $p < .05$, ** $p < .01$, *** $p < .001$

[a] Significant improvement in the model at $p < .05$