

Running head: Visual attention, attitude, physical activity,

Associations Between Visual Attention, Implicit and Explicit Attitude, and
Behaviour For Physical Activity

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Abstract

The current study explored associations between previous physical activity and both implicit and explicit attitudes, as well as visual attention and activity motivation (intention). Analyses were performed on participants initially unaware of the physical activity focus of the study (N=98). Higher levels of physical activity were associated with positive implicit attitudes and an attentional bias toward exercise cues. There was a quadratic ('U' shaped) relationship between implicit attitude and attention: the more extreme individuals' implicit attitudes toward exercise (positive or negative) the greater their attentional bias to exercise cues. Furthermore, explicit attitude moderated the relationship between attentional bias and physical activity: attentional bias to exercise cues was associated with higher levels of physical activity only for those who had a strong positive explicit attitude. Findings suggested that implicit cognitions are linked with previous physical activity. Future research should consider strategies for strengthening positive implicit and explicit attitudes and directing attention to cues signalling healthy behaviour.

Keywords: Implicit attitude, explicit attitude, visual attention, exercise, physical activity

Associations Between Visual Attention, Implicit and Explicit Attitude, and
Behaviour For Physical Activity

At least 30 minutes of moderate intensity physical activity five days per week is needed to benefit general health (World Health Organisation, 2003); 45-60 minutes, five days per week, are needed to combat weight gain (Department of Health, 2005). The majority of adults in the U.K do not achieve these levels of exercise, placing them at risk of a range of illnesses including cardiovascular disease, obesity, type-2 diabetes, and musculoskeletal diseases (Department of Health, 2004 & 2005). For example, obesity rates in the UK are three times higher than twenty years ago (Department of Health, 2002), which may partly be a consequence of low levels of physical activity (Prentice & Jebb, 1995). The high prevalence of sedentary lifestyles and associated health risks highlight the need to understand the potential barriers to physical activity.

Attitudes and allied constructs are a focus for understanding health-related motivation (Conner & Norman, 2005). The associated research has largely treated decision-making as deliberative and rational: for example, measures of attitudes are derived through the use of questionnaires where responding requires controlled (conscious) processing. However, attitudes might also be relatively automatic (e.g., Bargh, Chaiken, Raymond, & Hymes, 1996; Fazio, Sanbonmatsu, Powell, & Kardes, 1986), including those related to health behaviours. Individuals may be unaware of their attitude, or their attitude may occur unintentionally or uncontrollably (Bargh, 1994). Automatic, or implicit attitudes are essentially mental associations between an attitude object (e.g., physical activity) and its evaluation (positive or negative). The strength of the mental association reflects the accessibility of the attitude (i.e., the ease

with which it can be retrieved). Objects associated with highly accessible attitudes will likely attract attention, and behavioural decision-making should be eased such that attitude-consistent behaviour becomes more probable (Fazio, 1995; Roskos-Ewoldsen & Fazio, 1992).

Preferentially allocating attention toward attitude-relevant cues at the expense of other stimuli indicates an attentional bias. A limited body of research has suggested that implicit attitudes and attentional biases may be important variables in the maintenance of specific health-related behaviours. Research has highlighted attentional biases for smoking cues in smokers relative to non-smokers (Bradley, Field, Mogg, & De Houwer, 2004) and for food and body image related stimuli for those with eating disorders over healthy controls (Dobson & Dozois, 2004). Smokers have also been shown to have more positive implicit attitudes toward smoking than non-smokers (Swanson, Rudman, & Greenwald, 2001) and children with obesity have a more positive implicit attitude toward food than healthy controls (Craeynest, Crombez, De Houwer, Deforche, Tanghe, & Boureaudhuij, 2005).

Research has also found links between implicit attitude and attention in relation to health. Mogg, Bradley, Field and De Houwer (2003), for example, found a positive correlation between automatic evaluation of smoking cues and attentional bias to these cues in a visual probe task. Implicit attitude was assessed via a stimulus response compatibility task (SRC) which captured symbolic approach and avoidance tendencies. A manikin needed to be moved either toward or away from smoking-related stimuli. The underlying logic of this task is that approach-avoidance responding is an immediate consequence of specific automatically activated evaluations; approach and avoidance tendencies follow positive and negative evaluations respectively (Chen & Bargh, 1999). When the required manikin

movement is compatible with the automatic evaluation of the stimulus, response-times are facilitated; incompatible evaluation-response combinations inhibit manikin movement latency. Because the SRC task may be viewed as a surrogate measure for implicit attitude, the study showed that automatically activated attitudes guided allocation of attention (measured by a visual probe task).

The above findings resonate with functional models of attitude (e.g., Roskos-Ewoldsen & Fazio, 1992; Chen & Bargh, 1999). These models view the affective system as one that simplifies processing of information about the world; it affords the ability to selectively attend stimuli that have the potential for hedonic consequences and provides a heuristic for approach and avoidance responding.

An important influence on attitude formation and reinforcement is direct experience with the attitude object (e.g. Bem, 1972; Fazio, Eiser, & Shook, 2004; Fazio & Zanna, 1981; Zajonc, 1968). According to Fazio (1995), attitudes (as object-evaluation associations in memory) are formed and strengthened by the repeated mental pairing of the representation of the attitude object with the evaluation of that object. (Indeed, this form of associative learning has been exploited in experimental manipulations of attitude accessibility: e.g. Fazio, Blascovich & Driscoll, 1992; Fazio, Ledbetter & Towles-Schwen, 2000). As such, one would expect an association between previous behaviour and current attitude. Together, this suggests two implications for physical activity motivation. Firstly, attention will be directed toward physical activity cues for which there are strongly accessible attitudes. Secondly, attitude (and through this, attention) will be shaped by previous experience of physical activity behaviour.

The present research explored whether attitude and attentional processes were related to previous physical activity. We considered whether the degree of physical

activity during the previous week was associated with the subsequent evaluation of exercise cues and attentional bias toward those cues.

There have been recent attempts to explore attentional biases and implicit attitudes to physical activity (Berry, 2006; Craeynest et al, 2005; Eves, Scott, Hoppé, & French, 2007). Berry (2006), for example, used a modified Stroop task to show that physically active and non-active participants differed in their attention toward exercise cues. Physically active people had longer response latencies when identifying the colour of exercise words than when identifying the colour of control words. Non-exercisers exhibited the reverse pattern. The longer latencies indicated that attention was directed toward the content of the cues rather than their colour. However, there is some uncertainty as to what specifically the modified Stroop measures; it may reflect a general slow-down to emotionally relevant words rather than a selective attention mechanism (Algom, Chajut, & Lev, 2004). The dot probe task (MacLeod, Mathews, & Tata, 1986) provides a somewhat less ambiguous test of biases in visual attention (cf. Schmukle, 2005). It tasks participants with identifying the location of a dot (the probe) after it has replaced one word of a previously presented word pair. Responding should be faster if attention is initially attracted to the word in the same field as the probe. Where the probe appears in the opposite field, responding should be slowed by needing to shift attention toward the probe. The current study used the dot probe measure of attentional bias.

