Do the Transtheoretical Model processes of change, decisional balance and temptation predict stage movement? Evidence from smoking cessation in adolescents

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ABSTRACT

Aims To examine the effects of processes of change (POC) on forward stage movement directly, indirectly through decisional balance and temptation, and total effects as a test of the key hypothesis of the Transtheoretical Model (TTM).

Design Prospective cohort study.

Setting United Kingdom.

Participants A total of 1160 adolescents aged 13–14 years who were current or former smokers at baseline.

Measurements Stage was assessed with the standard algorithm three times, once every 3 months. On each occasion the POC, decisional balance and temptation were measured with the standard questionnaires. Path analysis was used to examine the direct, indirectly mediated and total contribution of POC and the other constructs to stage movement 3 months later.

Findings Four of the 24 analyses showed evidence that the theoretically appropriate POC predicted stage transition, with statistically significant total effects. Effect sizes were small. When the POC were summarized to experiential and behavioural process means, one transition from pre-contemplation was predicted by experiential processes and, contrary to the TTM, one transition predicted by behavioural processes. There was slightly more evidence that decisional balance (attitudes towards smoking) and temptation (ability to resist the urge to smoke) was associated with stage transition.

Conclusions POC use was not associated generally with stage transition and evidence that effects, if missed, must be modest, giving no support to the central tenet of the TTM.

Keywords Cohort study, decisional balance, path analysis, process of change, self-efficacy, stage of change, Transtheoretical Model.

INTRODUCTION

The Transtheoretical Model (TTM) is a stage-based theory of behaviour change [1]. Stages are qualitatively distinct states in a behaviour change process. The stages are pre-contemplation (not intending to change soon), contemplation (change is being considered but not definitely planned), preparation (behaviour change is intended imminently), action (behaviour change has been achieved in the short term) and maintenance (long-term behaviour change has been achieved). Movement through the stages is hypothesized to be caused by the processes of change (POC), decisional balance and temptation/self-efficacy. In the TTM, the processes of change are described as the independent variables [1] and decisional balance and temptation/self-efficacy as dependent variables, or sometimes mediators [2].

There are five experiential processes. They are consciousness raising, dramatic relief, environmental re-evaluation, self-re-evaluation and social liberation. The five behavioural processes are stimulus control, counter conditioning, reinforcement management, self-liberation and helping relationships (Table 1). The TTM postulates a second-order factor structure for POC, with individual factors loading on experiential and behavioural processes. The frequency of use of each POC is measured...
with either a 40- or (more commonly) a 20-item scale. Psychometric investigations of the POC scales show generally satisfactory factorial validity in adults [3] and adolescents [4].

The TTM proposes that the POC causing movement from one stage to the next differ across the stages [1]. Thus an optimum behavioural intervention will tailor interventions to suit the current stage (Table 2). As Prochaska & Velicer note: 'To help people move from pre-contemplation to contemplation, we need to apply such processes as consciousness raising and dramatic relief. Applying processes like contingency management, counter conditioning, and stimulus control to people in precontemplation would represent a theoretical, empirical, and practical mistake' [1].

In adolescents, cross-sectional differences in POC use between stages are found for nearly all POC except helping relationships, with similar although not identical patterns to those seen in adults, namely linear variation across stages [5]. Sutton has pointed out that the largely linear relationship seen between POC use and stage is actually evidence against the TTM [6]. Such patterns are evidence of a pseudo-stage model, in which stages are points on a continuum. Such a model is incompatible with the TTM, because it implies that higher use of any POC might result in stage movement.

Although there are tens of studies reporting moderately large differences in process use between stages in cross-sectional studies [5], few studies have examined whether differences in POC are associated with stage movement prospectively. Herzog and colleagues found that neither the POC scores individually or aggregated to experiential and behavioural scores nor the decisional balance scores predicted forward movement separately from pre-contemplation, contemplation and preparation stages [7]. (Only the pros score predicted forward movement from contemplation.) Segan and colleagues studied people preparing for quitting [8]. They found that no POC score predicted those who attempted to quit smoking, although higher self-efficacy did. In another study, Segan [9] followed an approach adopted by Perz and colleagues [10]. Perz had shown previously that using the stage-appropriate processes at the appropriate time in cessation was associated with a greater likelihood of cessation than

