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Long-Term Effects of Implementation Intentions on Prevention of Smoking Uptake Among Adolescents: A Cluster Randomized Controlled Trial

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Objective: To test the efficacy of implementation intentions in reducing smoking uptake in a sample of adolescents. ***Design:*** Classes of adolescents (aged 11–12 years) were randomly allocated to one of four conditions: implementation intention, self-efficacy, two control conditions. An implementation intention or a self-efficacy manipulation (both formed in relation to how to refuse offers of cigarettes) was completed by intervention condition participants at 0, 4, 8, 12, 16, 20, and 24 months. ***Main Outcome Measures:*** Long-term smoking behavior (self-report and objective) was assessed at 48 months post-baseline. ***Results:*** There were no differences between the two control conditions and the self-efficacy condition. Controlling for baseline smoking, sex, attitudes to smoking, friends and family smoking, and the multilevel nature of the data, intention-to-treat analyses indicated the implementation intention manipulation significantly reduced self-reported smoking compared to the other three conditions combined. Analyses on objectively assessed smoking (carbon monoxide breath measure) in a random subsample of participants also indicated that the implementation intention manipulation compared to the other three conditions significantly reduced smoking. ***Conclusion:*** Implementation intentions can reduce smoking in adolescent samples. Implications for using implementation intentions to reduce smoking in adolescents are discussed.

Keywords: U.K., implementation intentions, cluster randomized controlled trial, smoking initiation, adolescents

Smoking remains the largest single cause of preventable death in the Western world (Center for Diseases Control, 2002). Given that most adult smokers start smoking regularly before the age of 18 (The Royal College of Physicians, 1992) reducing smoking initiation in adolescent samples is potentially the most effective way to reduce the risks posed by smoking. However, few simple but effective interventions have been identified (Conrad, Flay, & Hill, 1992; Rooney & Murray, 1996; NHS Centre for Reviews & Dissemination, 1999; Sussman, 2002). The present research tested the effectiveness of forming implementation intentions (Gollwitzer, 1993) about how to refuse offers of cigarettes on reducing smoking between the ages of 12 and 16 years in U.K. adolescents.

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Smoking

Annually smoking related illnesses kill an estimated 443,000 people in the U.S (Center for Diseases Control, 2008b) and 106,000 people in the U.K. (Twigg, Moon, & Walker, 2004). The vast majority of smokers take up this habit as an adolescent (Paavola, Vartianen, & Puska, 1996; The Royal College of Physicians, 1992) with an estimated 90% of adult smokers beginning before they reach 21 years of age (American Lung Association, 2002a). Most (61%) new smokers in 2006 were under the age of 18 when they first smoked cigarettes (Substance Abuse & Mental Health Services Administration, 2007). The younger children are when they start smoking the more likely they are to be adult smokers (Chassin, Presson, Sherman, & Edwards, 1990). Young smokers have more respiratory infections, higher risk of strokes (The Royal College of Physicians, 1992), and a greater risk of lung cancer (Doll & Peto, 1981). It is also the case that the younger children are when they start smoking the younger they are in developing heart disease (The Royal College of Physicians, 1992). Nevertheless, smoking initiation rates in young people remain worryingly high. In 1999 there were an estimated 4.5 million adolescent smokers in the U.S., with 12% of students in Grade 9 and 23% of students in Grade 12 being regular smokers (American Lung Association, 2002b). Current smoking in high school students in the U.S. declined from over 30% in 1999 to 22% in 2003 but has remained at around this level between 2003 and 2007 (Center for Diseases Control, 2008a). In the U.K., the rates of regular smoking at 11 years of age are only 0.5%, although this rapidly rises to 14% by 15 years of age (Fuller, 2009). Decisions

to take up smoking appear to be made despite widespread awareness of the long-term negative consequences for health. It has been estimated that one third of the young people who take up smoking will die from a disease caused by smoking ultimately because of a decision made as an adolescent (American Lung Association, 2002b). Development of simple, effective interventions to reduce adolescent smoking could help tackle the detrimental long-term health consequences of smoking.

