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How much behaviour change should we expect from health promotion campaigns

targeting cognitions? An approach to pre-intervention assessment.

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Abstract

For those planning interventions based on social cognition models it is usually not clear what impact on behaviour will follow from attempts to change the cognitions specified in these models. We describe a statistical simulation technique to assess the likely impact of health promotion targeting Theory of Reasoned Action (TRA)-based predictors of condom use. We apply regression-based simulation techniques to data from the SHARE project (n = 756 Scottish adolescents) to assess the potential impact of changes in cognitions on condom use. Results support the predictive utility of TRA-based models of psychological antecedents of condom use but also provide a cautionary warning about the magnitude of behaviour change likely to be achieved by interventions based on such models.

 Keywords: Theory of Reasoned Action, Intervention Simulation, Sexual Behaviour, Young People, HIV/ AIDS

Introduction

Theory-based interventions in health psychology and health promotion are premised on the idea that it is possible to change cognitions within a target audience and that these changes in turn will influence health protective behaviours (Bennett & Murphy, 1997; Conner & Norman, 2005). For example, interventions based on the Health Belief Model (HBM; Becker & Rosenstock, 1984) often provide information about health risks designed to increase participants' feelings of vulnerability and/or susceptibility (see Abraham & Sheeran, 2005 for a review). Within the framework of the Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975), persuasive communication might be tailored to increase the strength of beliefs relating to particular behaviours by highlighting positively evaluated outcomes or the approval of significant others (see Conner & Sparks, 2005 for a review). It is unclear, however, what magnitude of behaviour change we should expect following interventions which successfully change such theory-based cognitions.

There is considerable evidence suggesting that the TRA provides a useful description of modifiable cognitive predictors of condom use. In a meta-analysis of psychosocial predictors of condom use, Sheeran, Abraham and Orbell (1999) examined 44 correlates of condom use and found four cognition measures to have medium to large average correlations with reported condom use across the literature. These were attitudes towards condoms (i.e., the perception that use would lead to positive outcomes), descriptive norms in relation to condom use (i.e., perceptions that others used condoms), intentions to use condoms and pregnancy motivation (e.g., the belief that condoms should be used for contraceptive purposes as well as STI protection). The largest correlation with

condom use observed in this review was for communication about condoms, measured in terms of whether condom use had been discussed with a sexual partner before intercourse. Sheeran *et al*. concluded that their results 'provide empirical support for conceptualizing condom use in terms of an extended Theory of Reasoned Action' (p. 126) and argued that these correlates specify important targets for safer sex promotion. Further meta-analyses of studies applying the TRA and the theory of planned behaviour (TPB; Ajzen, 1991; 2001) to condom use confirmed these findings and found that the addition of perceived behavioural control to the TRA did not significantly increase the variance explained in condom use (Albarracín, Johnson, Fishbein, M., & Muellerleile, 2001; Fishbein, 1993). Moreover, there is evidence that interventions which successfully change such cognitions are more likely to promote condom use. In a review of sex education interventions for adolescents, Jemmott and Jemmott (2000) found that interventions that had medium to large effects on cognitive antecedents (including beliefs about the consequences of condom use for sexual enjoyment, and HIV preventive intentions) had a significantly greater impact on condom use than interventions that had a small or no effects on cognitive antecedents. Similarly, Albarracín, Gillete, Earl, Glasman and Durantini (2005) found that interventions targeting attitudes and (in young audiences) normative beliefs were more likely to successfully promote condom use.

In this study we ask, - what is the likely impact of changing cognitions specified by the TRA on consistent condom use? For example, if an intervention successfully changed attitudes towards condoms to what extent would we expect this to shift behaviour so that more consistent condom use was observed in the target population? We also examine whether changing other cognitions, not specified by the TRA, but targeted

by previous condom promotion interventions for young people, is likely to impact on condom use. For example, previous interventions have emphasised feelings of responsibility for contraception and condom use (e.g., Gottsegen & Philliber, 2001) and the likelihood of future regret (e.g., Richard, van der Pligt &, de Vries 1996). Answers to these questions are important when designing health education interventions, for example in deciding which cognitions persuasive communications such target, and in conducting *a priori* cost-benefit and cost-effectiveness analyses.

