

Physical activity intervention: a Transtheoretical Model-based intervention designed to help sedentary young adults become active

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Abstract

Physical activity levels in young adults are low. Research supports the use of the Transtheoretical Model of behaviour change (TM) in designing physical activity interventions. This study used a pre–post randomized control design to investigate the effectiveness of a self-instructional intervention for helping sedentary young adults to initiate physical activity. Post-intervention, significantly more of the experimental group (80%), in comparison to the control group (68%), improved their exercise stage of change (SOC) from baseline ($P < 0.05$). Discriminant analyses revealed that discrimination between stage improvement/non-improvement was possible using the processes of change data. Stage improvers scored significantly higher on all of the behavioral and four out of five of the cognitive processes of change. For stage improvers, the processes of self-re-evaluation and self-liberation were most frequently used, whilst social liberation was used significantly more by the experimental than the control group. This inexpensive, self-instructional intervention, based on the TM and the ‘active living message’, is an effective method of assisting sedentary young adults to progress through the exercise SOC.

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Introduction

Regular physical activity is positively associated with physiological and psychological health benefits (US Department of Health and Human Services *et al.*, 1996). The Health Education Board for Scotland (Health Education Board for Scotland, 1997) showed that 62% of 16–24 year olds in Scotland were not achieving the minimum requirements of physical activity for health (defined as at least three times per week for 20 min of moderate to vigorous physical activity). Other studies have revealed that a high proportion of young adults are sedentary or irregularly active (Pinto and Marcus, 1995; Douglas *et al.*, 1997; Pinto *et al.*, 1998; Leslie *et al.*, 1999; Woods *et al.*, 1999). There is a need for research to establish effective ways of helping this population to become active.

The Transtheoretical Model (TM) has been described as an integrative and comprehensive model of behavior change that has drawn from all major theories of psychotherapy (Prochaska and Norcross, 1999). Its original use was in research into negative addictive behaviors like smoking and the initial research explored how self-changers made successful changes without professional intervention (Prochaska and DiClemente, 1983; Prochaska and Norcross, 1999). This model has been used in numerous studies across 12 health behaviours (Prochaska *et al.*, 1994) and is cited as one of the most important theoretical health promotion developments of the decade (Samuelson, 1997).

The processes of change dimension of the TM involves understanding ‘how’ individuals change their behavior. They include cognitive, affective,

Table I. *The processes of change as they apply to physical activity*

Process	Definition
Experiential processes	
consciousness raising	undertaking by the individual to find out more about physical activity
dramatic relief	emotional experiences associated with change
environmental re-evaluation	understanding how inactivity affects the physical/social environments
self-re-evaluation	emotional and cognitive reappraisal of values by the individual with respect to inactivity
social liberation	awareness and acceptance of social changes encouraging active lifestyles
Behavioural processes	
counter-conditioning	substitution of physical activity for sedentary behaviour
helping relationships	seeking out social support to help initiate and maintain activity
reinforcement management	using rewards to encourage or maintain behaviour changes
self-liberation	choosing and making a commitment to change, believing in one's ability to change/control behaviours
stimulus control	avoiding or controlling stimuli and other causes that support inactivity

evaluative and behavioral strategies that an individual may use to modify the problem behavior. Ten processes of change were identified which represented cognitive and behavioral constructs (Prochaska *et al.*, 1988). Table I defines each of the 10 processes of change as it applies to physical activity. The stages of change (SOC) make up another dimension of the TM; they are the temporal dimension identifying the 'when' part of the change equation. There are five SOC for physical activity adoption and maintenance. These are precontemplation (sedentary, no intention), contemplation (sedentary and 6-month intention), preparation (irregularly active and intention), action (regularly active for the last 6 months) and maintenance (regularly active for longer than 6 months). Individuals are thought to progress through the SOC at different rates and whereas the time to progress through the stages is variable, the 'set of tasks' which have to be accomplished at each SOC are less variable (Prochaska and Norcross, 1999). Both self-efficacy and decisional balance are two components of the TM; this paper focuses on the relationship between the processes and SOC, and so these elements will not be discussed further [see (Biddle and Nigg, 2000) for detailed coverage].