<table>
<thead>
<tr>
<th>Process</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Consciousness raising (CR)</td>
<td>Becoming aware of causes, consequences and treatment for smoking</td>
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<tr>
<td>Dramatic relief (DR)</td>
<td>Becoming emotionally moved by smoking or non-smoking state</td>
</tr>
<tr>
<td>Environmental re-evaluation (ER)</td>
<td>Thinking about how smoking affects others and the environment</td>
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<td>Self re-evaluation (SR)</td>
<td>Evaluating self-image as a smoker/non-smoker</td>
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<td>Social liberation (SoL)</td>
<td>Becoming aware of smoke-free alternatives in society</td>
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<th>Process</th>
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<tr>
<td>Self-liberation (SL)</td>
<td>Committing to action</td>
</tr>
<tr>
<td>Counter-conditioning (CC)</td>
<td>Substituting healthy behaviours for smoking</td>
</tr>
<tr>
<td>Stimulus control (SC)</td>
<td>Avoiding cues to smoke, adding new cues to do alternatives</td>
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<tr>
<td>Contingency management (CM)</td>
<td>Rewards for controlling smoking urges</td>
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<td>Helping relationships (HR)</td>
<td>Obtaining support from others</td>
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### Table 2 The processes used to move from each stage.

<table>
<thead>
<tr>
<th>Pre-contemplation</th>
<th>Contemplation</th>
<th>Preparation</th>
<th>Action</th>
<th>Maintenance</th>
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<tbody>
<tr>
<td>—CR—</td>
<td>—DR—</td>
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<td>—SC—</td>
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CR: consciousness raising; DR: dramatic relief; ER: environmental re-evaluation; SR: self re-evaluation; SL: self-liberation; CM: contingency management; HR: helping relationships; CC: counter-conditioning; SC stimulus control.
using alternative processes. Segan replicated these results but, crucially, then controlled for stage. In so doing, they showed that the replicated pattern disappeared. They attributed this effect to reverse causation—that stage movement causes changes in POC scores rather than vice versa.

Kleinjant and colleagues have reported recently the only study extant to examine whether the POC scores are associated with forward stage movement in adolescents [11]. They found no POC predicted movement from pre-contemplation/contemplation, with odds ratios (OR) of approximately 1. Only counter-conditioning predicted forward movement from action. However, they reported the same moderate-sizes differences in POC means between stage as are seen consistently in adults and adolescents when they examined their data cross-sectionally.

The mediators of change, decisional balance and temptation/self-efficacy have some causal role in stage change, even though they are referred to as dependent variables. For decisional balance, the TTM proposes the so-called strong and weak principles [12]. The strong principle is that progress from pre-contemplation to action is associated with a 1 standard deviation (SD) increase in the cons of smoking. The weak principle is that the same transition is accompanied by a 0.5 SD decrease in the pros of smoking. Even though these principles are couched in terms of association, Prochaska & Velicer emphasize the interventional value of these principles [1]. The incorporation of this construct into interventions such as the expert system imply that it has a causal role [13]. The role of temptation/self-efficacy in stage movement is not elucidated, although a linear relationship has been described (e.g. [14]). The originators of the TTM have not theorized how the independent variables, the processes, relate to the mediators, whether the mediators can change without the independent variables, and the relative contributions of the independent and mediator variables to stage movement. In this study we use path analysis to test the contribution of the POC to stage movement. In these models we examined the contribution of the POC directly and mediated via temptation and decisional balance.

METHODS

Participants and measures

The data used in the present study were from a previously reported trial of smoking prevention and cessation [15,16]. In the trial, 4343 year 9 students, aged 13 to 14 years, in the West Midlands, UK used an interactive computer program for preventing smoking acquisition or assisting smoking cessation, as appropriate. The intervention was ineffective for prevention of uptake or cessation.

The computer program was used three times, once during each term of 1997. There were 1160 former and current smokers who used the program on the first occasion, 978 on the second and 836 on the third occasion. The computer program would not allow participants to skip items. The participants had a similar sociodemographic and smoking profile to that of England as a whole, and full details have been published [15,16]. At baseline, in year 9, 13% were regular (at least weekly) smokers, 8% former smokers, 25% had tried smoking and the remainder had never smoked. The median consumption of regular smokers at baseline was 2.6 cigarettes per day (see [16] for a description of how these medians were calculated).