There are three main ways to assess the impact of an intervention designed to change a psychological determinant on a particular behaviour. The first is by experimental manipulation where, prototypically, a group is provided with the intervention and their later behaviours are compared to those of some relevant control group (e.g., Thrush, Fife-Schaw & Breakwell, 1999). This approach (e.g., use of a randomised control trial or variant thereof) can effectively address the question '*is this intervention effective?*' (e.g., Wight, Henderson, Abraham, Buston, Hart, & Scott, 2002). However, it is rare that analyses of such experimental manipulations answer the question, '*what is the role of changes in a particular construct or cognition in changing behaviour?*'. This is because most interventions include multiple components, target multiple modifiable determinants simultaneously and do not conduct mediation analyses (Michie & Abraham, 2004). This limits the degree to which evaluations of behaviour change interventions can inform us about the utility of psychological theories as theories of behaviour *change* – because we are rarely able to identify which particular psychological changes occurred and which were responsible for any observed behaviour change. Moreover, evaluations assess effectiveness after investment in intervention

design and implementation. This is an expensive approach to deciding which interventions should be funded so exploratory trials should only be conducted when the best possible modelling research has been completed (Campbell *et al*., 2000).

A second method is to conduct meta-analyses of similar intervention studies such as that conducted by Albarracín *et al.* (2005) in the context of condom use. This is an very useful approach because it not only permits the estimation of the impact of particular interventions but it can answer important questions about what sorts of interventions work best with what sorts of populations. The major limitation to this approach is that meta-analyses depend upon there being a large body of broadly comparable studies involving interventions addressing the same theoretical constructs in the published literature. Albarracín *et al.* (2005) were able to conduct their analyses because of the very substantial investment in cognition change interventions designed to reduce HIV-risk behaviors, including condom use. Consequently, such meta-analyses are rare and unable to assess the potential impact of changing cognitions not been previously targeted by multiple interventions. Moreover, generalizations about effect sizes based on a mixture of many target groups may be less accurate predictors of impact than analyses based on the population to be targeted by a planned intervention.

A third approach is to use statistical procedures to model the anticipated behaviour change that might be expected to follow from changes in cognitions on the basis of the observed magnitude of associations between cognitions and behaviour. This involves imputation of hypothetical behaviour in order to simulate the effect of 'small', 'medium' and 'large' increases in cognitions thought, on the basis of theory and correlational research, to be the key causal determinants of the target behaviour. This

method can be applied before an intervention has been designed and does not depend on the accumulation of many intervention evaluations over time. Thus it can be used in the pre-intervention or 'modelling' stage of intervention development (Campbell, et al., 2000) to estimate the potential cost effectiveness of behaviour change interventions. The approach was pioneered in the field of political science (e.g., Althaus, 1998; Bartels, 1996; Delli Carpini & Keeter, 1996; Gilens, 2001) where researchers have assessed the impact of political knowledge (or, rather, lack of knowledge) on political preferences and voting choices. Until now, however, it has not been used to model the impact of health behaviour change interventions.

In the political preference literature regression-based procedures have been used to adjust survey respondents' preferences to match the predicted preferences of a respondent who shares the same background but possesses the highest level of political knowledge (usually a maximum score on a knowledge test). The importance of political knowledge is then assessed by comparing the sample's observed scores on key outcomes (such as policy preferences) with the imputed outcomes of a 'fully informed' but otherwise identical sample. For example, Althaus, (1998) modelled the effect of having 'full' political information on 45 policy preferences covered in the 1988 and 1992 US National Election Studies surveys. The modelled 'fully informed' sample was, on average, 11.6% more in favour of paying for services and deficit reduction and 9.2% more in favour of free market approaches and less government intervention.