The Extrinsic Affective Simon Task (EAST; De Houwer, 2003) has been used to measure implicit attitudes to physical activity (Craeynest et al, 2005). Participants press keys in response to words presented on a computer screen to designate either their colour (blue, green) or valence (good, bad). The keys used for valence judgements are the same keys used to categorise coloured words as blue or green.

Study critical words are presented only in coloured words; the EAST exploits an automatic bias to read and evaluate words (as positive or negative) on trials when the explicit task is to categorise words by their colour. Faster responding is expected where (implicit) valence matches the key used for responding to the word's colour, with slower responding expected when valence and colour keys differ. Thus, a participant with a positive implicit attitude to physical activity would have shorter reaction times to activity words when the colour key was the same as the 'good' key than when it was the same as the 'bad' key, and vice versa for a negative attitude.

The EAST is a variant of the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998), a more commonly used implicit measure. Despite its popularity and repeated demonstrations of reliability and validity (Nosek, Greenwald, & Banaji, 2006), the IAT may not always be the best choice of measure. The IAT relies on comparing two concepts with one another and so requires there to be a suitable comparison category. Because physical activity as a concept did not appear to us to have an appropriate comparison category, the IAT was not deemed suitable. ('Inactive' might seem to be a comparator category, but because physical activity occurs on a continuum, even very active people are inactive at times and so 'inactive' would encompass both active and inactive people). Conversely, the EAST allows the measurement of a single target concept and was selected as the measure of implicit attitude in the current study.

To measure physical activity, we used the 7-day Physical Activity Recall (PAR; Sallis, Haskell, & Wood, 1985). This is a structured interview employing recovered memory techniques to index each parameter of physical activity (e.g., type, frequency, intensity, and duration; Carron, Hausenblas, & Estabrooks, 2003).

To summarise the study backdrop and rationale, attentional bias to a competing cue in the immediate environment is likely governed by accessible attitudes which are associated with consistent behavioural (approach/avoidance) tendencies. Weak or negative implicit attitudes to exercise and non-allocation of attention to exercise cues may therefore act as barriers to physical activity uptake; if people do not notice physical activity cues in their environment they are unlikely to adopt the necessary approach behaviours that result in physical activity engagement. For example, when leaving the tube station, a person will be presented with the option of taking the escalator or the stairs. Whichever of these cues will grab attention is likely to be dependent upon whatever attitude is most accessible. If a strong positive attitude to walking/stair climbing is most accessible (reinforced by stair-taking behaviour in the past), the individual is likely to take the stairs. If a negative attitude is most accessible, the individual will likely avoid the stairs and use the escalator instead. Similar situations will likely present themselves to people over the course of their daily lives. Hence, understanding the relationships between attitude, attention and physical activity will inform interventions focused on increasing physical activity uptake and maintenance.

Based on the preceding theory and research, the current study examined the following hypotheses: There would be a positive association between implicit attitude (EAST) and previous physical activity (H_1); there would be a positive association between attentional bias to exercise words (dot probe) and previous physical activity (H_2); and there would be a positive association between implicit attitude and attentional bias for exercise words (H_3). (It is also possible that exercise cues will be noticed by those who have highly accessible positive or negative attitudes. Therefore, an alternative prediction, (H_{3b}) is that there may be a curvilinear, 'U' shaped,

relationship between implicit attitude and attentional bias).

Whilst the current study emphasised implicit processes, we recognized that explicit attitudinal processes are relevant to exercise motivation (e.g. Godin & Shephard, 1986; Hausenblas, Carron & Mack, 1997; Lowe et al., 2003; Lowe, Eves & Carroll, 2002; Norman & Smith, 1995). Therefore, we included examination of the association of explicit attitudes (affective, instrumental) and intention with physical activity, and whether associations were independent of implicit attitudes and visual attention.

Method

Pilot Phase

A pilot phase identified (pilot 1; $N = 25$) and refined (pilot 2; $N = 25$) suitable exercise and non-exercise words to be included in the EAST and dot probe tasks. Both pilot studies were conducted on students at a British university campus (Pilot 1; 22 female, 3 male, $M_{age} = 20$ years, $SD = 5$; Pilot 2: 16 female, 9 male, $M_{age} = 20$ years, $SD = 1$). Using the MRC Psycholinguistic Database, potential word pairs (exercise and non-exercise) were identified according to their length, written frequency, and number of syllables. Identified words were included in the pilot questionnaires, which asked participants to rate them according to exercise (un)relatedness, their familiarity and valence. Emotion-laden words, words implying a position (e.g., top), and food items (e.g., lobster) were avoided because they might be afforded a processing advantage. Final dot probe and EAST stimuli are given in the appendix.

Exercise is a sub-component of physical activity. Exercise behaviour is generally an end in and of itself, requiring specific motivation. Physical activity, in

contrast, is any use of large muscle masses as part of behaviour (Caspersen, 1989). Hence physical activity can be seen as a higher-order construct, involving activities which may be a goal, or serve a super-ordinate goal (e.g. gardening, DIY, and so on). Accordingly, stimuli focusing on exercise were deemed most appropriate for exploring (implicit) motivation for activity per se.

Main Study Phase

Participants and Procedure

One hundred and twenty five students (90 female, 34 male, 1 did not report their gender; $M_{age} = 23$ years, $SD = 6$), who identified themselves as native English speakers and not colour-blind, were recruited from a British university, and paid £6 (approximately 10 US dollars) for participating.

Participants arrived at the laboratory individually and were told that the session comprised a dot probe task, a dual categorisation task, a lifestyle interview and questionnaire. Participants were not told the primary objectives of the study. Instead, they were told that the study was “exploring the link between cognitions and lifestyle”.

Participants first completed the dot probe and the EAST (the dual categorisation task) with task order counterbalanced across participants. Participants then completed a brief questionnaire that probed their awareness of the specific lifestyle behaviour of interest. Next, participants were informed of the actual behavioural focus because subsequent assessments were explicitly about exercise. The experimenter then conducted the 7-day PAR interview. Participants then completed a questionnaire booklet assessing their explicit attitude toward exercise, their intention

to exercise, as well as some demographic information. Finally, participants were fully debriefed and paid for their participation.