The TM has allowed researchers to identify and work with sedentary populations, as an individual does not need to be an exerciser to fit into the model. A SOC effect for process use has also

been identified (Prochaska and DiClemente, 1983; Prochaska *et al.*, 1991; Marcus and Simkin, 1993; Prochaska and Marcus, 1994; Marcus *et al.*, 1996). This suggested that in helping someone to modify a behavior, initially their SOC would be established and then the processes of change most applicable to that SOC would be used to design an intervention. This provides the exercise consultant with an effective way of helping an individual to adopt a physically active lifestyle. Research has demonstrated that an integration of the stages and processes of change can provide a useful guide for physical activity interventions (Marcus *et al.*, 1998a).

Studies that examine the usefulness of the TM in exercise behavior modification have increased exponentially over the last two decades. The majority of these studies focused on middle-aged adults or the elderly and did not take place in Europe. Several of these studies involved interventions and their results highlighted the importance of various constructs from the TM in helping individuals to become more active [e.g. (Marcus *et al.*, 1998b; Dunn *et al.*, 1999; Steptoe *et al.*, 1999)]. The present study builds on current research as it focuses on a young adult group which is in the transition from late adolescence to young adulthood. This period has been identified as a key point for intervention to help young adults adopt and maintain an active lifestyle (Dishman, 1994).

The purpose of this research was to determine the efficacy of a postal intervention, based on the TM's processes of change, in helping sedentary young adults become more active and to explain any changes in SOC over the 7-month intervention period in terms of process of change use.

Method

Procedure

Sedentary students (precontemplators and contemplators) at a large urban university in Scotland were the population of interest. The baseline data was extracted from a larger survey on physical activity (Woods *et al.*, 1999). Seven months later, the target group was asked to complete a follow-up questionnaire as they waited to collect their maintenance subsidy from the government. This method, in combination with posting questionnaires, was chosen as written mail surveys tend to give low response rates (Hayes, 1997).

This study used a pre-post randomized control design. At baseline, the sedentary students were randomly assigned into an experimental or a control group. The experimental group was targeted with an intervention during their first 6 months in university. The control group did not receive the intervention, although they had access to all the opportunities provided to the experimental group via the Sport and Recreation Service (SRS) at the university. The SRS provides access to low-cost (£5.00 p.a.), on-campus leisure facilities, exercise classes and exercise advice to all undergraduate students. No contact between the participants and the authors happened during the study.

Completing the questionnaires was entirely voluntary and all students were informed that the research would help in the understanding of physical activity patterns among young people. In order to lessen social desirability bias, anonymity and confidentiality were guaranteed through the use of matriculation numbers rather than individual names and addresses. The Ethics Committee of the university approved this study.

Measures

The baseline questionnaire was based on one used in a previous study (Carney and Mutrie, 2000). This questionnaire had to be short to facilitate completion during the matriculation process. The action criterion, regular physical activity, was defined using both the CDC/ACSM (1995) and the ACSM (1990) recommendations. An individual's habitual exercise behavior was assessed using an ordered-categorical SOC scale (Marcus *et al.*, 1992b; Loughlan and Mutrie, 1995). The construct validity and test-retest reliability of this measure had been demonstrated by a number of studies (Marcus and Simkin, 1993; Marcus *et al.*, 1994; Mutrie and Caddell, 1994; Cardinal 1995a,b; Wyse *et al.*, 1995). These studies revealed that the different stages on the SOC instrument significantly differentiated an individual's activity levels into regularly or not regularly active. Binary questions (yes/no) on previous experience of physical activity in school and a section on qualitative comments made up the remainder of the baseline questionnaire.

To allow for comparison the follow-up questionnaire used the same SOC measure. As no time restrictions applied, cross-sectional data on the processes of change (Marcus *et al.*, 1992a) were gathered. This instrument used a five-point Likert scale for individuals to rate how frequently they used a particular process of change during the last month [never (1) to frequently (5), range 4–20]. The instrument's validity and reliability have previously been demonstrated (Marcus *et al.*, 1992a; Nigg and Courneya, 1998). Questions on the intervention, the university's SRS and a final section for qualitative comments concluded the questionnaire.

The questionnaires were piloted on students and staff in the university ($n = 46$ for baseline and $n = 32$ for follow-up). All respondents were asked to comment on the appropriateness, clarity and interpretability of the questionnaire to the administrator (first author) who was present. No changes were made to the measure.