The technique is equally applicable to assessment of the impact of changing any psychological state on a specified behaviour. Fife-Schaw, Sheeran and Norman (2007), using the Theory of Planned Behaviour (TPB; Ajzen, 1991), used this approach to model

the impact of an 'ideal intervention' that maximized attitude, subjective norm and perceived behavioural control scores on intentions to perform, and subsequent performance of, 30 different behaviours (e.g., attending lectures, recycling waste) amongst a student sample (n=211). Taking each TPB variable in turn they simulated the impact of conventionally small, medium and large and maximum possible increases in these variables on intentions and then behaviour. As expected the findings indicated that increasing each of the predictors on their own produced stronger intentions compared with the intention scores originally observed and that simultaneous maximization of all three variables generated the largest increase in intentions. In the case of many of the behaviours, under simultaneous maximisation of TPB variable scores the increased intentions lead to nearly all simulated sample members performing the behaviours suggesting that the TPB was an adequate explanation of these behaviours.

The Present Research

While this technique has been used to assess the potential impact of political education, it has not been used to assess the likely impact of interventions targeting cognitions in order to generate health behaviour change. Our aim is to demonstrate the utility of the technique for this purpose. We employed a large sexually-active sample of teenagers derived from an initial sample of fourteen year olds, representative of Scotland in terms of parents' social class and proportion of one-parent households (Abraham, Henderson & Der, 2004). We assessed the likely impact of varying magnitudes of intervention effectiveness in changing cognitions on self-reported consistent condom use among adolescents, thereby focusing on a group and a behaviour regularly targeted by health promoters.

We first specified a socio-cognitive model based on a modification of the TRA developed using traditional regression methods. We have used a model that reflected the results of the meta-analysis conducted by Sheeran and colleagues. Thus predictors include attitudes towards condoms, descriptive norm and intentions to discuss condom use with sexual partners. We have also included other key cognitions targeted in such interventions. Unlike many other health behaviours, condom use is a co-operative action which could result in diffusion of responsibility. In addition, anticipated regret (AR) has been added to the model because AR has been found to be operationally distinct from traditional measures of attitude (Richard, de Vries & van der Pligt, 1998) and to predict intentions to use condoms when TRA predictors are controlled (Richard *et al.,* 1995; 1998). Both responsibility and AR have been targeted in previous condom promotion interventions for young people. Consequently, we modelled the impact of changing both these additional cognitions. In line with studies suggesting that TRA cognitions can have direct effects on behaviour (e.g., Abraham, Clift, & Grabowski, 1999; Bagozzi, Baumgartner, & Yi, 1989; Norman & Smith, 1995) we modelled the impact of predictors having both direct effects on behaviour and effects mediated by intentions. Having specified this model we then simulated the effect of an intervention that enhances each of these predictor variables in turn by a conventionally 'small', 'medium' and 'large' amount, using Cohen's (1992) conventions on effect sizes, to assess each variable's contribution to the model and likely impact on changed behaviour.

Finally, we modelled the effect of interventions that might simultaneously enhance scores on combinations of variables to assess model adequacy. By doing this we are not only able to assess the likely behavioural impact of each candidate variable but

the collective impact of modelled cognitions. This allowed consideration of the comprehensiveness of the model. If simulated behaviour change suggests nearly all members of the population would use condoms consistently if the cognitions in the model were changed then the model would seem to be addressing the important determinants of this behaviour. If, however, even after a maximally effective simulated intervention a substantial number of people would not use condoms consistently this would suggest that the model is inadequate and in need of non-trivial re-specification.

