Review

Meta-analytic examination of the strong and weak principles across 48 health behaviors

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Abstract

Objective. The strong and weak principles of change state that progress from the precontemplation to the action stage of change is associated with a one standard deviation increase in the pros and a one-half standard deviation decrease in the cons of change. In this study these relationships, originally developed by Prochaska [Prochaska, J.O., 1994. Strong and weak principles for progressing from precontemplation to action on the basis of 12 problem behaviors. Health Psychology, 13, 47–51] based on an examination of 12 studies of 12 different behaviors, were re-examined using many more datasets and much more rigorous statistical methods.

Methods. The current study analyzes 120 datasets from studies conducted between 1984 and 2003 across and within 48 health behaviors, including nearly 50,000 participants from 10 countries. The datasets were primarily analyzed utilizing meta-analytic techniques.

Results. Despite the range of behaviors and populations, the results were remarkably consistent with the original results (pros=1.00 standard deviation, cons=0.56 standard deviation). Few potential moderators showed any impact on effect size distributions.

Conclusions. This updated and enhanced examination of two important principles of behavior change is a significant contribution to the field of multiple health risk behaviors, as it clearly demonstrates the consistency of the theoretical principles across multiple behaviors, which has implications for developing multiple health risk behavior interventions.

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Keywords: Transtheoretical Model; Stages of change; Decisional balance; Pros and cons; Behavior change

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Introduction

The Transtheoretical Model (TTM) of behavior change has been utilized internationally across a large variety of health behaviors for more than 25 years. The model not only delineates a way to conceptualize behavior change, it also provides the foundation for developing assessments of an individual’s readiness to change and for tailoring interventions to actualize behavior change. The central organizing construct of the TTM characterizes behavior change through five distinct stages of change (SOC): precontemplation, contemplation, preparation, action, and maintenance. Two intermediate indicators of when these changes occur are decisional balance (DB; the pros and cons of change) and self-efficacy (situational confidence or temptation). Additionally, the TTM explains behavior change strategies through 10 processes of change. This study focuses on testing the theoretical relationship between SOC and DB across multiple health behaviors. Originally developed in 1985 to study decision-making for smoking (Velicer et al., 1985), the use of DB expanded to a dozen behaviors by 1994 (Prochaska et al., 1994). Lewin (1948) postulated that behavior changes as a function of the increases and decreases in motivation to contemplate gains and losses. The TTM builds on this notion by suggesting a clear directionality to the function as well as a characteristic way of examining it. The function is based on the relationship of when and how much the pros increase and the cons decrease. The initial research on SOC and DB suggested that progress from precontemplation to contemplation involved an increase in pros whereas progress from contemplation to action involved a decrease in cons; that is, participants endorsed more negative aspects of change in the earlier stages and more positive aspects of change in the later stages. A more detailed analysis of the results of Prochaska et al. (1994) by Prochaska (1994) found that the average maximum increase in the pros from precontemplation to action was 1.06 standard deviation (S.D.) units. For cons, the average maximum decrease from precontemplation to action was 0.45 S.D. These results led to the formulation of the strong and weak principles of change, which state that progress from the precontemplation to the action stage of change is associated with a one standard deviation increase in the pros and a one-half standard deviation decrease in the cons. More simply, these data showed that the pros increase twice as much as the cons decrease from precontemplation to action.

Since 1994, numerous additional studies have examined the SOC–DB relationship. These new studies included many new behaviors as well as many more studies examining some of the original 12 behaviors in new populations and settings. In addition, a reevaluation of the staging paradigm by DiClemente et al. (1991) resulted in the addition of a new stage, preparation. In 1994, only 2 of the 12 studies included the preparation stage. Since this stage is now considered an integral part of the TTM, its inclusion is essential for validation of the SOC–DB relationship. The current investigation re-examines the strong and weak principles more comprehensively by including many more datasets, behaviors, study populations and settings, and employs more systematic and rigorous quantitative meta-analytic methods to examine potential moderating variables of the strong and weak principles.