The expert system computer program staged students using an algorithm described by Pallonen [17], which is similar to that for adults [18]. Participants who were not regular smokers completed the POC questionnaire for smoking acquisition, which is completely different, and these participants are not considered further. Current and former regular smokers completed the POC questionnaire for smoking cessation [4]. Decisional balance was assessed to examine its role as a direct cause of stage transition and a mediator of the action of processes. The decisional balance scale for adults was described by Velicer [19], which measures the importance/non-importance of a series of belief statements. The beliefs presented to adolescents are different from those in adults, e.g. adolescent items include ‘smoking stinks’ (con); ‘smoking makes you get more respect from others’ (pro). This scale was proposed by Pallonen [17]. The psychometric properties of this scale are satisfactory [14,20]. Self-efficacy is regarded as the converse of temptation to smoke in the TTM. This was measured first in adult smokers [21], from which an adolescent version was developed [22]. The psychometric properties of the adolescent scale showed reasonable validity [14,17]. This measures temptation to smoke in specific situations. The first-order factors are negative affect, positive social, habit strength and weight control.

Analysis

The analysis examined the predictors of forward movement for each starting stage. We examined this for movement from baseline to 3 months, and from 3 to 6 months. Based on the causal models derived from the TTM, we estimated coefficients for paths from process use to the outcome, forward stage movement. We examined both the direct path from process use at time 1 to forward stage movement at time 2 directly and via indirect paths from process use at time 1 to decisional balance (pros and cons separately) and via temptations, also measured at time 1. We applied probit regression to calculate coefficients in
path analysis models with binary outcomes using Mplus version 4.1 [23]. We used bootstrapping to estimate the 2.5–97.5th percentiles [equivalent to 95% confidence intervals (CI)] using 5000 draws in the sampling procedure. The analysis was performed for each of the processes hypothesized to be important for each stage transition (Table 2). Finally, we took the mean experiential and behavioural process score and examined whether these predicted stage transitions.

**RESULTS**

Compared with adults [24,25], young people were more likely to be intending to stop smoking in the next month (the key variable in preparation stage) and more likely to actually stop smoking. Stage shifts were more common than staying in the same stage [26].

Table 3 summarizes the effects of the theoretically appropriate processes for movement from each stage. Probit coefficients may be unfamiliar, but they can be transformed to approximate to logistic coefficients and hence the more familiar ORs. The formula is \( \logit(B) = \text{probit}(B) \times (\pi^2/3)^{0.5} \). Thus the OR is approximately \( \exp^{1.81B} \).

For movement from pre-contemplation, the transition between times 1 and 2 was predicted by environmental re-evaluation but not the other two processes. For transition from times 2–3, forward movement was predicted by consciousness raising, but not by the other two processes. The effect was an approximate doubling of the odds, with an OR (95% CI) of 1.97 (1.37, 2.95). These overall effects, however, hide more complex patterns (Fig. 1). The path diagrams indicate significant associations between each of the processes at time 1 and the cons, often with significant indirect effects on forward stage movement, mediated via cons. However, the effects mediated by other pathways meant that the total effect of processes on stage movement were mainly not significant.

For movement from contemplation there was only one significant total effect: for consciousness raising. The estimates of the effects of processes on stage movement were modest, with the largest of the non-significant coefficients suggesting approximate OR of 1.48 (95% CI: 1.02, 2.21). There were some significant paths between processes and temptation and cons, but no consistent pattern (Fig. 2).

Self-liberation did not predict movement from pre-contemplation. There were no consistent patterns of association between self-liberation and the mediators and no significant indirect or direct paths (Fig. 3).

For movement from action to maintenance, one of the four theoretically appropriate processes, counter condition-
Figure 1  Forward transitions from precontemplation (PC). Statistically significant paths are indicated by a solid line and statistically insignificant paths by a dashed line. Statistically significant indirect paths via a mediator are indicated by bold lines. CR: Consciousness raising; DR: Dramatic relief; ER: Environmental re-evaluation.
Figure 2: Forward transitions from contemplation (C). Statistically significant paths are indicated by a solid line and statistically insignificant paths by a dashed line. Statistically significant indirect paths via a mediator are indicated by bold lines. CR: Consciousness raising; DR: Dramatic relief; ER: Environmental re-evaluation; SR: Self re-evaluation.
tioning, on one of the two transitions was associated with such movement. The approximate OR was 1.70 (95% CI: 1.17, 2.12), the largest effect size for action in Table 3, implying that effects of other processes were minor with estimated effects all being close to the null. However, there were significant paths from each of the processes to cons and pros in most cases and temptation in two of the eight analyses (Fig. 4).