Materials and Measures

The visual display and response collection for the dot probe and EAST were controlled by Cedrus SuperLab Pro (version 2.04) software, running on a Dell Latitude D810 laptop computer (Intel Pentium M Processor 780 (2.26Ghz), 1GB DDR2 RAM, with Microsoft's Windows XP operating system). The laptop was docked to a 15 inch CRT monitor (Evesham, model no: EV771 Rev A), set to 1024 x 768 resolution at 85 Hz refresh rate. Participants responded using a Cedrus RB-730 response box.

Visual attention was assessed using the dot probe procedure (MacLeod et al., 1986) which tasks participants with identifying the location of a dot (the probe) across a series of trials. Each trial ran as follows: an orienting cross ('+') appeared in the centre of the screen for 500 ms. A word pair was presented immediately after the orientation cross. Each word in the stimulus pair was placed on the vertical axis approximately 15 mm from the screen centre (one word was above the screen centre, the other below). Words were presented in white, bold, size 35, Arial, lowercase font on a black background. Characters were approximately 5 to 7 mm tall. The word pair remained on screen for 500 ms. This then disappeared and the dot (the probe; '.') was immediately presented in one of the word locations (aligned on the central vertical axis). The dot remained on-screen until the participant responded using a pad key-press to denote the probe's location (i.e. 'top' or 'bottom'). There was a 1000 ms inter-trial interval.

In each pair, the control word was matched with its critical study partner according to length, number of syllables, written frequency, familiarity and valence.

Trials where a critical word and the probe appeared in the same location are referred to as *congruent*. Trials where the critical word and the probe appear in the opposite location are referred to as *incongruent*. There was a block of 8 practice trials before the experimental block of trials began. In the experimental block, the first 4 trials were buffers. The location of the critical words and the dot probe was fully counter-balanced. All exercise, non-exercise and filler words appeared in the top and bottom half of the screen. On half the trials the dot appeared in the same location as the critical word, for the other half it appeared in the opposite location to the critical word. Therefore, each of the 38 critical word pairs (15 exercise, 12 non-exercise, 11 filler) appeared 4 times (congruent top, congruent bottom, incongruent top, incongruent bottom) resulting in 152 experimental trials. Within each block, all word pairs were presented in random order for each participant.

An attentional bias score for exercise cues was computed by subtracting the mean response latencies for congruent trials from the mean response latencies for incongruent trials. Positive and negative scores indicated attention toward or away from exercise cues respectively, with higher scores reflecting stronger bias.

Implicit attitude. The EAST protocol followed De Houwer (2003). Screen background, font style and size were the same as for the dot probe task. Each trial ran as follows: A white fixation cross ('+') appeared in the screen centre for 500 ms. Next, the stimulus word (white, green or blue) was presented and remained on the screen until participants made a correct response (valence for white words, colour for green/blue words). Errors were indicated by a red cross appearing underneath, remaining until a correct response was given. The inter-trial interval was 1000 ms.

Two initial practice blocks allowed participants to practice categorising white words (Block 1; 20 trials) and coloured words (Block 2; 20 trials). Following this

were 10 buffer trials (2 positive white words, 2 negative white words, 3 words presented once in blue and once in green) prior to two experimental blocks. Both experimental blocks consisted of 100 trials during which 28 white words (14 positive and 14 negative) were presented once; the 15 exercise words, 15 filler words, and 6 controls ('xxxxx') were presented once in each colour. Within each block, all trials were randomly presented for each participant. Critical trials were those where the (coloured) exercise words were paired with the 'good' key (faster response for positive attitude) and the 'bad' key (faster response for negative attitude). EAST scores were computed for exercise by subtracting the mean response latency for exercise words paired with the positive key from the mean response latency for exercise words paired with negative key. Positive and negative scores reflected a positive and negative evaluation respectively, with higher scores indicating stronger evaluations.

Awareness check. Participants completed a brief questionnaire. They were told that the research focused on a specific lifestyle activity/behaviour and asked whether they knew what this was. Participants recorded a 'yes' or 'no' response. If a 'yes' response was given, participants were asked to report what they thought the lifestyle behaviour was.

Physical activity. We used the 7-day PAR interview (Sallis et al, 1985). Participants recalled the physical activities they had engaged in over the preceding week. Only activities that were performed for at least 10 minutes continuously or intermittently during each segment of the day (morning, afternoon, or evening) were recorded. The duration of physical activity reported excluded breaks. A weighted physical activity score was constructed. Firstly, we employed the Sallis et al. (1985) time rounding rules. The duration of each physical activity reported was rounded to

the nearest quarter of an hour and converted into a time proportion score (i.e., 15 mins = .25, 30 mins = .50, 1 hour = 1.0, and so on). The time proportion for each activity was then multiplied by its associated metabolic intensity (MET) value (Ainsworth et al., 2000). Lastly, all weighted physical activities were summed.

Explicit attitude, intention and demographics. Explicit attitude items were those used by Conner and Sparks (2005) and Lowe, Eves, and Carroll (2002). Using a 7-point semantic differential scale, participants indicated the extent to which they believed exercise was: *important/unimportant*, *harmful/beneficial*, *healthy/unhealthy*, *foolish/wise*, (instrumental attitude, $\alpha = .69$) and *enjoyable/unenjoyable*, *pleasant/unpleasant*, *satisfying/unsatisfying*, *interesting/boring* (affective attitude, $\alpha = .88$). Higher scores indicated a more favourable attitude. Participants also completed five intention to exercise statements (e.g., 'I intend to exercise'; $\alpha = .91$). The final variables comprised means of relevant items. Participants also reported any sports club membership, and demographic information (e.g. age, gender).

Results

Data Preparation and Preliminary Analyses

Treating reaction time data: Dot probe. Dot probe latencies less than 100 ms or more than 4000 ms were excluded (Mogg, Bradley, & Williams, 1995). Latencies were log transformed and those more than two standard deviations above each participant's own mean were removed. Log scores were then retransformed back into millisecond metric. Inspection of both the transformed and re-transformed scores revealed that the re-transformed scores were more normally distributed. The retransformed scores were therefore used in all subsequent analyses. Five participants had errors on more than half of the experimental trials so their data were excluded

from subsequent analyses. For the remaining 120 participants, 5.14% of responses were excluded due to errors and outliers.