Method

Literature searches

Datasets were identified through literature searches on several computerized databases (PUBMED, Cancerlit, Cinahl, Health and Wellness Resource Center and PsyCLIT), conference proceedings, personal communications with authors, and reviews of reference lists from acquired articles. This included published articles, manuscripts in progress, and raw data from 1984 to October 2003. Studies involving any behavior that examined SOC and DB were included if (1) the dataset contained sufficient data to extract ES information; (2) at least the precontemplation and action SOC were reported; and (3) SOC was assessed by an algorithm procedure that classifies individuals into one of the five stages.

Data extraction and coding

The following were extracted for each dataset: a brief description of the study population, study recruitment setting, sample size, participant age groups, publication status, country, percent of males/females, response format, cessation vs. acquisition behavior, and behavior. Since many behaviors included very few studies, some behaviors were aggregated to form conceptually consistent categories for subsequent moderator analyses. For instance, the category “condom use” combined datasets that examined condom use: 1) for vaginal intercourse; 2) for anal intercourse; 3) with main partners; 4) with other partners; and 5) condom use in general. Each behavior in a multiple behavior study was evaluated and coded separately.

Analysis

Primary analyses included effect size (ES) for the maximum change in the pros and cons across SOC from precontemplation to action. Secondary analyses included homogeneity tests of ES distributions for pros and cons and exploration of potential moderators.

Assessment of ES

ES was calculated based on Prochaska’s (1994) definitions of strong and weak principles of change. As specified by Prochaska (1994), for pros, the lowest mean of a stage from precontemplation to action was identified along with the highest value following the low. Similarly for cons, the highest value from precontemplation to action was identified along with the lowest value following the high. Once these two values were identified, ES was calculated using Hedges’ g, which is defined as the difference between group means divided by the pooled within-group S.D. (Hedges, 1981). Because different SOC would be used for the calculation of g across studies, and since n’s could vary substantially by stage, the pooled S.D. was based on data from all available SOC, not just those contributing to the high and low scores, to provide a more reliable basis for estimating g. The ESs were corrected for sample size bias.

Modeling the distribution of effect sizes

A random effects model was used to model the distribution of effect sizes for the pros and cons. This model assumes that subject-level sampling error is
accompanied by a random effects variance component associated with study-level variability. Previous research suggests that a random effects model is appropriate for studies pooled across populations with pre-existing differences (Hedges and Olkin, 1985). The wide range of behaviors, age groups and recruitment settings from which the study populations were drawn also suggests that a random effects approach is warranted. In contrast to a fixed-effects model, a random-effects model aims to make inferences regarding the distribution of effects (Hedges and Vemana, 1998). Therefore, random-effects modeling will enable greater generalization of the results beyond the observed datasets, which is an important goal of this study.

The random effects variance components for both the pros and cons were estimated using an iterative maximum likelihood estimation routine (Overton, 1998; Raudenbush, 1994) employing SPSS macros written by Wilson (Lipsey and Wilson, 2001). This procedure provides a random effects mean effect size and the inverse variance weights, standard errors, and 95% confidence intervals for the effect sizes. Additionally, the Q statistic is computed to assess the homogeneity of the effect size distributions. A significant Q statistic indicates that the random effects component of the model is significantly greater than zero and that the variance in the sample of effect sizes is greater than would be expected from sampling error alone (Hedges-Medina et al., 2006; Lipsey and Wilson, 2001).

Upon the discovery of heterogeneity, follow-up tests were conducted as a preliminary examination of potential moderators of effect size. The ANOVA analog procedure (Lipsey and Wilson, 2001) was used to explore moderators of effect size including behavior category, age group of subjects, acquisition or cessation of a behavior, publication status, response format, and country of study. Additionally in order to capture the potential moderating effect of gender, correlations of effect sizes and proportion of males and females in the study was examined.