Table 4 summarizes the association between the mean of the behavioural and experiential processes on forward stage transition. The TTM hypothesizes that experiential processes are important in stage movement in pre-contemplation and contemplation and this was confirmed in one of four transitions. Contrary to the theory, the behavioural processes mean was associated with transition from pre-contemplation. For transition from preparation and action, neither the experiential nor behavioural process mean predicted forward movement.

**DISCUSSION**

We examined whether higher POC scores were associated with forward transition from each stage when young smokers were assessed three times 3 months apart. We found that theoretically appropriate POC scores predicted few transitions. For the global experiential and behavioural POCs, contrary to theory, behavioural POCs predicted transition from pre-contemplation. For times 1–2, one of the three POCs theoretically causing transition was associated with transition. For contemplation, one of four POCs theoretically causing transition from contemplation was associated with forward movement. No POC was associated with transition from other stages. For times 2–3, one of three POCs theoretically causing forward movement from pre-contemplation was associated with such movement. No POC predicted forward movement from contemplation or preparation and one of four from action. The so-called dependent variables, decisional balance and temptation/self-efficacy, were associated more consistently with stage transition across all stages.

The TTM’s central prediction is that matching interventions to stage to encourage the appropriate POC use for that stage is more effective than is providing similar interventions to a whole population, producing ‘unprecedented effects on entire populations’ ([1], p. 47). These results and results from similar studies reviewed in the Introduction suggest that this is not the case. We found typical large differences in process use between stages when stages were compared in a cross-sectional study (currently unpublished). In the main, differences in mean POCs between adjacent stages were in the range 0.3–0.5, while differences in means between pre-contemplation and maintenance were in the range 1.0–2.0 points on the
Figure 4. Forward transitions from action (A). Statistically significant paths are indicated by a solid line and statistically insignificant paths by a dashed line. Statistically significant indirect paths via a mediator are indicated by bold lines. CC: Counter-conditioning; SC: Stimulus control; CM: Contingency management; HR: Helping relationships.
five-point scale. Had such size of differences existed prior to stage movement, as predicted by the TTM to drive movement, we would have detected them. Given that such differences existed after stage shifts in the cross-sectional data from this sample, and given the direct evidence from elsewhere [9], the evidence suggests that differences in POC use by stage appear to be a consequence of moving stage, and not the cause of it.

One caveat to this is a concern over the outcome variable, stage. We measured stage with an algorithm, as is usual. We used latent class analysis to show that individuals were placed reliably in stages by the staging questions [26]. However, latent transition analysis showed that stage transitions were not orderly from one stage to the next, but apparently random. This is consistent with other data showing that a third of teenage smokers apparently do not have stable intentions about stopping smoking [27]. It is also consistent with data from adults showing that stage of change moves frequently and apparently randomly and not in orderly sequence [28]. There is no evidence that humans plan activities such as stopping smoking months in advance, which is implied by the staging algorithm questions. If at least some people do not do so, stages as they are conceived within the TTM cannot exist and therefore causes of stage transitions will not be discovered. If people do not have intentions in this form, when forced to declare either an intention to continue to smoke or to stop by the algorithm they give a response that is meaningless, even if they are reasonably internally consistent on any one presentation of the algorithm questions. Thus stage transitions, which depend critically on intention in the early stages, are random for these individuals and such misclassification will tend to lead to null results.

There was slightly stronger evidence that both decisional balance and temptation/self-efficacy were associated with stage movement, which argues that the caveat about staging does not explain completely the null results for POC use. Decisional balance, the pros and cons of smoking, are beliefs and have been rated on three response formats in the TTM: frequency [19], importance (most commonly) and agreement [29]. Psychometric testing shows that the questions mean much the same to individuals whichever response formats are used [19,20]. As belief statements, the pros and cons could be taken as measures of attitude towards smoking. Thus these results support the notion that attitude influences both intention and behaviour.