Method

Sample

The data are drawn from the 'Sexual Health And RElationships: Safe, Happy and REsponsible' (SHARE) project (Abraham, Henderson & Der, 2004; Wight *et al*., 2002). The SHARE project evaluated a school sex education programme using a representative sample of Scottish teenagers in terms of parents' social class and proportion of one-parent households as reported in the 1991 Census data. Students were recruited from non-denominational schools within 15 miles of the main cities in Tayside and Lothian Regions of Scotland. At follow-up, SHARE achieved an 88% response rate with less than 3% attrition accounted for by student or parental withdrawal from the study or students moving out of the area. Full details of the trial design and participant flow are provided elsewhere (Wight *et al*., 2002).

The present sample was a subsample of students who were randomly allocated to the control arm of the SHARE project and who responded to the follow-up survey. They were selected on the basis that they were sexually active and had provided information on condom use in the follow up survey. This generated a sample before screening for

missing data of 824 students (505 men and 319 women) with an average age of 16 years and one month.

Procedure

Survey questionnaires were piloted and amended to ensure ease of comprehension. They were administered by trained researchers in classrooms under examination conditions without class teachers present. Respondents were assigned an identity number known only to the research team and students returned their forms in sealed envelopes. Students who were absent on the data collection days were left questionnaires to post back to the researchers as was the case for pupils who had subsequently left school.

Questionnaire

The survey instruments contained a large number of questions about sexual and health behaviour with separate versions tailored for males and females. Only those items directly relevant to the modelling and simulation analyses are described here.

     Consistent condom use This self-report measure of behaviour was created by asking respondents to record the number of times during the past year that they had had sexual intercourse and the number of occasions on which they had used a condom. Response options for both items were: 0,1,2,3,4-6 (scored as 4), 7-9 (5), 10 or more (6). A single consistency index was created by dividing the frequency of condom use by the frequency of intercourse score giving a maximum possible score of 1.0 indicating condoms were used on all occasions. Abraham, Henderson and Der (2004) report that this index was correlated at $r = 0.82$ (p<0.0001) in this subsample with a similar question ("How often did you use a condom *ever*?, never, not very often, about half the time, most of the time, always") suggesting consistent self reporting of condom use.

Intention to use condoms consistently was measured by a single item scored on a 5-point scale ("In the future, if you have sexual intercourse with someone and don't want to get pregnant would you intend to *always* use a condom during sexual intercourse?" responses ranged from 'Strongly do not intend to' to 'Strongly intend to').

Seven measures were used in the model as predictors of intention, as follows. Items were scored on 5-point response scales ranging from strongly agree to strongly disagree unless otherwise stated. *Attitude towards condom use* was measured using a three item composite scale including two items which were reverse coded (alpha = 0.70; "Using a condom would interrupt sexual fun", "Using a condom would reduce sexual enjoyment" and "Condoms are very effective in preventing HIV/AIDS"). *Descriptive norm* was indexed using a single item ("When your friends have sex with someone for the first time most of them will use condoms"). *Intention to discuss condom use with partner* was also measured by a single item ("In the future, if you have sexual intercourse with someone and don't want to get pregnant would you intent to discuss condoms with him/her before having sex?") responded to on a scale ranging from "Strongly do not intend to" through to "Strongly intend to". Similarly, *Anticipated regret* was measured with a single item ("In the future, if you have sexual intercourse with a boyfriend/girlfriend you would regret having had sex if you felt ready for sex but only used the contraceptive pill, NOT a condom."). *Perceived obligation to take personal responsibility for condom use* was measured using the mean of two items (e.g., "When you have sex with someone, even if you think (s)he has condoms should you personally take care that.. (i) a condom is available (ii) a condom is used"). Respondents were also asked about their *Intention not to have a child in the next two years* ("How likely is it that

you will be doing the following in 2 years time? (i) have a child/ children?"; very

unlikely – very likely) since we assumed that those intending to have a child would be

less likely to intend to use contraceptive measures, including condoms. Finally, we

included respondents' sex as sex differences have been found in young people's condom-

related cognitions (e.g., Abraham Sheeran, Spears & Abrams, 1992). For clarity and

brevity these will be referred to collectively as 'intention predictors' from here onwards.