Results

A total of 120 datasets from 10 countries encompassing 48 different behaviors were included in this study, of which 119 reported findings for the pros of behavior change and 118 for the cons. All studies reported cross-sectional data. The total number of participants was 47,757, with study sample sizes ranging from 30 to 2925. Basic study descriptive data are provided in Table 1.

Magnitude of “strong” and “weak” effects

The random effects variance component was significant for both pros, $Q(118)=441.07, p<0.001$, and cons, $Q(117)=409.41, p<0.001$. The average ES for pros was 1.00 (weighted S.D. = 0.34, 95% CI: 0.93, 1.06, range = 0.07–2.65) and for cons was 0.56 (weighted S.D. = 0.34, 95% CI: 0.50, 0.63, range = −0.44–1.94). The ES distribution for pros and cons is shown in Fig. 1. Table 2 shows ES means, standard errors (S.E.), and 95% confidence intervals (CI) by behavior.

Moderator analyses

Due to the heterogeneous ES distributions for both DB measures indicated by the $Q$-test results, additional analyses were performed to explore possible moderators. Behavior categories with more than 5 datasets were explored as possible moderator variables. Seven categories satisfied this criterion: condom use, diet, exercise, medical screening, organ donation, smoking cessation, and stress management. ANOVA analog results indicated significant differences between the seven behaviors on pros, $Q(6)=39.77, p=0.01$, and cons, $Q(6)=20.26, p=0.02$. Means, S.E.s and CIs, are reported in Table 3.

Homogeneity tests within behaviors revealed significant results for exercise pros, $Q(19)=40.29, p<0.01$, medical screening cons, $Q(4)=22.99, p<0.01$, and smoking cons, $Q(16)=
Further moderator analyses (see Table 2) showed no significant differences between age groups (pros: $Q(2)=0.59, p=0.74$; cons: $Q(2)=1.09, p=0.58$), acquisition and cessation behaviors (pros: $Q(1)=2.83, p=0.09$; cons: $Q(1)=0.92, p=0.32$), publication status (pros: $Q(1)=0.80, p=0.37$; cons: $Q(1)=1.86, p=0.17$), or response format (pros: $Q(1)=1.50, p=0.22$; cons: $Q(1)=5.11, p=0.17$). The pros did not differ significantly between US and non-US studies ($Q(1)=2.83, p=0.09$), but significant differences in variability were found for the cons ($Q(1)=0.92, p=0.32$), with greater ESs found for studies conducted outside the US.

An additional psychosocial moderator variable, percent of males/females, was assessed using correlation coefficients. Effect sizes of the cons of change were positively correlated with the percent of males ($r=0.254, p=0.012$). There were no correlations between the pros of change and percent of males ($r=0.083, p=0.416$) or females ($r=-0.078, p=0.442$).

**Discussion**

For 48 health behaviors, the average ES for the pros was one standard deviation and for the cons was slightly larger than one-half standard deviation. Both results are remarkably consistent with Prochaska’s (1994) original findings for the strong and weak principles. That is, the magnitude of the maximum increase in the pros of change was approximately twice the maximum decrease in the cons of change from precontemplation to action.

Few potential moderators were identified. No ES differences were found for publication status, suggesting no publication bias for the pros and cons, nor were there any differences for response format, age groups, and cessation vs. acquisition behaviors. Only a small difference was found for US vs. non-US studies and only for cons. The principal moderator of ES for both pros and cons was behavior. For the pros, exercise displayed a considerably larger ES than the other behavior categories. For cons the differences were more muted. Medical screening, organ donation, and smoking showed larger ESs than condom use, diet, exercise and stress.