Intervention

The TM was used to guide the intervention design. Research suggests that interventions promoting

Table II. A list of the processes of change targeted by the intervention and strategies used

	Process of change	Examples of strategy used: the intervention encouraged subjects to...
PAL1	consciousness raising social liberation	read the materials that they received in the post become aware of how physical activity was normal in their university environment
PAL2	self-re-evaluation self-liberation and counter-conditioning helping relationships reward management	consider the benefits (to them) of adopting a physically active lifestyle commit to becoming active through small changes initially, and build from there do activity with friends use the rewards that were included in PAL2, but also to give themselves praise for effort

PAL refers to the physically active lifestyle intervention.

physical activity for precontemplators and contemplators should focus on cognitive aspects of behavior change (Marcus *et al.*, 1997). This intervention was personally addressed and it was made up of two packages on active living (PAL1 and PAL2). A list of the processes targeted and examples of the strategies suggested are shown in Table II. PAL1 was distributed in November, PAL2 the following January. Both PALs were reviewed by two experts in the field of exercise psychology, and they were also piloted on student and staff members of the university ($n = 12$). Only items that were reviewed as *good* on quality of production, suitability of content, information and attractiveness were included in the intervention.

Data analysis

Non-parametric statistics were used for analysis, as they could cope with the ordered categorical SOC data. In order to examine the relationship between SOC and other variables (physical education, extracurricular participation and gender), χ^2 -tests of association were used. The odds ratio (and 95% CI) was calculated for those cases where the χ^2 -tests was shown to be statistically significant. Kruskal–Wallis ANOVAs were used to determine if there was a SOC effect for process of change scores. Where an effect was evident, Mann–Whitney procedures (corrected to 99% confidence level for multiple comparisons) were used. Median scores identified the most frequently used processes of change. Discriminant analyses were used to determine the discriminatory power of the pro-

cesses of change for categories of SOC improvement or non-improvement.

Results

Sample

The baseline questionnaire was completed by 74% of all first year undergraduate students ($n = 2,943$). Seventeen percent ($n = 519$) of the respondents categorized themselves as sedentary (i.e. precontemplation or contemplation). Due to some of the information being incomplete, data was only usable from 88% ($n = 459$; 15% precontemplators and 85% contemplators) of the returned questionnaires. These were selected as the target group for the study and were randomly assigned into an experimental group ($n = 229$) or a control group ($n = 230$) group. Sixty-two percent were female, the average age was 19 (± 4.5) years and approximately 76% of the population were Scottish.

The follow-up data collection yielded a response rate of 40% ($n = 186$) at grant cheque distribution from the target group. This number was subsequently increased to 49% ($n = 223$; 47% precontemplation and 50% contemplation) through other collection methods (post and telephone calls). Sixty-eight percent were female, average age was 19 (± 4) years and 96% were Scottish. Due to incomplete information, only 92% ($n = 203$) of the questionnaires were usable in the analysis of the processes of change data.

In order to identify any differences between

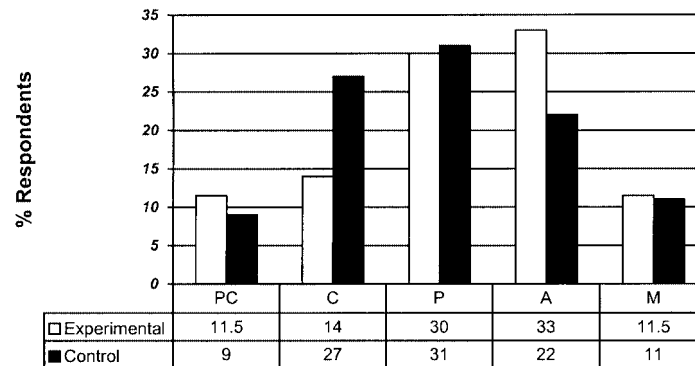


Fig. 1. SOC post-intervention ($n = 223$). PC = precontemplation, C = contemplation, P = preparation, A = action and M = maintenance.

responders and non-responders, a statistical analysis was carried out. This revealed that the only difference between groups was that there were significantly more females in the responders group in comparison to the non-responders [68 versus 58%; $\chi^2(1, n = 426) = 4.3, P < 0.05$]. No significant differences between responders and non-responders on any other variables measured at baseline (i.e. SOC, physical education participation and extracurricular physical activity) were found. Similarly, no notable dissimilarity existed between the groups pre-intervention.