Thus the model included six cognitions (attitude, descriptive norm, intention to discuss

condom use, anticipated regret, condom responsibility and intention not to have a child)

as well as gender all of which are, for our purposes, 'intention predictors'.

Results

The TRA indicates that the impact of all predictors on behaviour should be mediated by

behavioural intention; however, we also considered direct unmediated effects of our

predictors as these have been observed in the literature. This initial model was developed

on the basis of the results reported below. Correlations between predictors as well as

means and standard deviations are presented in Table 1.

Simulations

For the purposes of the present simulation only those cases with no missing data on all

variables are considered (n= 756, 280 male and 476 female). Two sets of simulations

were conducted that reflected the ordering of processes within the model. First, the

impact of simulated small (0.2 *SD*), medium (0.5 *SD*) and large (0.8 *SD*) increases in each

of the predictors of intention on condom use intentions was modelled. The second set of

simulations modelled the separate and combined impact of intentions and the predictors

of intention on behaviour. Consistent with the model, it was assumed that interventions that engender changes in the variables that predict intention are then reflected in changes in intentions, and that intention change then has a substantial role in generating behaviour change. Thus, we modelled the impact on behaviour of simulated values of intentions accruing from changes in the values of the exogenous variables rather than any attempt to simulate interventions intended to change intentions directly, thereby respecting the change processes specified by the TRA. The direct effects of changes in these variables on behaviour was also modelled.

Simulations for intentions to use condoms. The process of simulating intention scores proceeded in stages as follows: First, intention was regressed onto the seven predictors of intention. Second, a simulated data set was generated where participants' scores on all variables remained unchanged except for the to-be-increased variable where an enhanced value of the mean plus a small/medium/large increment (0.2, 0.5 or 0.8 *SD*) was substituted for the observed value to reflect the impact of the imaginary intervention. Third, predicted intention scores were calculated using the regression weights obtained in the first stage. This process was repeated for each predictor separately and for combinations of the predictors.

The first column of Table 2 summarizes the regressions for intentions. The findings indicate that the model generally provides very good prediction of intention. The variance explained in intention across behaviours was 38%. This value is virtually identical to the R^2 value obtained in Armitage and Conner's (2001) meta-analysis of 185 TPB studies ($R^2 = .39$), and suggests that the present dataset is a suitable example for illustrating simulated impacts of interventions based on a related model. We retain the

marginally significant effect for perceptions of friends' condom use since normative influence is central to the TRA.

Figure 1 shows the simulated intention scores when each predictor of intention is increased individually by 'small', 'medium' and 'large' amounts and when all predictors are simultaneously increased by these amounts. As expected from the initial regression weights (Table 2) enhancements to perceptions of responsibility for condom use have the greatest individual impact on intention scores which rise from 4.03 to 4.25 with a large simulated intervention (an effect size of 0.22 *SD*). Perceived friend's condom use (descriptive norm) is the least effective in producing change (0.05 *SD*).

Simulations for Behaviour. The process of simulating behaviour scores proceeded in the following stages: First, behaviour was regressed on to intentions and all the predictors of intentions as proposed by the model. Second, a simulated data set was generated where participants' scores on all variables remained unchanged except for the to-be-increased variable where an enhanced value of the mean plus a small/medium/large increment (0.2, 0.5 or 0.8 *SD*) was substituted for the observed value and the intention score was set to the value obtained from the simulated enhancement of the individual predictor(s) (and their combinations) in the analyses described in the previous section. The third stage involved calculating predicted consistent condom use scores using the coefficients derived from the first stage.