EAST. Following De Houwer (2003), only critical trials in which coloured words were presented were analysed. Reaction times on trials with an incorrect response were discarded (3.99% of the data were excluded due to errors). Reaction times below 300 ms and greater than 3000 ms were recoded to 300 and 3000 ms respectively. Response latencies were log transformed. We inspected the distributions of both sets of scores (transformed and untransformed); the untransformed scores more closely approximated a normal distribution and were consequently used in all subsequent analyses.

Reliabilities of the dot probe and EAST: To determine the internal consistency of both implicit cognition measures, split-half reliability and Cronbach's α were calculated (Schmukle, 2005). For the dot probe task, to estimate the Cronbach's α the 60 critical trials (involving the exercise words) were divided into 15 quadruplets consisting of one exemplar of each kind of critical trial (e.g., congruent top, congruent bottom, incongruent top, incongruent bottom). Then a bias index was calculated for each quadruplet (mean RT for incongruent trials – mean RT for congruent trials; in essence an attentional bias score was calculated for each of the 15 exercise items). A Cronbach's α was subsequently computed based on the 15 values; $\alpha = .16$. To estimate the split-half reliability, exercise words were randomly divided into two blocks and separate attentional bias indices were computed for each block (mean latencies for incongruent trials minus mean latencies for congruent trials). The bias scores were then correlated and a Spearman-Brown correction applied; *adjusted* $r = .73$. For the EAST, to estimate the Cronbach's α we firstly calculated an individual EAST score for each of the 30 exercise words (each exercise word was presented

twice in the EAST), for each participant. This was done by subtracting the RT to the individual exercise word (e.g., football) when it was paired with a positive response from the RT to the same word when it was paired with a negative response.

Cronbach's α was subsequently computed on the resulting 30 values; $\alpha = .42$. For the split-half reliability, separate EAST scores were calculated for each of the two experimental blocks. These EAST scores were correlated and a Spearman-Brown adjustment applied; *adjusted* $r = .40$.

The analysis of the internal consistency of the dot probe showed mixed results; the Cronbach's α was low yet the split-half reliability was high. Later, we discuss this issue and propose that this pattern of reliability is to be expected from the dot probe for this particular area of research. However, both internal consistency statistics showed that the EAST was less reliable. Nevertheless, significant and interpretable findings did emerge using the EAST (see below); 'noise' in the measure meant that findings probably under-represented the actual strength of associations of critical variables with implicit attitudes (also see the Discussion).

Awareness check. Twenty-five participants correctly identified the particular lifestyle behaviour of interest. Because our specific focus was on automatic cognition, we excluded "aware" participants from the current analyses (remaining $N = 100$)¹.

Exploration of physical activity, explicit attitude and intention. Box plots identified two outliers (z scores -4.99 and 5.17) across the affective attitude, instrumental attitude, intention, and physical activity measures. Because of concerns over the distorting influence of extreme values, these data were excluded from analyses (remaining $N = 98$).

Further inspection of the physical activity data revealed that a minority of participants (16 out of 98) engaged in 'sporting' behaviours (e.g., football, rugby,

martial arts) in addition to other physical activity behaviours (e.g., jogging, cycling, walking). These two sets of behaviours may represent different motivational states in the approach to physical activity. 'Sporting' behaviours are externally driven in the sense that they involve interceptive actions (e.g., pass, catch, tackle, throw). For these behaviours, much of the enjoyment can be derived from the performance aspects of one's ability, rather than the intrinsic value of the physical activity itself. As such, the main explicit goal to sporting activities is extrinsic. The other class of behaviours (walking, cycling, etc.), however, have fairly minimal interceptive actions. The motivation for engaging in these sorts of behaviours is more likely to stem from the intrinsic value of the physical activity itself. The main explicit goal to exercise here is intrinsic. We separated the extrinsically and intrinsically motivated activities. However, it was difficult to assess associations between extrinsically motivated activities and implicit cognition variables because few participants actually engaged in the extrinsically motivated activities. Because of the assumed psychological differences in the motivation for the engagement of or maintenance of different types of physical activity we felt it would be prudent to omit extrinsically motivated behaviours from our analyses. Consequently, we created a weighted physical activity measure for each participant for only intrinsically motivated activities².

Means and standard deviations for all study variables for the final sample can be seen in Table 1.

Effects of task order. A series of one way analyses of variance (ANOVA) were performed to determine whether the order of administration of the dot probe and the EAST affected attention, implicit attitude, explicit attitude, intention, and physical activity. Results revealed no significant effect of task order on any of the study variables (all F values < 2.31 , all p values $> .13$).

We also tested the idea that task order moderated the association between the implicit cognition variables (implicit attitude and attention) and past physical activity³. Accordingly, we conducted two moderated hierarchical regressions, one examining task order moderating the attentional bias and past physical activity relationship and one examining task order moderating the implicit attitude and past physical activity relationship. Main and interaction effects were entered in the first and second steps respectively. All variables (but not the interaction terms) were mean centred before entry into the regression model. The dependent variable was physical activity. Task order did not moderate the association between implicit attitude and physical activity ($\beta = .14$ $p > .65$), or attention and physical activity ($\beta = .50$ $p > .14$).

Main Analyses

Associations between study variables. To test our hypotheses that there will be a positive association between implicit attitude and previous physical activity (H_1), a positive association between attentional bias to exercise cues and previous physical activity (H_2), and that implicit attitude will be positively related with attention (H_3), we computed Pearson's correlations between implicit attitude, attentional bias and physical activity variables⁴. Pearson's correlations were also performed between all other study variables (Table 1).

Supporting H_1 and H_2 , positive correlations were observed between implicit attitude and previous physical activity and between attentional bias and previous physical activity. Explicit attitude (affective and instrumental), and intention were all positively associated with each other. Affective attitude and intention were positively associated with previous physical activity. There was no reliable linear relationship between implicit attitude and attentional bias, offering no support for H_3 . However,

there was support for our alternative hypothesis, H_{3b} , which posited that the relationship between implicit attitude and attention is non-linear. It was predicted that highly accessible *negative and positive* implicit attitudes might both be associated with attending an exercise cue. Curve estimation was used to test for a quadratic relationship⁵. Implicit attitude was centred and entered as the independent variable in the regression model. The dependent variable was attention. The model accounted for 5% of the variance in attentional bias, $F(2, 91) = 3.20, p < .05$. Results revealed a ‘U-shaped’, quadratic relationship ($\beta = .29, p > .02$).