Variations in how SOC is defined across behaviors might also result in ES differences. This is especially likely to be true for the large ES observed for exercise pros of change. The usual “action” criterion for exercise has been 20 min a day, 3–5 times per week (Reed et al., 1997; Schumann et al., 2002). For individuals not exercising at this level, the “standard” TTM definition for pre-action stages focuses on intention to increase exercise to meet the criterion within the next 6 months (Redding et al., 1999). An individual is classified into precontemplation if they have no serious intention of increasing exercise to criterion in the next 6 months. However, many exercise DB studies used a different definition, employing one developed by Marcus et al. (1992), who defined precontemplation as follows: “I currently do not exercise and I do not intend to start exercising in the next 6 months” (p. 258). Compared to those engaged in at least some exercise, individuals who are not exercising at all might very well endorse fewer pros for the behavior. This would lead to a greater difference in the pros between precontemplation and action, and thus a larger ES, especially as compared to other behaviors. Several recent papers have recommended use of the more “traditional” stage algorithm for exercise (e.g., Nigg et al., 2005; Schumann et al., 2002), but there are not yet enough studies available to compare the ESs that result from the use of the different algorithms. This will be an interesting area for more systematic examination in the future. As for gender, the percentage of males in a sample was positively correlated and the percentage of females negatively correlated with effect size for cons but there was no significant correlation of gender with effect size for pros. This indicates that for the weak effect, as the percentage of males increased, the magnitude of the weak effect also increased. Therefore, a greater proportion of males in the...
sample was associated with a greater decrease in cons from precontemplation action. Although the effect for cons was small ($r=0.25$), one implication of this finding is that gender based feedback for the cons of change may be warranted in the development of more highly tailored interventions. Few studies reported (or even appeared to examine) potential gender differences in DB and, in general, the relationship between the pros and cons and demographic characteristics should be assessed more thoroughly in future studies.

More broadly, it is possible that study demographics, while individually not related to ES, may interact with behavior categories resulting in ES differences. The nearly 50,000 participants across studies included diverse populations that were not represented equally across behaviors, giving rise to the possibility of complex higher order interactions as a source of ES variability. For example, medical screening studies utilized primarily adult female samples, smoking acquisition studies employed only adolescent samples, and smoking cessation studies
Behavior category

Prochaska (1994) has characterized the strong movement of participants from precontemplation to action with some of the same relationships will occur when examining the magnitude of the effect in almost any context, but required as individuals move through the stages towards action, providing guidance for intervention development and tailoring. In progressing from precontemplation to action, tailored interventions should place primary emphasis on increasing the pros of change. An increase of one standard deviation is a “large” effect in almost any context, but especially so for behavioral health interventions, and underscores the difficulty of changing such behaviors. An emphasis on increasing the pros of changes seems particularly warranted for individuals in the precontemplation stage. As individuals progress to contemplation and preparation, further progress can be facilitated by adding intervention components targeting the cons of change. Individuals in these intermediate stages of change tend to evaluate the importance of the pros and cons about equally, leading to ambivalence about the value of changing behavior. Intervening on both the pros and cons might help these individuals continue their progress towards action. Further, despite some variability, these results are reasonably generalizable across behaviors, suggesting that multiple behavior interventions may

Table 3
Moderator sample size, mean ESs, standard errors and confidence intervals

<table>
<thead>
<tr>
<th>PROS/strong principle</th>
<th>CONS/weak principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Mean ES</td>
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<tr>
<td>Overall results</td>
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<tr>
<td>Behavior category</td>
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<td>Condom use</td>
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<tr>
<td>Diet</td>
<td>14</td>
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<tr>
<td>Exercise</td>
<td>20</td>
</tr>
<tr>
<td>Medical screening</td>
<td>5</td>
</tr>
<tr>
<td>Organ donation</td>
<td>5</td>
</tr>
<tr>
<td>Smoking</td>
<td>17</td>
</tr>
<tr>
<td>Stress</td>
<td>5</td>
</tr>
<tr>
<td>Cess vs. Acq</td>
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<td>Cessation</td>
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<tr>
<td>Age group</td>
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<td>Adolescents</td>
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<td>College</td>
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<td>Adults</td>
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<tr>
<td>Response format</td>
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</tr>
<tr>
<td>How important</td>
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</tr>
<tr>
<td>Agree/disagree</td>
<td>13</td>
</tr>
</tbody>
</table>

The limited amount of socio-demographic variables reported and/or consistently reported in the literature precludes more detailed analyses of gender and other variables such as socioeconomic and education status, urban/rural environments, race/ethnicity, and age (more specific than age group). The authors recommend that future studies report these variables to enable more meaningful systematic reviews of the literature.