In a similar manner to the sensitivity analyses conducted for intentions, we modelled the impact of 'small' (0.2 *SD*), 'medium' (.5 *SD*), and 'large' (.8 *SD*) increments in the intention predictors on behaviour. Figure 2 presents the results of these simulations. For 'small' (mean plus 0.2 *SD*) increments of any of the intention predictor

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variables individually the increase in self-reported consistent condom use is negligible (median effect size of 0.03 *SD*). In combination, however, 'small' changes produce a 0.16 *SD* increase in consistent condom use while 'large' increases across all variables produce a substantial 0.65 *SD* increase with a predicted near ceiling effect of 0.99 on the consistent condom use measure (max. score = 1). So, despite 'significant' regression weights for these terms in the model, interventions would have to generate quite considerable changes in many different cognitions simultaneously to bring about substantial behavioural impacts.

As gender has often been identified as an important moderating variable in studies modelling condom use the above simulations contained respondent gender as a covariate in the analyses. To explore this more directly we repeated the above simulations separately for each gender. While there are absolute level differences between the genders with males reporting higher levels of consistent condom use, there are no substantial differences in the slopes of the simulation curves or indeed the regression weights in the models.

Discussion

Our analyses illustrate the utility of simulating potential impacts of changing cognitions on health behaviour change. This technique has been widely used in assessing the potential impact of political campaigns but rarely been used in health psychology research yet it has considerable potential to assess the likely cost effectiveness of interventions targeting particular psychological changes. The UK Medical Research Council framework for designing health-related interventions suggests that a modeling

(or pre-intervention) research stage should precede the design of exploratory trials. The simulations illustrated here provide a useful additional research method to those considering interventions designed to change health-relevant cognitions.

The size of the effect of modelling intervention effectiveness in the present sample confirms what many health educators and health psychologists will have anticipated. Focussing on cognition change specified by single theoretical constructs alone is unlikely to bring about major behavioural change in absolute terms. In the case of consistent condom use among sexually active teenagers, intentions to use condoms consistently and self-reports of condom use were already relatively high in this sample and substantial improvements in condom use over and above this baseline were only likely to be achieved if a number of cognitions could be influenced simultaneously. Whether it is possible to design an intervention programme capable of producing 'large' simultaneous effects on a number of theory-based cognitions, and whether cognition change is synergistic (e.g., attitude change prompts changes in perceived responsibility) is a separate question that can only be assessed through empirical experiments and meta-analyses. However, our data emphasise the tough challenge facing health promoters confronted with reasonably high pro-health behaviour cognitions who nonetheless want to engineer population-level behaviour change by means of cognition change.

As well as suggesting the magnitude of likely behaviour change from various levels of cognition change the simulation exercise also provides information about the adequacy of the model that the simulations were based on. When conventionally 'large' increases were made to all the cognitions predicting intentions the simulated impact on condom use was to yield effectively maximum levels of (reported) consistent condom use

(0.99 vs. a theoretical maximum of 1). This is not a necessary outcome of the simulation process (see Fife-Schaw *et al.*, 2007). Had the model been inadequate and missing key determinants of behaviour then the improvement in behaviour relative to the real baseline might well have been much smaller. Thus these data indicate that the model we tested is a good cognitive model of relevant behavioural determinants, albeit one that requires large multiple cognition changes to lead to substantial increases in consistent condom use amongst this population.

It is interesting to note that when we limit ourselves to the basic TRA model with intentions fully mediating the influence of attitude and normative perceptions of friends' condom use, the simulated condom use measure rises to only 0.85 from its initial observed base level of 0.82. This suggests that the extended model tested here with the possibility of direct effects of cognitive predictors of intentions to use condoms consistently on reported consistent use is a more adequate account of the cognitive targets for intervention in this population. Some cognitions have direct as well as mediated effects with attitudes in particular having an independent, non-mediated effect on reported behaviour. Such direct effects for attitudes have been identified in previous research and may indicate affective or automatic action activation rather than deliberative regulation (e.g., Abraham, Clift, & Grabowski, 1999; Bagozzi, Baumgartner, & Yi, 1989; Norman & Smith, 1995).