Following contemporary research on the interplay between implicit and explicit cognitions (Perugini, 2005), we also tested whether attitude and attention were related to one another in their association with previous physical activity. That is, we tested whether the relationship between attentional bias and previous physical activity was partly a function of (was moderated by) attitude. We conducted three moderated hierarchical regressions, one examining implicit attitude as a moderator, one examining explicit affective attitude as a moderator, and one examining explicit instrumental attitude as a moderator. Main and interaction effects were entered in the first and second steps respectively. All variables (but not the interaction terms) were mean centred before entry into the regression model. The dependent variable was physical activity. Implicit attitude did not moderate the association between attention and physical activity ($\beta = .05, p > .66$). However, both affective and instrumental attitude did (Table 2). For affective attitude, the model accounted for 18% of the variance in physical activity, $F(3, 90) = 7.73, p < .001$, with the adjusted R^2 change from Step 1 to Step 2 significant: Step 1, $F(2, 91) = 7.07, p = .001$; Step 2, $F_{change} = 7.98, p = .006$. For instrumental attitude, the model accounted for 9% of the variance in physical activity, $F(3, 90) = 3.90, p < .02$, with the adjusted R^2 change from Step 1

to Step 2 significant: Step 1, $F(2, 91) = 3.25, p < .05$; Step 2, $F_{change} = 4.92, p < .03$.

To decompose each interaction, we performed a simple slope analysis of the association between attentional bias and physical activity at two levels ($\pm 1 SD$) of attitude (Figure 1 for affective attitude, Figure 2 for instrumental attitude). As both figures illustrate, for those with a low (more negative) attitude, there was no significant association between attention and physical activity, $t_{affective}(90) = -.07, p > .46$; $t_{instrumental}(90) = -.45, p > .60$. However, for those with a high (more positive) attitude there was a significant positive association between attention and physical activity, $t_{affective}(90) = 3.90, p < .0005$; $t_{instrumental}(90) = 3.75, p < .0005$. To summarise, attentional bias to exercise cues was associated with physical activity only among those with a positive explicit (affective or instrumental) attitude. This provides partial support for H_3 .

---Figures 1 & 2 about here---

We also examined whether implicit and explicit (affective and instrumental) attitude interacted in their association with previous physical activity. Separate hierarchical multiple regression analyses were computed with the (mean centred) independent variables entered in the first step and the interaction term in the second step. Instrumental and affective attitude did not interact with implicit attitude in their association with previous physical activity; instrumental attitude \times implicit attitude $\beta = .08, p > .43$; affective attitude \times implicit attitude $\beta = .07, p > .50$.

Additional Analyses

The unique associations of attentional bias, intention, and implicit and explicit attitude with physical activity were explored using sequential multiple regression. Step 1 consisted of implicit attitude and attentional bias measures. Step 2 comprised

instrumental and affective (explicit) attitude. Intention was included at step 3. The dependent variable was physical activity (Table 3). In Step 1, both implicit attitude and attentional bias emerged as significantly associated with physical activity. In Step 2, attentional bias to exercise remained significant, and implicit attitude was marginally significant; affective attitude also emerged as significantly associated with physical activity. In Step 3, attentional bias to exercise remained significant along with implicit attitude as marginally significant. Intention was not found to be independently associated with physical activity. The model accounted for 14% of the variance in physical activity, $F(5, 88) = 3.99, p = .003$. Adjusted R^2 change was significant for Step 1 and Step 2: Step 1, $F(2, 91) = 5.51, p = .006$; Step 2, $F_{change} = 3.88, p < .03$; Step 3, $F_{change} = .56, p > .45$.

Discussion

We speculated that engagement in physical activity might impact on implicit attitudes and selective attention for subsequently encountered exercise cues. We suggested that implicit attitudes may guide attention such that individuals might attend to objects (physical activity cues) for which they have strong implicit (i.e. accessible) attitudes (Roskos-Ewoldsen & Fazio, 1992); the underlying assumption being that attitude was shaped by previous behaviour (Bem, 1972; Fazio, Eiser, & Shook, 2004; Fazio & Zanna, 1981; Zajonc, 1968). Accordingly, we examined associations between implicit attitude, attention and recent physical activity. Support was found for our expectation that previous physical activity would be accompanied by an increase in the accessibility of a positive implicit attitude (H_1). Evidence also supported our prediction of a positive association between attentional bias and physical activity (H_2). A curvilinear association between implicit attitude and

attentional bias emerged, providing support for H_{3b} . Additionally, partial support for H_3 was found. Here, explicit (affective and instrumental) attitude moderated the association between physical activity and attentional bias. That is, attitude and attention were linked such that there was a positive association between recent physical activity and attentional bias only for those who held a strong positive explicit attitude.

The results suggested that physically active people holding strong affective and/or instrumental attitudes are more likely to notice unexpected or ad hoc exercise cues. Conversely, sedentary individuals who negatively evaluate exercise cues would likely disregard (ignore/disengage attention from) those cues. An implication of this is that basic attentional processes may undermine interventions aimed at increasing physical activity uptake because sedentary people are automatically disengaging from cues to exercise. Put differently, in terms of attentional processes, people are in a better position to engage in ad hoc exercise opportunities if they are already physically active.

We tacitly equated implicit attitudes with accessibility. Accessibility refers to the ease with which an attitude can be retrieved from memory. Even though, by their very nature, strong implicit attitudes are more accessible than weakly held attitudes, accessible attitudes are not necessarily implicit. Strong explicit attitudes may also index attitude accessibility. Accordingly, explicit attitudes may also serve the function of guiding attention. We found evidence for this: attentional biases were linked with physical activity via their association with accessible explicit (affective and instrumental) attitude. It appears, therefore, at least for exercise, that individuals notice cues if they possess strong attitudes which they can consciously introspect.

We also found evidence that accessible implicit attitudes facilitate attention allocation to exercise cues. The curvilinear relationship between implicit attitude and attentional bias implied that individuals were more likely to notice exercise cues when they held either a strong positive or strong negative implicit attitude. This finding is consistent with a functional account of attitudes (Roskos-Ewoldsen & Fazio, 1992).

Interpreting the above findings within an applied context, individuals who enjoy (or dislike) exercise are likely to notice relevant cues in the environment (e.g., may notice the stairs rather than the escalator at the tube station) and provide them with an opportunity to act in accordance with their accessible attitude. A strong positive implicit attitude may likely lead to approach behaviour (taking the stairs) whereas a strong negative implicit attitudes may likely lead to avoidance behaviour (taking the escalator).

Evidence showed that physical activity was linked to attentional bias and implicit attitude. These implicit variables were independently associated with physical activity over and above explicit attitude and intention. There are, however, two caveats to these findings. Firstly, effects only emerged for individuals who were unaware of the study focus and, therefore, unaware that cognitions associated with the study focus were being assessed. We do not know why this effect emerged. It is contrary to theorising on this issue; awareness is expected to increase implicit-explicit consistency (e.g., Fazio & Olson, 2003). It is not possible to speculate about likely mechanisms behind this effect because they were beyond the scope of our research. Caution should be exercised when assessing implicit cognitions because awareness of cognition measurement does appear to influence critical associations. Further research may wish to explore the moderating role of awareness on the implicit cognition-behaviour relationship.