Physical activity participation

The baseline data revealed that 53% ($n = 223$) had taken part in physical education (PE) and 31% ($n = 130$) had taken part in extracurricular physical activity (EC) during their final 2 years in school. SOC was significantly associated with participation in PE [$\chi^2(1, n = 453) = 9.294, P < 0.005$] (OR 0.44, 95% CI 0.19–0.75), but not with EC. Twenty-one percent ($n = 87$) of subjects had heard of the university's SRS in school and from this number 25% ($n = 22$) said it had influenced their choice of which university to attend. At follow-up, significantly more of the experimental group in contrast to the control group (62%:38%) were members of the SRS [$\chi^2(1, n = 222) = 13.139, P < 0.001$] (OR 2.7, 95% CI 1.57–4.63), and membership of the SRS was associated with an improvement in SOC from baseline for both the experimental

[$\chi^2(1, n = 113) = 6.560, P < 0.01$] (OR 0.31, 95% CI 0.12–0.78) and the control [$\chi^2(1, n = 108) = 5.681, P < 0.05$] (OR 0.34, 95% CI 0.13–0.86) groups. Sixty percent of the experimental group said they found the intervention useful for adopting a physically active lifestyle. No significant gender differences were recorded.

SOC

At baseline, all of the subjects were sedentary; post-intervention significantly more of the experimental group (80%, $n = 88$) in comparison to the control group (68%, $n = 72$) reported that they had improved their SOC from baseline [$\chi^2(1, n = 223) = 4.243, P < 0.05$] (OR 0.54, 95% CI 0.29–0.98). The proportion of subjects in each SOC at follow-up is shown in Figure 1. Forty-five percent ($n = 50$) of the experimental group in comparison to 33% ($n = 36$) of the control group were in the regularly active SOC (action and maintenance). The SOC distribution of women in both groups was similar.

Interaction between the longitudinal SOC and cross-sectional process data

Table III presents the pattern of process use for SOC improvers and non-improvers. This is cross-sectional data and from this table the processes used the most and the least frequently can be identified. For example, self-re-evaluation and self-liberation received the highest frequency-of-use

Table III. Ranked median process score for SOC improvers and non-improvers for all subjects

Process ^a	Improvers (<i>n</i> = 148)	Non- improvers (<i>n</i> = 55)
Self-re-evaluation ^c	14	11
Self-liberation ^c	13	11
Reinforcement management ^c	12	9
Counter-conditioning ^c	12	8
Social liberation ^b	11	9
Consciousness raising ^c	10	8
Dramatic relief ^b	10	7
Environmental re-evaluation	9	9
Helping relationships ^c	9	7
Stimulus control ^b	7	6

Processes are listed from the most frequent (self-re-evaluation) to the least frequent (stimulus control). Due to incomplete process of change information, data was usable on 92% (*n* = 148) of the SOC improvers' follow-up questionnaires.

^aMann-Whitney comparisons between the improvers and non-improvers.

^b*P* < 0.05.

^c*P* < 0.001.

scores, whilst stimulus control received the lowest score.

In evaluating the predictive validity of the shift in SOC (classified as improvement or no improvement, irrespective of group) as a function of process score a linear discriminant analysis (with cross-validation) was carried out. Approximately 70% of the respondents were correctly classified using only the processes of change as explanatory variables management (Wilks' $\lambda = 0.816$, $\chi^2 = 39.94$, d.f. = 2, *P* < 0.001). In order to establish if there was any significant difference in process scores between improvers and non-improvers Mann-Whitney tests (confidence level corrected to 99% for multiple comparisons) were used. The results revealed that SOC improvers scored significantly higher, than SOC non-improvers did, on all the behavioral processes and on four of the cognitive process. Only environmental re-evaluation was non-significant.

This research has shown that post-intervention significantly more of the experimental group than

Table IV. Ranked median process score for SOC improvers only by group

Process ^a	Experimental (<i>n</i> = 81)	Control (<i>n</i> = 67)
Self-re-evaluation	13	14
Self-liberation	13	13
Reinforcement management	12	11
Counter-conditioning	12	11
Social liberation ^b	11	9.5
Consciousness raising	10	10
Dramatic relief	10	9
Environmental re-evaluation	10	9
Helping relationships	9	9
Stimulus control	7	7

Processes are listed from the most frequent (self-re-evaluation) to the least frequent (stimulus control). Due to incomplete process of change information, data was only usable on 92% (*n* = 148) of the follow-up questionnaires.

^aMann-Whitney comparisons between the experimental and control group.