Smoking is a complex behavior. Attempts to understand this behavior have led to research into risk factors associated with smoking initiation. For example, Goddard (1992) reported a number of factors associated with adolescent smoking initiation in the U.K. These included being a girl (Goddard & Higgins, 2000; Jarvis, 1997), having friends who smoke (Bricker et al., 2009; Chassin, Presson, Sherman, Corty, & Olshavsky, 1984; Paavola et al., 1996), having siblings or parents who smoke (Bricker et al., 2009; Jarvis, 1997; Paavola et al., 1996), and having more positive attitudes toward smoking (Jarvis, 1997; Royal College of Physicians, 1992). Interventions to reduce adolescent smoking might usefully target or control for such effects in assessing their effectiveness. Charlton, Moyer, Gupta, and Hill (2000) identified the lack of skills about how to refuse an offer of a cigarette (particularly from friends or potential friends) as a key influence on smoking initiation in adolescence. The current research tested the impact of forming implementation intentions in relation to refusing offers of cigarettes as one way to reduce adolescent smoking.

Implementation Intentions

Implementation intentions are simple if-then plans (Gollwitzer, 1993). Gollwitzer (1993, 1999) defined an implementation intention as a plan of how, where and when to perform a behavior. This type of plan establishes a link between a situation and a planned behavior ("If I encounter situation X then I will do Y"). By forming an implementation intention, it has been argued that people pass on control of goal directed activities from the self to the environment (e.g., Aarts, Dijksterhuis, & Midden, 1999). When the target situation is encountered it prompts the intended behavior, through automatic activation of the plan (see Webb & Sheeran, 2007). Implementation intentions facilitate quick and reliable initiation of the intended behavior by increasing readiness to respond to specified opportunities (when "Y" occurs) (Gollwitzer, 1993). Gollwitzer and Sheeran (2006) provided a meta-analysis of the effectiveness of implementation intentions. Their review indicated that across 94 independent studies containing 8,461 participants implementation intentions were associated with a medium sized effect (Cohen, 1992) on behavior change (frequency weighted mean $d_+ = .65$). Specifically, in relation to health behaviors, a total of 23 independent studies were reviewed containing 2,861 participants and indicating a medium sized effect on behavior ($d_+ = .59$). However, their review also indicated a number of gaps in relation to the testing of implementation intentions in the health domain (see Sheeran, Milne, Webb, & Gollwitzer, 2005, for a review). In particular, the reviewed health behavior studies rarely examined risk behaviors or adolescent samples.

In relation to risk behaviors, only 6 out of the 23 health behavior implementation intention studies reviewed by Gollwitzer and Sheeran (2006) tested health-risk behaviors, and none examined smoking. Three subsequent studies (Armitage, 2007, 2008; Armitage & Arden, 2008) have provided some support for the use of versions of implementation intentions on smoking cessation and one study (Higgins & Conner, 2003) has examined their role in reducing smoking initiation. Armitage (2007) reported implementation intentions to significantly increase quitting smoking (12% quit) compared to controls (2% quit). Similarly, Armitage (2008) reported a volitional help sheet based on implementation intentions to significantly increase quitting (19 vs. 2% quitting for implementation intention and control conditions respectively). Armitage and Arden (2008) reported implementation intentions to be significantly more effective in promoting quitting behavior (12% quit) than either passive (1% quit) or active (2% quit) control conditions. Less conclusive results have been reported in relation to smoking initiation. Higgins and Conner (2003) tested the effects of a single implementation intention (about how to refuse offers of cigarettes) on self-reported smoking over a period of 2 months in a sample of 162 adolescents. Although the results were promising (0% or 0/51 initiated smoking in the implementation intention condition; 6% or 3/53 initiated in the control condition), the study was inadequately powered to detect significant changes in smoking status over such short time intervals. The present work extends that study by examining the effects of repeated implementation intentions (i.e., forming an implementation on more than one occasion) in a larger sample and over a longer time period.

It is also the case that comparatively few studies using implementation intentions have focused on adolescent samples. Although 79 out of the 94 tests of implementation intentions reviewed by Gollwitzer and Sheeran (2006) were from student samples only two were from children or young adults. As far as we are aware only Higgins and Conner (2003) have examined the use of implementation intentions in relation to health behaviors in adolescent samples.