The second caveat to this research is that our findings are only correlational. We were unable to identify or specify the casual relationships between these variables. We cannot conclude that stronger implicit attitude or greater attentional bias to exercise cues is directly caused by previous exercise behaviour. Nevertheless, this research has taken an important first step to illustrate that these implicit cognition variables are linked with physical activity and, importantly, identified individual differences in attentional biases and implicit attitudes to exercise.

Recent research has questioned the reliability and validity of the EAST as a measure of implicit attitude. Craeynest *et al.*, (2005) used the EAST to measure differences in implicit attitudes to physical activities in clinically obese and non-obese children. They found no differences in EAST scores between these two groups. However, only three target items were used for each category of physical activity (sedentary, moderate, intense). Similarly, recent experiments by De Houwer and De Bruycker (2007) showed the EAST was outperformed by the IAT on at least two dimensions: the EAST had poorer internal consistency and did not correspond to measures of explicit attitude. However, the experiments also included very few target items. With more critical target items, the EAST has been shown to capture inter-individual differences (e.g., Ellwart, Becker, & Rinck, 2005).

For the current study, we included a sizeable and relevant list of stimuli for the EAST measure, and were able to identify individual difference in implicit attitudes (despite rather low measure reliability). One reason that we captured individual differences might have been due to the breadth of exercise-related stimuli included in the measure. Exercise is not a unitary construct. Individuals will not evaluate every activity (e.g., football, sprinting, golf) equally. They may have preferences for a finite set of activities. If some of these are not included in a measure then the measure may

be less relevant for them. Previous research assessing implicit attitudes toward physical activity employing the EAST (e.g. Craeynest et al, 2005) used only three items to capture moderate and intense physical activities, and they did not find any differences in implicit attitude between obese and non-obese children. Similarly De Houwer & De Bruycker (2007) used only one item to capture attitude toward specific political parties (i.e., party name), beer (i.e., 'beer') or specific sexual orientation (i.e., 'hetero') and also found the EAST to be a weak measure of implicit attitudes. We speculate that sufficient and relevant stimuli may be one boundary condition for enhancing the reliability and validity of the EAST.

A question mark may remain over the reliability of the dot probe. Although it demonstrated very good split-half reliability, the internal consistency was poor. This finding has some resonance with those of Schmukle (2005), who suggested that poor reliability (split-half and internal consistency) of the dot probe accounts for inconsistent attentional bias effects reported in the literature. On the basis of this (combined with reliability issues of the EAST), one may suggest that relationships found between the implicit cognition measures and physical activity may be spurious. However, we do not believe that the numerous and conceptually meaningful correlations and interaction effects that emerged could have done so by chance, especially if what we were supposedly measuring was error variance. Furthermore, the dot probe was stable. Stimuli that were attended to in the first part of the task were also attended to in the second part of the task. That is, previously active individuals consistently noticed the same physical activity cues. The low internal consistency simply indicated that the physical activity items were not equally relevant for every individual. Individuals participate in a finite set of activities with different goals at the point of selecting the activity. As such, a footballer, for example, would not be

expected to notice cues to cricket or swimming. Instead, it is likely that individuals notice cues to physical activity behaviours that are familiar and semantically meaningful. Moreover, a central assumption to this research was that past behaviours will form positive attitudes that guide attention to relevant physical activity cues (and the assumed consequent approach behaviours). The high split-half reliability provides indirect support for this contention.

Findings were also consistent with previous research. Like Berry (2006), we found that physical activity was positively associated with attention toward physical activity cues. Use of the dot probe, however, permitted specific assessment of visual attention deployment; it was possible to determine whether attention was directed toward or away from physical activity cues. Attention was not inferred through interference effects on a modified Stroop task which may reflect a generic slow-down to emotional stimuli and not selective attention (Algom et al., 2004). Results also illustrated the association of physical activity with deliberative evaluations. Increased physical activity was associated with more positive explicit (affective) attitude; this resonates with previous research exploring links between explicit cognitive processes and physical activity (e.g., Lowe, Eves & Carroll, 2002; Eves, Hoppé, & McLaren, 2003).

Social psychology applied within the health domain is beginning to consider conceptual and empirical advances in implicit cognition (Perugini, 2005; Sheeran, Aarts, Custers, Ravis, Webb, & Cooke, 2005). The current research is consistent with this development. However, the applied strategic nature of the study means that results would likely have a more indirect than immediate impact on health interventions; data will be relevant to those developing psychological interventions derived from conceptually driven research. The current findings showed that

physically active and less active individuals differed in both implicit attitude and attentional bias to exercise. The association of attention and implicit attitude with physical activity highlights the need for further exploration of these variables in understanding underlying physical activity motivation (and maybe motivation for other health-related behaviours). In this regard, future research should focus on strategies to generate a positive implicit attitude toward exercise among more sedentary individuals, and to find ways of attracting such peoples' attention to cues signalling exercise opportunities. This in turn may help sedentary people engage in issues associated with physical activity. For example, it may be fruitful to employ cognitive training to increase attention to exercise cues, and increase positive associations with exercise. Training paradigms from the addiction literature (Wiers et al., 2006) may prove useful in this regard.

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Appendix
Dot Probe and EAST Stimuli

EAST Words

Practice white: happy, love, sentimental, waterfall, pleasure, sad, poison, sickness, rotten, funeral. *Practice green/Blue*: diploma, careful, table, tiger, crispy, doctor, errand, carton, theory, butler. *Buffer white*: kiss, friendly, hostile, boring. *Buffer green/Blue*: armour, robotic, impartial. *Positive white*: sweetheart, honest, comedy, affectionate, angel, cute, truth, gift, passion, kindness, pretty, romantic, diamond, laughter. *Negative white*: slave, loneliness, unfaithful, abuse, assault, war, humiliate, violent, hostage, poverty, execution, disaster, morbid, tragedy. *Control green/blue*: xxxxx. *Filler green/blue*: chair, sit, recline, composed, relax, comfort, calm, unwind, restful, mellow, silence, corn, news, cloth, imitate. *Exercise blue/green*: throw, football, tennis, badminton, golf, fit, energetic, sprinting, rowing, bicycle, cricket, exercise, hockey, swim, walk.