^b*P* < 0.05.

the control group had improved their SOC from baseline. The data on SOC improvers and non-improvers were analyzed for group differences. The median process scores for non-improvers were lower than for improvers across all 10 processes; no significant group differences were recorded. The improvers data are shown on Table IV. These are listed in rank order, and reveal a similar pattern of scoring for both the experimental and control groups. Only one significant difference between groups was recorded. This revealed that the experimental group scored significantly higher than the control group on the experiential process of social liberation ($U = 6609.5$, (0, 2), *P* < 0.05).

In order to establish if there was a significant stage effect for process use for SOC improvers, Kruskal-Wallis ANOVAs were used. A significant SOC effect was found for four out of 10 of the processes, i.e. self-re-evaluation [$H = 19.74$, d.f. (*n* = 148) = 3, *P* < 0.001], self-liberation [$H = 25.93$, d.f. (*n* = 147) = 3, *P* < 0.001], reinforcement management [$H = 13.05$, d.f. (*n* = 148) = 3, *P* < 0.005] and counter-conditioning [$H = 38.01$, d.f. (*n* = 148) = 3, *P* < 0.001]. Mann-Whitney procedures revealed

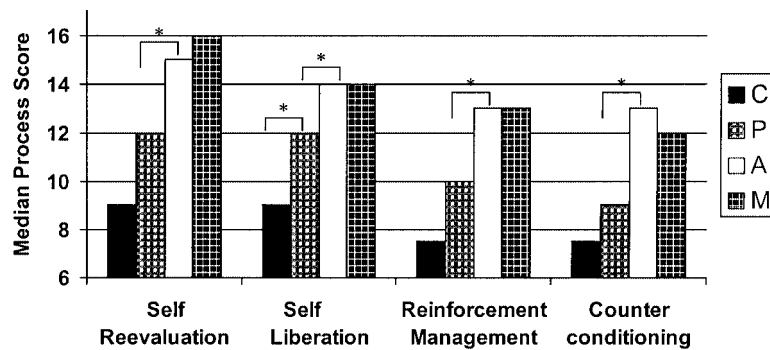


Fig. 2. Median processes of change across SOC for SOC-PA improvers only. C = contemplation, P = preparation, A = action and M = maintenance. * $P < 0.05$ significant difference between two consecutive stages.

that preparation scored significantly higher than contemplation in self-liberation [$U = 101.15$ (-5 , -0.001) $P < 0.05$], while action scored significantly higher than preparation in self-liberation [$U = 4317.5$ (1.001 , 4) $P < 0.05$], reinforcement management [$U = 4168.5$, (0.001 , -4) $P < 0.05$], counter-conditioning [$U = 4492$, ($2.4.9$) $P < 0.05$] and self-re-evaluation [$U = 4181.5$ (1 , 5) $P < 0.05$]. This pattern of results is shown in Figure 2.

Discussion

This study reports on novel research that examined the effectiveness of an intervention designed to promote physical activity and explained the impact of this intervention in terms of the processes of change constructs of the TM. A mail-delivered intervention based on the TM was designed to encourage, support and motivate sedentary young people to become more physically active. There was no specific exercise programme to adhere to, but the students were encouraged to make use of the university's SRS. The researchers had no personal contact with the subjects apart from data collection at baseline and at 7-month follow-up. Half of the baseline subjects completed the follow-up questionnaire. The only difference found between the respondents and non-respondents at follow-up was that significantly more females than males had responded. The likelihood of women responding more than men is evident in other

intervention research in physical activity (Bull *et al.*, 1999). The identification of strategies for increasing the recruitment and retention of sedentary young adults into physical activity intervention studies is a challenge for future research.

Only one-fifth of the subjects had heard about the SRS while they were in school and from this, one in four said it had a positive influence on their choice of university. This impact on recruitment potential of new students could be a positive element of a university's marketing strategy. Almost twice as many of the experimental group, in comparison to the control group, were members of the SRS post-intervention and membership was significantly associated with an improvement in SOC from baseline. These results imply that sports facility administrators can increase the likelihood of sedentary students becoming members by sending them an intervention based on adopting a physically active lifestyle.

Post-intervention, significantly more of the experimental group in contrast to the control group improved their SOC from baseline and indicated that they intended to exercise in the future. The only difference between groups was that the experimental group received a physical activity intervention directly through the post; the control group did not. This provides encouraging results for intervention design based on the TM. DiClemente *et al.* (DiClemente *et al.*, 1991) found that helping people progress through just one stage can double their chances of successful behavioral change in

the near future. A high percentage of the control group also improved their SOC from baseline; this is thought to have been due to the supportive environment for physical activity that exists in the university, e.g. low-cost access to an on-campus leisure centre (SRS). It could also have been because the control group had access to all the elements of the intervention through normal university life. No gender differences were found with respect to shift in SOC over the intervention period.