It is informative to compare our estimates with the findings of a comprehensive meta-analysis of condom promotion interventions (Albarracín *et al.*, 2005). Direct comparisons are impossible because Albarracín *et al*. do not group interventions in terms of combinations of targeted cognitions but only in terms of whether a particular

intervention technique was or was not employed. In addition, their study did not include

anticipated regret or condom responsibility-based interventions. Nonetheless, across all

interventions targeting condom attitudes, the mean effect size on attitude change ranged

from 0.16 to 0.24 (their Table 2) suggesting 'small' effects in our terms. Moreover,

interventions targeting attitude change tended to raise intervention effect sizes on condom

use by 0.10 – 0.14 (inferred from their Table 3) compared to a corresponding impact for

'small' effects in the present simulations of 0.05.

Interventions designed to promote condom use by any combination of means generated

effect sizes of 0.26 – 0.29 (their Table 2) although it should be noted that significant

change occurred in the control arms of their sampled studies (effects in the range 0.08 to

0.11). These effects are comparable to the simulated combined effects of 'small' changes

in multiple cognitions found in our simulations (i.e., an effect size of 0.16). Taken

together this suggests that the simulation approach is a little conservative but,

nonetheless, produces estimates within a realistic range. It is encouraging to note that our

simulations based on a single sample of Scottish teenagers correspond so closely to

analyses of 354 HIV-prevention interventions and 99 control groups gathered over

seventeen years of research.

The regression-based simulation procedure used here makes some assumptions

about the nature of models and interventions which are worth considering. By

investigating the impact of increasing positive attitudes towards condom use, for

example, we are assuming that it is possible to conceive of an intervention that influences

attitudes and nothing else; that is, anticipation of regret and perceptions of what others do

would not also change. While in the present context of condom use most correlations

between the predictors are relatively low, as yet we do not know whether changes in one cognition will have unplanned cross-over effects on other cognitions. If such effects do occur then we will need to revisit our models since at present causal relationships between predictors of intentions are not implied by most TRA-based models. Clearly it is technically possible to model these interactions and simulate their effects on behaviour. We have not done this here since there are a large number of potential interactions that could be modelled and there is a danger of capitalising on chance; however, given the positive correlations between the predictors the impact of modelling such cross-over effects would inevitably increase the impact of the simulated interventions bringing them even closer to effects sizes of the magnitude found by Albarracín *et al*. (2005).

As with all simulation studies the quality of the estimates depends crucially on the quality of the data on which they are based and the assumptions underlying the modelling. The consistent condom use measure used here was reliable but necessarily based on self-report. Simulations, and indeed meta-analyses, are likely to yield more accurate estimates of behavioural impact when based on objective behavioural measures. Many of the measures were based on single items because of the limitations of classroom-based surveys in which measures must be readily understood and simultaneously retain the attention of students with a range of intellectual abilities. However, these measures were carefully piloted and because associations between them correspond well to other studies using multi-item measures (Abraham *et al*., 2004, Armitage & Conner, 2001) there is no reason to question their validity. Nonetheless, it would be useful to repeat such simulations using multi-item measures.

Another implication of the use of regression models is that they implicitly assume that the same regression weights apply to all individuals in the sample even though this is not necessarily the case (Sutton, 2002). This equal applicability assumption is an assumption of the simulation exercises presented here and, from the viewpoint of estimating likely maximum impact of an intervention aimed at a group, is a reasonable one to make. It is likely however, that the impact of changing attitudes will vary between individuals and indeed may even vary over time. In principle this could be modelled though it would necessarily involve multiple data collections from the same individuals. This has much to recommend it and could be focus of future applications of this simulation method.