Present Study

The study reported here was designed to address the above issues in relation to using implementation intentions (formed every 4 months over a 2-year period) to reduce smoking initiation in a sample of adolescents over a further 2-year period. This work extends the above literature in a number of ways. First, by focusing on smoking initiation in adolescence, the study provides a test of the effectiveness of implementation intentions in relation to health behaviors (i.e., health-risk) and populations (i.e., adolescents) that have been relatively little explored. Second, by testing the effects of forming repeated implementation intentions over a 2-year period on smoking behavior 2 years later again, the study provides a test of effectiveness over a greater time interval than has previously been reported. Third, by examining impacts on both self-reported and objectively assessed smoking, the study provides a test of the extent to which implementation intentions produce similar impacts on objective measures of health risk behaviors as they do for self-report measures. Finally, by controlling for various known determinants of smoking initiation (i.e., sex, baseline attitude toward smoking, friends smoking, and family smoking) the present study provides a stronger test than previous studies of the effects of implementation intentions on smoking in adolescents.

Method

Study Design

Classes of adolescent schoolchildren were randomly allocated at baseline by the second researcher to one of four conditions: implementation intentions intervention, self-efficacy intervention, control Condition 1, control Condition 2. The researchers were not blinded to condition. Within each condition adolescents completed questionnaires, the relevant intervention materials, and read antismoking material. Details of the questionnaire are provided below (*Measures* section). The implementation intention intervention (Higgins, 2002) involved the task of forming an implementation intention: planning how, where, and when to resist smoking. The intervention was designed to give adolescents simple responses for how to refuse a cigarette. It was also designed to link this simple response to likely situations where a cigarette might be offered. Five options were provided for *how* they could refuse the offer of a cigarette or resist the temptation to smoke ('No thanks, I don't want to smoke; No thanks, I don't want the habit; No cancer sticks for me; No thanks, smoking makes you smell bad; No, it's bad for your health'). Participants were required to check the options they planned to use or to write in an additional response. Similarly participants were required to check *where* they would not smoke ('I will not smoke at school; I will not smoke at home; I will not smoke at a party; I will not smoke with my friends; I will not smoke if offered a cigarette') and *when* they would not smoke ('I think I can make sure I don't smoke this term') and to sign their plan.

The self-efficacy intervention (Higgins, 2002) involved the task of planning what to say to refuse to smoke in increasingly difficult situations. Participants first read the statement, 'You can refuse to smoke this term!' They were then presented with six statements each containing spaces for the participant to write in what they could easily say in that situation ('I can say _____ to smoking, even at school'; 'I can say _____ to smoking, even if I'm offered a cigarette'; 'I can say _____ to smoking, even if my friends want me to smoke'; 'I can say _____ to smoking, even if I'm the only one in the group not smoking'; 'I can say _____ to smoking, even if I feel left out of the group'; 'I can say _____ to smoking, even if I feel like smoking'). After completing these statements participants were asked to sign it if they thought they could say no to smoking that term.

Control Condition 1 required participants to form an implementation intention for when, where, and how to complete all their schoolwork (again by checking boxes to indicate how, where, and when and signing the sheet). Control Condition 2 required participants to complete a series of self-efficacy statements about how they might complete all their schoolwork that term despite various barriers (e.g., feeling like giving up) and sign the sheet.

Participants in *all* conditions read information against smoking and committed to not smoking (i.e., an active control). This information was designed to persuade the children not to smoke by emphasizing mainly the short term detrimental effects of smoking (cp. Evans, Dratt, Raines, & Rosenberg, 1978). Under the heading "Smoking stinks" participants were provided with 10 reasons why starting to smoke was a bad idea (e.g., 'Smokers smell! The smoke gets in your hair, your clothes, and it clings to you! At first you might notice the stench, but soon you are used to it and you're the only one who doesn't notice the pong!'). Following this all participants committed to not smoking ("Now you've read the facts on smoking, to save yourself from the bad effects of smoking, will you make sure you don't smoke this term?" yes/no).

At 4, 8, 12, 16, 20, and 24 months postbaseline, participants again completed a questionnaire on smoking including the same smoking measure as used at baseline, completed the same intervention materials and read antismoking materials (the latter were slightly revised for each testing). At 48 months postbaseline participants again completed a questionnaire on smoking including a self-reported smoking measure. A randomly selected subset of participants present on the day of testing also completed an objective measure of smoking (see below). The objective measure of smoking was conducted by a research assistant blind to condition. On average participants were present on 6.2 of the 8 testing occasions. Those in control Condition 1 ($M = 6.53$, $SD = 1.55$) were present on significantly more testing occasions than those in the other 3 conditions ($M = 6.09$, $SD = 1.85$), $F(1, 1336) = 7.76$, $p < .01$. However, number of times participants were present did not influence measures of smoking at 48 months.