This study has provided encouraging results for the use of data from the processes of change questionnaire to help in the design of physical activity interventions. This data was found to correctly classify 70% of the shift in SOC from baseline, categorized as 'improvement' or 'no improvement'. Descriptive statistics revealed SOC improvers had significantly higher process scores than the non-improvers, across all of the behavioural and all of the cognitive processes except environmental re-evaluation. This may have been due to the subjects being in their first year in university, and therefore the environment being so new to both improvers and non-improvers. This result supports the hypothesis of the TM, which is that the more advanced an individual is in SOC, the more frequently they will use the processes of change (DiClemente *et al.*, 1991).

In order to examine which processes of change were key to movement along the SOC scale, data from individuals who had improved their SOC from baseline in both the experimental and the control groups was examined. Initially, summary statistics provided the main information. From median scores, it was found that the process of social liberation was used significantly more by the experimental group in comparison to the control group. This is not surprising as the intervention encouraged subjects to use this process of change; however, the intervention also targeted consciousness raising, helping relationship and other processes. None of these could significantly differentiate between the groups. This implies that encouraging a vision of physical activity as something that is natural and socially acceptable could be influential aspect of physical activity interventions

designed to help sedentary young adults to initiate activity.

Self-evaluation, self-liberation, counter-conditioning and reward processes were given the highest frequency scores across all SOC. This is at odds with previous research that has suggested that the processes consciousness raising (CR) and dramatic relief (DR) are among the most frequently used in earlier SOC (Prochaska and DiClemente, 1983; Prochaska and Velicer, 1997; Prochaska and Norcross, 1999). This may be due to the fact that this young, highly educated population may think they know enough about physical activity (CR) and that dying due to inactivity is unlikely (DR). However, these findings have implications for the 'set of tasks' that each SOC has to achieve in order to progress along the SOC continuum. They suggest that the adoption of a positive behaviour may need to be treated differently to the cessation of a negative behavior. A similar pattern of process use can be seen in the summary statistics of other research (Marcus *et al.*, 1992a; Nigg and Courneya, 1998); some slight differences could be due to the sample age variance among the various studies. More research is needed to clarify these findings.

Similar to other research findings, a SOC effect was found for process use in both the experimental and the control groups (DiClemente *et al.*, 1991; Marcus and Simkin, 1993; Marcus *et al.*, 1996; Prochaska and Velicer 1997). Precontemplators were found to use the processes the least, while process use tended to peak in action or maintenance. The pattern of process use by both groups was very similar. Gender differences revealed that women tended to use the experiential processes more than men, but there was no significant difference in these scores. More research is needed which is specifically designed to examine gender influence on process use.

The findings of this study are based on an undergraduate student population; this might have implications for the transferability of the findings to a wider population. The study is based on an individual's self-reported levels of exercise behavior change. However, the self-report instrument used has been shown in other studies to

correspond favourably with more objective measures of physical activity e.g. 'Blair seven-day physical activity recall' (Marcus and Simkin, 1993; Marcus *et al.*, 1994; Wyse *et al.*, 1995), VO_{2max} , body mass index and CALTRAC (Cardinal, 1997; Lowther *et al.*, 1999). Also, the results provide some evidence that self-reported level of exercise behavior corresponds to process of change use. This study was limited by its outcome data, as due to time restrictions at baseline data collection, only cross-sectional data on the processes of change were gathered; these data were used in an attempt to explain the longitudinal shift in exercise SOC and behavioral intention amongst the subjects. Whilst this information is valuable, as it identifies differences that exist between stage improvers in comparison to non-improvers in terms of these variables at follow-up, future research needs to examine longitudinal data from all constructs of the TM.

To summarize, a relatively inexpensive, mail-delivered, self-instructional intervention based on the 'active living message' is an effective method of assisting sedentary young adults to progress through the SOC construct of the TM of behavior change. This research also highlights the importance of targeting specific change strategies for assisting sedentary individuals to become more physically active. It suggests intervention design for the adoption of a positive behavior should be based on different processes of change than have previously been advocated for the cessation of a negative addiction.