We have shown that simulations estimate the potential impact that a cognition change intervention could have on behaviour. It is important to note, however, that an intervention evaluation could fail to replicate the findings of a simulation for a variety of reasons. First, the intervention may be ineffective and so fail to achieve even a small effect on the specified cognitions. Second, even if the intervention effectively creates cognition change, it will not appear to be effective when compared to a control intervention which has similar effects on cognition. For example, if routine treatment generates similar levels of cognition change during the intervention evaluation, then no significant differences between conditions would emerge even though both groups showed positive changes in cognitions and behaviour (cf. the control-arm effects noted by Albarracín *et al*., 2005). Third, if the intervention is delivered to a group who appear to be similar to the group used in the simulation but who, in fact, are distinct in their behaviour-relevant cognitions or the resources or barriers relevant to the target behaviour.

Thus the modelling stage of intervention design must carefully examine the potential to change targeted cognitions, the characteristics of the target population and the contexts in which interventions are required and evaluated (Abraham & Michie, 2004).

In conclusion, this simulation approach offers the potential to provide health practitioners with estimates of how effective their interventions could be. It complements the use of meta-analytic data and is especially useful when testing the utility of changing cognitions that have not yet been subject to meta-analytic review (e.g., condom responsibility in the present study). Such simulation also has value in cases where the nature of the sample or features of the particular context have not yet been the subject of meta-analyses. In principle similar analyses could be conducted to assess the likely impact of interventions aimed at any candidate predictor (or indeed moderator) of any health behaviour. For example, many interventions attempt to increase people's self-efficacy and/or self regulatory skills (e.g., Bandura, 1997; Lorig and Holman, 1993) and it would be possible to model the impact of enhanced efficacy and/or self regulatory skills on a specified behaviour change (such as adherence). Such analyses could inform cost-benefit analyses, help intervention designers to conceptualise the scale of psychological change required to generate useful behaviour change and so facilitate more realistic planning of health promotion campaigns targeting psychological change.

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Table 1

Means, standard deviations and intercorrelations of variables used to predict consistent condom use.

	1	2	3	4	5	6	7	8	9
1. Intention to use condoms consistently									
2. Attitude toward condom use	0.41**								
3. Perceptions of friends' condom use	0.30**	0.29**							
4. Intention to discuss condom use	0.43**	0.35**	0.26**						
5. Responsibility for condom use	0.51**	0.43**	0.40**	0.43**					
6. Anticipated regret	0.33**	0.21**	0.13*	0.20**	0.25**				
7. Intention not to have a child	0.21^{ns}	0.15**	0.12^{*}	-0.12*	0.26^{**}	0.11^{***}			
8. Sex	0.06^{ns}	0.19**	0.05^{ns}	-0.25**	0.09*	0.06^{ns}	0.05^{ns}		
9 Consistent condom use	0.36**	0.36**	0.34**	0.19**	0.35**	0.21**	0.25**	-0.10**	
Mean	4.03	4.02	3.93	2.04	4.44	3.14	4.16	1.63	0.82
Standard deviation	1.00	0.80	0.95	0.90	0.65	1.11	1.00	0.48	0.27

Notes:

N= 756

** = $p<0.001$, * = $p< 0.05$,
ns = non-significant

Table 2

Regression to predict intention to consistently use condoms.

	Beta To predict Intention	Beta To predict Behaviour
Attitude toward condom use	0.17**	0.21**
Perceptions of friends' condom use	0.06^{ns}	0.19**
Intention to discuss condom use	0.22**	-0.02^{ns}
Responsibility for condom use	0.27**	0.09*
Anticipated regret	0.18**	0.07*
Intention not to have a child	0.06*	0.15**
Sex	-0.07*	-0.17**
Intention to use consistently		.14*
Adjusted R^2	0.38	0.27

Notes:

N= 756

** = p<0.001, * = p<0.05

Figure Captions

Figure 1

Impacts on intentions arising out of simulating increases in cognition variables.

Figure 2

Impacts on consistent condom use arising out of simulating increases in the intention predictor variables.