Dot Probe Matched Word Pairs

Practice: diploma-careful, table-tiger, doctor-crispy, errand-carton, theory-butler, street-chance, loyal-trail, comparison-population. *Buffer*: rattle-armour, elegant-robotic, wealthy-lampoon, promotion-impartial. *Filler*: chair-dress, sit-dry, recline-entrust, composed-donating, relax-glory, comfort-touched, calm-cash, unwind-acquit, restful-acclaim, mellow-allure, silence-suggest. *Non-exercise*: palace-sacred, pencil-jacket, context-outlook, contents-conclude, month-cause, ant-jug, carpeting-germinate, salute-fiddle, folk-myth, press-trade, glacier-figment, adverse-dentist. *Exercise*: throw-cloth, football-sentence, tennis-devote, badminton-coherence, golf-corn, fit-dog, energetic-evolution, sprinting-ancestors, rowing-clowns, bicycle-imitate, cricket-pretext, exercise-electric, hockey-bauble, swim-earn, walk-news.

Footnote

¹ Hierarchical multiple regression analysis showed that awareness moderated the association between attentional bias and physical activity. The independent variables in the first step of the model were attentional bias and awareness. The interaction between these variables were entered in the second step. Physical activity was the dependent variable. The model accounted for 3% of the variance in physical activity, $F(3, 116) = 2.24, p < .09$, with the adjusted R^2 change from Step 1 to Step 2 significant: Step 1, $F(2, 117) = .74, p = .48$; Step 2, $F_{change} = 5.18, p = .03$. For those who were aware of the study focus there was no reliable association between attention and physical activity, $t(116) = -.73, p = .47$. However, for those who were unaware of the study focus there was a significant association between attention and physical activity, $t(116) = 2.16, p < .04$. Awareness did not moderate the association between implicit attitude and physical activity ($\beta = -.04, t(124) = -.39, p > .69$). An interaction may have been undetectable given the lower reliability of the EAST. Accordingly, we conducted analyses both with and without “aware” participants. When including aware participants, we found fairly weak, non-significant associations between implicit attitude and physical activity ($r = .15, p > .09$). When excluded, associations were stronger and statistically significant ($r = .20, p < .05$). It should be noted that the latter effect emerged despite the smaller sample size and associated decrease in statistical power. In short, awareness unduly influenced associations between physical activity and implicit cognition.

² We also performed analyses on the physical activity data that included extrinsically motivated behaviours. The overall pattern of effects was similar to those that were performed on the physical activity data that excluded these behaviours. Here we report corresponding analyses to those in which we found reliable effects when the

physical activity measure excluded extrinsically motivated behaviours: Zero-order correlations between physical activity (including externally motivated behaviours) and critical study variables were as follows: implicit attitude $r = .21, p < .05$, attention $r = .18, p < .10$, instrumental attitude $r = .08, p > .44$, affective attitude $r = .30, p < .01$, and intention $r = .32, p = .001$. Hierarchical regression analyses assessing whether explicit attitude (instrumental and affective) moderated the relationship between attention and physical activity revealed either no or weaker interaction effects (instrumental attitude $\beta = .09, p > .40$; affective attitude $\beta = .17, p < .10$). Additional analyses exploring the unique contributions of our main study variables revealed that implicit attitude and attentional bias were only marginally associated with previous physical activity (implicit attitude $\beta = .17, p > .08$; attentional bias $\beta = .17, p < .08$; instrumental attitude $\beta = -.12, p > .32$; affective attitude $\beta = .20, p > .20$; intention = $\beta = .22, p > .10$). These results suggest that although there were clearly some associations between previous physical activity and the implicit cognition variables, externally motivated behaviours were partly obscuring this correspondence. We would like to thank one anonymous reviewer for suggesting the separation of physical activity data to enhance cognition-behaviour measure correspondence.

Because the implicit measures included extrinsic activity words, it could be argued that poorer implicit cognition-behaviour correspondence would result from omitting extrinsically motivated behaviours from the 7-Day PAR. Although theoretically appealing, there are important reasons why we believe weaker associations did not follow from this. Firstly, clear and consistent semantic categories are important for affective (and effective) priming (Storbeck & Robinson, 2004). Our implicit measures included items from the semantic category of exercise. Removal of stimuli representing extrinsically motivated behaviours could dilute the category

salience (and consequently reduce effects of affective or evaluative judgements on physical activity stimuli). Secondly, at a methodological level, excluding these items would mean that the attitude/attentional bias estimates would be based upon fewer trials. This may worsen the reliability of these indices (as we outline elsewhere, we believe the EAST is already quite vulnerable in this regard).

³We thank an anonymous reviewer for suggesting we use this analysis.

⁴We also computed an EAST score using the error data and included it in correlational analyses. There was no relationship with physical activity using this indicator of implicit attitude ($r = -.01, p > .95$). That no effect emerged was not surprising given the particularly low error rate for the sample; consequently we left out this variable from all analyses.

⁵We thank an anonymous reviewer for suggesting we use this analysis.

Figure 1

*Simple Slope Analysis: Affective Attitude Moderates the Association Between
Attentional Bias to Exercise Cues and Physical Activity*