References

- American College of Sports Medicine (1990) The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness in healthy adults. *Medicine and Science in Sports and Exercise*, **2**, 265–274.
- Biddle, S. J. H. and Nigg, C. R. (2000) Theories of Exercise Behaviour. *International Journal of Sport Psychology*, **31**, 290–304.
- Bull, F. C., Jamrozik, K. and Blanksby, B. A. (1999) Tailored advice on exercise—does it make a difference? *American Journal of Preventive Medicine*, **16**, 230–239.
- Cardinal, B. J. (1995a) Behavioural and biometric comparisons of the preparation, action and maintenance stages of exercise. *Wellness Perspectives: Research, Theory, and Practice*, **11**, 36–43.
- Cardinal, B. J. (1995b) The stages of exercise scale and stages of exercise behavior in female adults. *Journal of Sports Medicine and Physical Fitness*, **35**, 87–92.
- Cardinal, B. J. (1997) Construct validity of stages of change for exercise behavior. *American Journal of Health Promotion*, **12**, 68–74.
- Carney, C. and Mutrie, N. (2000) The impact on transition from university on physically active students. *Journal of the Institute of Health Education*, **38**, 113–118.
- DiClemente, C. C., Prochaska, J. O., Fairhurst, S. K., Velicer, W. F., Velasquez, M. M. and Rossi, J. S. (1991) The process of smoking cessation: an analysis of precontemplation, contemplation, and preparation stages of change. *Journal of Consulting and Clinical Psychology*, **59**, 295–304.
- Dishman, R. K. (1994) *Advances in Exercise Adherence*. Human Kinetics, Champaign, IL.
- Douglas, K. A., Collins, J. L., Warren, C., Kann, L., Gold, R., Clayton, S., Ross, J. G. and Kolbe, L. J. (1997) Results from the 1995 National College health risk behavior survey. *Journal of American College Health*, **46**, 55–66.
- Dunn, A. L., Marcus, B. H., Kampert, J. B., Garcia, M. E., Kohl, H. W. and Blair, S. N. (1999) Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness. *Journal of the American Medical Society*, **281**, 327–334.
- Hayes, B. (1997) Sampling methods. In Hayes, B. (ed.), *Measuring Customer Satisfaction: Survey Design, Use and Statistical Analysis Methods*. ASQ Quality Press, Milwaukee, WI, pp. 83–106.
- Health Education Board for Scotland (1997) *The Promotion of Physical Activity in Scotland: A Strategic Statement*. Health Education Board for Scotland, Edinburgh.
- Leslie, E., Owen, N., Salmon, J., Bauman, A. and Kai Lo, S. (1999) Insufficiently active Australian college students: perceived personal, social and environmental influences. *Preventive Medicine*, **28**, 20–27.
- Loughlan, C. and Mutrie, N. (1995) Recruitment of sedentary NHS staff for a workplace exercise programme using an adapted 'stages of change' exercise questionnaire. *Journal of Sports Sciences*, **13**, 63–64.
- Lowther, M., Mutrie, N., Loughlan, C. and McFarlane, C. (1999) Development of a Scottish physical activity questionnaire: a tool for use in physical activity interventions. *British Journal of Sports Medicine*, **33**, 244–249.
- Marcus, B. H. and Simkin, L. R. (1993) The stages of exercise behavior. *Journal of Sports Medicine and Physical Fitness*, **33**, 83–88.
- Marcus, B. H., Bock, B. C., Pinto, B. M., Forsyth, L. H., Roberts, M. and Traficante, R. (1998a) Efficacy of an individualised, motivationally-tailored physical activity intervention. *Annals of Behavioural Medicine*, **20**, 174–180.
- Marcus, B. H., Emmons, K. M. and Simkin-Silverman, L. (1998b) Evaluation of motivationally tailored vs. standard self-help physical activity interventions at the workplace. *American Journal of Health Promotion*, **12**, 246–253.
- Marcus, B. H., Rossi, J. S., Selby, V. C., Niaura, R. S. and Abrams, D. B. (1992a) The stages and processes of exercise adoption and maintenance in a worksite sample. *Health Psychology*, **11**, 386–395.