Limitations and future directions

All datasets utilized cross-sectional data, and we cannot assume the same relationships will occur when examining the movement of participants from precontemplation to action with longitudinal data. Prochaska (1994) has characterized the strong and weak principles of change as the amount of effort required to move from the precontemplation stage to the action stage of change. Presuming that these results can be interpreted as representations of changes within individuals across time, some fascinating possibilities arise regarding ES differences among behaviors. For example, could the much larger ES for exercise pros mean that moving from precontemplation to action requires more effort for exercise than for other behaviors? Would extending these results to other variables, such as the processes of change and self-efficacy, permit a rank-ordering of the difficulty of changing behaviors? As intriguing as such conclusions might be, we must caution against such interpretations. Beyond the study level differences in sample populations among behaviors and the methodological limitations described above, other factors seriously limit such conclusions. Such an interpretation assumes a level of measurement invariance across behaviors for both SOC and DB that is not currently possible. This is not a reflection on the status of measures of the transtheoretical model, which are generally well developed psychometrically, but an acknowledgement of the current limitations of measurement and theory in the social and behavioral sciences.

These results suggest that targeting both pros and cons should be included as part of a tailored intervention package. Notwithstanding the cross-sectional nature of these data, it is likely that the magnitude of the “strong” and “weak” effect sizes reflects the amount of effort or “resources” required as individuals move through the stages towards action, providing guidance for intervention development and tailoring. In progressing from precontemplation to action, tailored interventions should place primary emphasis on increasing the pros of change. An increase of one standard deviation is a “large” effect in almost any context, but especially so for behavioral health interventions, and underscores the difficulty of changing such behaviors. An emphasis on increasing the pros of changes seems particularly warranted for individuals in the precontemplation stage. As individuals progress to contemplation and preparation, further progress can be facilitated by adding intervention components targeting the cons of change. Individuals in these intermediate stages of change tend to evaluate the importance of the pros and cons about equally, leading to ambivalence about the value of changing behavior. Intervening on both the pros and cons might help these individuals continue their progress towards action. Further, despite some variability, these results are reasonably generalizable across behaviors, suggesting that multiple behavior interventions may
also be guided by a consideration of the strong and weak principles of change.

However, in characterizing change from precontemplation to action, the strong and weak principles in a sense do not go far enough. If the goal of tailored interventions is to move people from precontemplation to contemplation to preparation to action and finally to maintenance, then it is essential for future studies to examine ES magnitude and moderators for each stage of change transition in order to explore the possibility of more complex impact patterns. Stage transition analyses could identify more effective strategies for tailoring behavior interventions. Ultimately, careful and systematic investigation of change across stage transitions by behavior can provide even more detailed evidence for exactly how to use these measures most efficiently in future stage-tailored interventions. Such a program of research will be a considerable undertaking. Even for DB, a comprehensive analysis of stage transitions would require eight concurrent meta-analyses, one for each of the four stage transitions for both pros and cons; extending this approach to the TTM’s 10 processes of change would require no less than 40 concurrent meta-analyses.

This study has demonstrated the robust relationships of the strong and weak principles of change using many more datasets and behaviors and more sophisticated analytical techniques than previous studies. In addition to being useful for improving the design of tailored interventions, establishing more formal, quantitative relationships between such important constructs as DB and SOC has the potential for leading to the development of a more cumulative and integrated science of behavior change.

Acknowledgments

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References

References marked with an asterisk indicate studies included in the meta-analysis.


Further reading


*Eaton, C., Goldstein, M.G., Guadagnoli, E., Niura, R., McDonald, N., Dube,