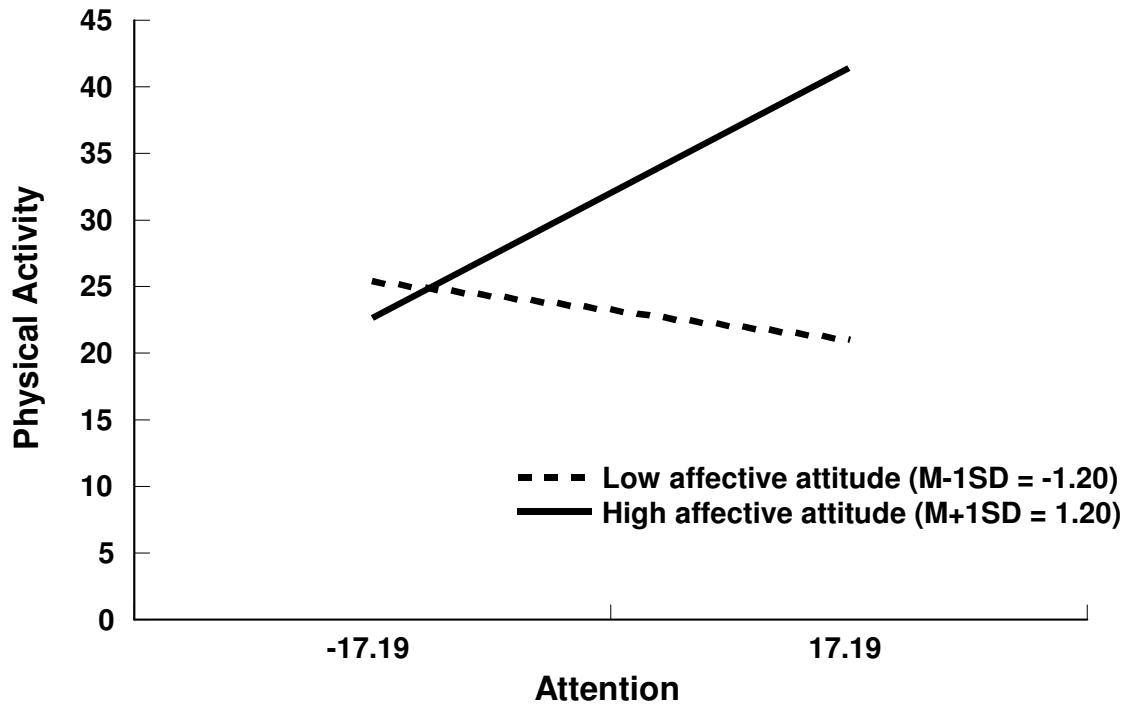


Figure 2

Simple Slope Analysis: Instrumental Attitude Moderates the Association Between Attentional Bias to Exercise Cues and Physical Activity

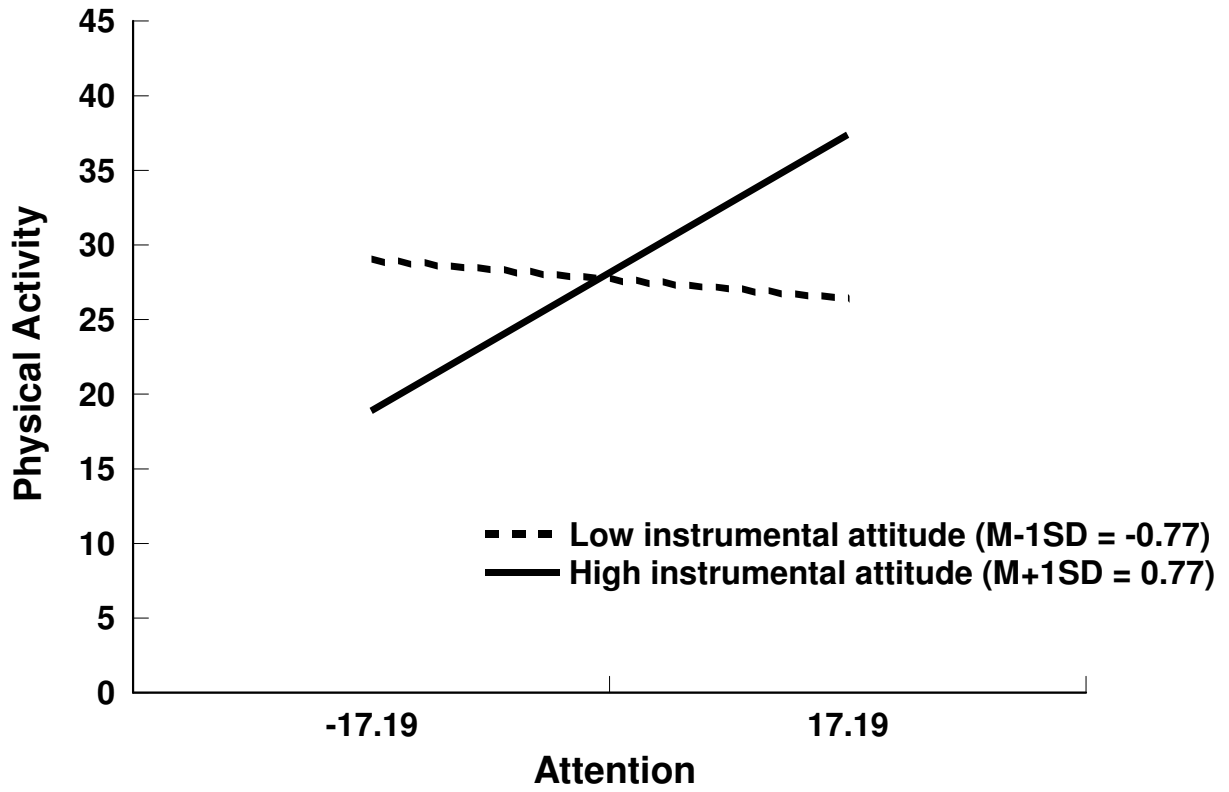


Table 1

Means (M), Standard Deviations (SD), Range and Inter-Correlations for Implicit Attitude, Attention, Instrumental Attitude, Affective Attitude, Intention, and Physical Activity

Study Variables	M	SD	Range	1	2	3	4	5
1. Implicit Attitude	-3.12	74.09	383.74					
2. Attentional Bias	2.96	17.19	87.93	-.07				
3. Instrumental Attitude	6.34	.76	5.00	.12	-.05			
4. Affective Attitude	5.30	1.18	4.75	.14	.01	.58***		
5. Intention	5.63	1.13	4.60	.09	.02	.32***	.68***	
6. Physical Activity	27.42	18.21	95.83	.22*	.25*	.05	.27**	.24*

Note: * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$ (2-tailed). N = 98 except for correlations involving the attentional bias measure where N = 94.

Table 2

Hierarchical Regression: Affective and Instrumental Attitude Moderates the Association Between Attentional Bias to Exercise Cues and Physical Activity

Step/Variable	Adjusted R ²	Adjusted R ² Increase	Step 1 β	Step 2 B
<u>Model For Affective Attitude</u>				
1. Affective Attitude		.12***	.27**	.24*
Attentional Bias			.25*	.20*
2. Affective Attitude x Attentional Bias	.18***	.06**		.27**
<u>Model For Instrumental Attitude</u>				
1. Instrumental Attitude		.05*	.07	.01
Attentional Bias			.25*	.22*
2. Instrumental Attitude x Attentional Bias	.09*	.04*		.23*

Note: * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.

Table 3

Hierarchical Multiple Regression for Physical Activity

Step/Variable	Adjusted R ²	Adjusted R ² Increase	Step 1 β	Step 2 β	Step 3 β
1. Implicit Attitude		.09**	.22*	.19 •	.19 •
Attentional Bias			.26**	.25*	.25*
2. Instrumental Attitude		.05*		-.14	-.13
Affective Attitude				.33**	.25
3. Intention	.14**	.00			.10

Note: • $p \leq .06$, * $p \leq .05$, ** $p \leq .01$.