The study was given approval by the ethics committee of the Institute of Psychological Sciences, University of Leeds, U.K. This paper reports findings on the relationship between measures taken at the initial time point (baseline, month 0) plus intervention condition in predicting later smoking behavior at the last data collection point (i.e., self-reported and objective smoking at 48 months) after all the repeated implementation intentions had been completed. Higgins and Conner (submitted) report the effects of the same intervention before all repeated implementation intentions had been completed on smoking behavior at earlier time points (up to 24 months).

Study Population and Data Collection

Based on previous research (Higgins & Conner, 2003) we initially recruited a total of 20 schools with mixed ability classes from a single area (Local Education Authority) in northern England between September and October 1998. Within these schools a total of 65 classes participated. At the start of the study (baseline) participants were initially 11–12 years of age. This paper reports on smoking behavior when the same adolescents were 15–16 years of age, that is, 48 months postbaseline. At baseline there were 1,551 adolescents (792 boys; 759 girls) who agreed to participate. However, because of missing data the final sample consisted of 1,338 adolescents (668 boys, 670 girls) for the self-reported smoking measure and 305 adolescents (146 boys, 159 girls) for the objective smoking measure split between the four conditions. Figure 1 provides further details of the numbers participating at each testing point.

To examine the effects of dropout we compared our final sample ($N = 1{,}338$) for the self-reported smoking measure to those lost to follow-up ($N = 213$) on the baseline measures. Chi-square tests indicated no significant differences on sex, attitudes, friends smoking, or family smoking, χ^2s$(1) < 2.12$, ps $> .15$ (two-tailed). This confirmed that our final sample for the self-reported smoking analyses was not biased in relation to the initial sample. Similarly, in relation to our final sample for the objective measure of smoking we compared our final sample ($N = 305$) to those lost to follow-up ($N = 1{,}246$) on the baseline measures. Chi-square tests