- Marcus, B. H., Selby, V. C., Niaura, R. S. and Rossi, J. S. (1992b) Self-efficacy and the stages of exercise behavior change. *Research Quarterly for Exercise and Sport*, **63**, 60–66.
- Marcus, B. H., Eaton, C. A., Rossi, J. S. and Harlow, L. L. (1994) Self-efficacy, decision-making and stages of change: an integrative model of physical exercise. *Journal of Applied Social Psychology*, **24**, 489–508.
- Marcus, B. H., Simkin, L. R., Rossi, J. S. and Pinto, B. M. (1996) Longitudinal shifts in employees' stages and processes of exercise behavior change. *American Journal of Health Promotion*, **10**, 195–200.
- Marcus, B. H., Bock, B. C. and Pinto, B. M. (1997) Initiation and maintenance of exercise behavior. In Gochman, D. S. (ed.), *Handbook of Health Behavior Research II*. Plenum Press, New York, pp. 335–352.
- Mutrie, N. and Caddell, C. (1994) Stages of exercise behaviour change in corporate employees. *Journal of Sports Sciences* **12**, 202–203.
- Nigg, C. R. and Courneya, K. S. (1998) Transtheoretical model: examining adolescent exercise behavior. *Journal of Adolescent Health*, **22**, 214–224.
- Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., Buchner, D., Ettinger, W., Heath, G. W., King, A. C., Kriska, A., Leon, A. S., Marcus, B. H., Morris, J., Paffenbarger, R. S., Jr, Patrick, K., Pollock, M. L., Rippe, J. M., Sallis, J. and Wilmore, J. H. (1995) Physical activity and public health: a recommendation from the Centres for Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association*, **273**, 402–407.
- Pinto, B. M., Chericco, N. P., Szymanski, L. and Marcus, B. H. (1998) Longitudinal changes in college students' exercise participation. *College Health*, **47**, 23–27.
- Pinto, B. M. and Marcus, B. H. (1995) A stages of change approach to understanding college students' physical activity. *Journal of American College Health*, **44**, 27–31.
- Prochaska, J. O. and DiClemente, C. C. (1983) Stages and processes of self-change of smoking: toward an integrative model of change. *Journal of Consulting and Clinical Psychology*, **51**, 390–395.
- Prochaska, J. O. and Marcus, B. H. (1994) The transtheoretical model: applications to exercise. In Dishman, R. K. (ed.), *Advances in Exercise Adherence*. Human Kinetics, Champaign, IL, pp. 161–180.
- Prochaska, J. O. and Norcross, J. C. (1999) Comparative conclusions: toward a transtheoretical therapy. *Systems of Psychotherapy: A Transtheoretical Analysis*. Brooks/Cole, Pacific Grove, CA, pp. 487–528.
- Prochaska, J. O. and Velicer, W. F. (1997) The transtheoretical model of health behavior change. *American Journal of Health Promotion*, **12**, 38–48.
- Prochaska, J. O., Velicer, W. F., DiClemente, C. C. and Fava, J. (1988) Measuring processes of change: application to the cessation of smoking. *Journal of Consulting and Clinical Psychology*, **56**, 520–528.
- Prochaska, J. O., Velicer, W. F., Guadagnoli, E. and Rossi, J. S. (1991) Patterns of change: dynamic typology applied to smoking cessation. *Multivariate Behavioral Research*, **26**, 83–107.
- Prochaska, J. O., Velicer, W. F., Rossi, J. S., Goldstein, M. G., Marcus, B. H., Rakowski, W., Fiore, C., Harlow, L. L., Redding, C. A., Rosenbloom, D. and Rossi, R. R. (1994) Stages of change and decisional balance for 12 problem behaviors. *Health Psychology*, **13**, 39–46.
- Samuelson, M. (1997) Changing unhealthy lifestyle: who's ready...who's not? An argument in support of the stages of change component of the transtheoretical model. *American Journal of Health Promotion*, **12**, 13.
- Steptoe, A., Doherty, S., Rink, E., Kerry, S., Kendrick, T. and Hilton, S. (1999) Behavioral counselling in general practice for the promotion of healthy behavior among adults at increased risk of coronary heart disease. *British Medical Journal*, **319**, 943–948.
- US Department of Health and Human Services, Centers for Disease Control and Prevention, and National Center for Chronic Disease Prevention and Health Promotion (1996) *Physical Activity and Health: A Report of the Surgeon General*. US Department of Health and Human Services, Atlanta, GA.
- Woods, C. B., Mutrie, N. and Scott, M. (1999) More students, more active, more often: exercise behaviour change in a student population. *Journal of Sports Sciences*, **17**, 70.
- Wyse, J., Mercer, T., Ashford, B., Buxton, K. and Gleeson, N. (1995) Evidence for the validity and utility of the stages of exercise behavior change scale in young adults. *Health Education Research*, **10**, 365–377.

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