Temptation measures the degree to which an individual feels the urge to smoke in certain situations, such as when offered a cigarette or when angry. In the path analysis, higher temptation scores were associated with subsequent forward stage movement in a number of analyses, although the pattern was not consistent across time. The specific role of temptation/self-efficacy in stage movement in the TTM is unclear. It might be assumed that confidence in one’s ability not to smoke in the face of temptation would predict those individuals who moved forward from preparation (imminent intended cessation) to action (actual cessation), but we found no evidence of this. Instead, lower temptation scores were associated with stage movement, which argues that the caveat about the decisional balance and temptation/self-efficacy was associated with stage movement. Herzog & Blagg showed that the staging algorithm seriously under-

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**Table 4** Total effects as probit regression coefficients (2.5, 97.5 percentiles) and approximate equivalent odds ratios (95% confidence intervals) for effects of experiential and behavioural processes of change on stage transition.

<table>
<thead>
<tr>
<th></th>
<th>Time 1–time 2</th>
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<th>Time 2–time 3</th>
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<tbody>
<tr>
<td></td>
<td>Probit coefficient</td>
<td>Odds ratio</td>
<td>Probit coefficient</td>
</tr>
<tr>
<td></td>
<td>(percentiles)</td>
<td>(confidence intervals)</td>
<td>(percentiles)</td>
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<tr>
<td>Forward from pre-contemplation</td>
<td></td>
<td></td>
<td>Forward from pre-contemplation</td>
</tr>
<tr>
<td>Experiential</td>
<td>0.017 (–0.004, 0.081)</td>
<td>1.07 (0.99, 1.16)</td>
<td>Experiential</td>
</tr>
<tr>
<td>Behavioural</td>
<td>0.119 (–0.130, 0.387)</td>
<td>1.24 (0.79, 2.02)</td>
<td>Behavioural</td>
</tr>
<tr>
<td>Forward from contemplation</td>
<td></td>
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<td>Forward from contemplation</td>
</tr>
<tr>
<td>Experiential</td>
<td>0.258 (–0.019, 0.552)</td>
<td>1.60 (0.97, 2.72)</td>
<td>Experiential</td>
</tr>
<tr>
<td>Behavioural</td>
<td>0.161 (–0.124, 0.467)</td>
<td>1.34 (0.80, 2.33)</td>
<td>Behavioural</td>
</tr>
<tr>
<td>Forward from preparation</td>
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<td>Forward from preparation</td>
</tr>
<tr>
<td>Experiential</td>
<td>0.087 (–0.300, 0.425)</td>
<td>1.17 (0.58, 2.16)</td>
<td>Experiential</td>
</tr>
<tr>
<td>Behavioural</td>
<td>0.111 (–0.399, 0.549)</td>
<td>1.22 (0.48, 2.71)</td>
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<tr>
<td>Forward from action</td>
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<td>Forward from action</td>
</tr>
<tr>
<td>Experiential</td>
<td>0.075 (–0.128, 0.274)</td>
<td>1.15 (0.79, 1.64)</td>
<td>Experiential</td>
</tr>
<tr>
<td>Behavioural</td>
<td>0.104 (–0.108, 0.320)</td>
<td>1.21 (0.82, 1.79)</td>
<td>Behavioural</td>
</tr>
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</table>
estimates the motivation of some pre-contemplators to stop smoking [30]. Such people are really mislabelled. In this explanation, differences between those who move forward and those who do not represent differences in their ability, motivation and intention to control their smoking that are not captured by the staging algorithm. Given that the algorithm forces individuals to make arbitrary choices [27], more motivated pre-contemplators are more likely to check responses which indicate apparent forward stage transition on the subsequent assessment than less motivated pre-contemplators. This would create the erroneous impression that temptations cause stage movement, particularly in pre-contemplation.

Where do these results leave the TTM? Prior to this study it was possible to argue that the long interval between stage assessments, 12 months, was responsible for the lack of association between predictor variables and stage movement in the studies reviewed in the Introduction. The 3-month assessment intervals in our study belie that argument. West has argued that the model has so many obvious flaws and makes so many predictions that are contradicted by either common sense or data from studies that it should be abandoned [31]. The central claim to usefulness of the theory is that stage-matching improves outcomes. Those few studies that have attempted this have shown no benefit from stage-matched compared to stage-mismatched interventions [32]. These results help to explain why: Stage matching is not effective because POCs are not drivers of stage movement, at least in so far as these variables are assessed by the standard questionnaires developed by the originators of the TTM.

Declarations of interest

Paul Aveyard has conducted consultancy work for the pharmaceutical and biotechnology industry that has led to payments to him and his institution. This includes work for companies providing smoking cessation medication. No other authors have competing interests.

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References