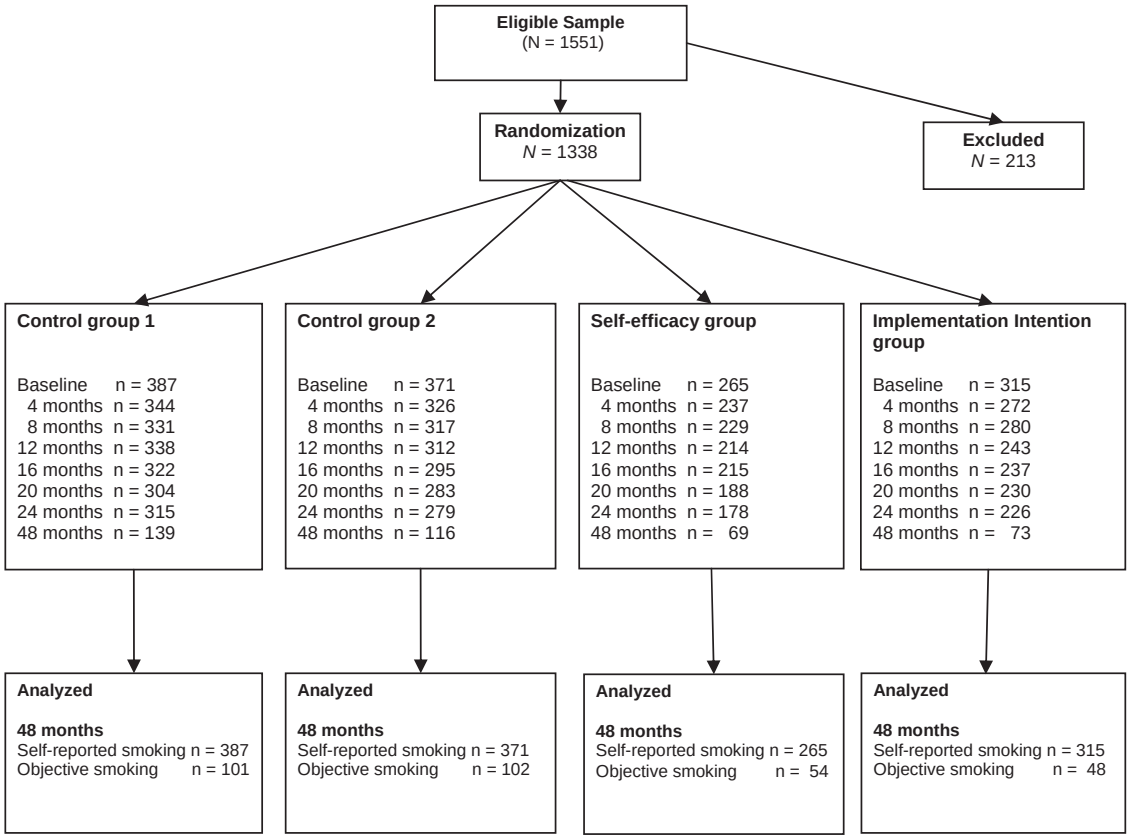

Figure 1. Randomization flowchart.

indicated no significant differences on sex or attitudes, χ^2s(1) < 3.10, *p*s > .08 (two-tailed). However, those who completed the objective measures had fewer smoking friends, $\chi^2(1) = 8.88$, $p < .01$, and fewer family members who smoked at baseline, $\chi^2(1) = 8.71$, $p < .01$. We return to these biases in the discussion.

Measures

The questionnaire at baseline measured the following variables along with a number of other measures not reported here: sex, attitude to smoking, friends smoking, family smoking, and self-reported smoking. At 48 months the questionnaire measured the following variables along with a number of other measures not reported here: self-reported smoking, objective smoking by breath carbon monoxide (48 months only). The smoking measures at 48 months were the primary outcome measures. Skewed measures were dichotomized before analysis. However, use of the nondichotomized data did not substantively change the findings.

Sex. Was a self-report measure (1 = male; 2 = female).

Attitude toward smoking (ATT). Was assessed as the mean of five items, each measured on 5-point scales ('How would it be for you if you smoked this term,' bad-good, harmful-beneficial, unpleasant-pleasant, unenjoyable-enjoyable, foolish-wise; all scored 1 to 5, with higher scores indicating more positive attitudes toward smoking; see Higgins, 2002). Cronbach's α was .81. Attitudes toward smoking were strongly skewed toward negative attitudes. A median split on this measure was therefore computed (0 = negative attitudes; 1 = positive attitudes) and this dichotomous measure used in subsequent analyses.

Friends smoking. This was assessed via a single item ('How many of your friends smoke?' none of them, only a few, half and half, most but not all, all of them; scored 1–5; see Higgins, 2002). Again, this measure was skewed toward no friends smoking. A median split on this measure was therefore computed (0 = none of them; 1 = other responses) and the dichotomous measure used in subsequent analyses.

Family smoking. This was assessed as the number of family members smoking ('Who smokes in your family? (cross all the people who smoke)'; followed by a list of 10 family members plus an opportunity to add additional family members; see Higgins, 2002). This measure was skewed. A median split on this measure was therefore computed (0 = none or one family member smoking; 1 = more than one family member smoking) and the dichotomous measure used in subsequent analyses.

Self-reported smoking behavior at baseline. This measure was adapted from Jarvis (1997); 'Cross one of the following: I have not smoked at all last term; I have only ever tried smoking once last term; I used to smoke sometimes last term, but I never smoke cigarettes now; I sometimes smoked cigarettes last term, but not as many as one a week; I usually smoked between one and six cigarettes a week last term; I usually smoked more than six cigarettes a week last term.' Responses were coded as zero if the first response was checked and 1 if any other response was

checked. This same measure was also used to measure smoking at months 4, 8, 12, 16, 20, and 24.

Self-reported smoking behavior at 48 months. This was also adapted from Jarvis (1997); 'Cross one of the following: I have never smoked; I have only ever tried smoking once; I used to smoke sometimes, but I never smoke cigarettes now; I sometimes smoke cigarettes now, but I don't smoke as many as one a week; I usually smoked between one and six cigarettes a week; I usually smoked more than six cigarettes a week.' Responses were coded as zero if any of the first three responses were checked and 1 if any other response was checked. This was used as our measure of smoking and showed good correspondence with our objective measure of smoking.

Objective measure of smoking at 48 months. The objective measure used a battery operated, portable carbon monoxide monitor (EC-50-Micro Smokerlyzer, Bedfont Scientific, Limited, Kent, England). This gives a measure of carbon monoxide in the breath in parts per million (ppm) accurate to within 2% based upon exhaling one breath into the device. Although a number of factors influence carbon monoxide in the breath, recent smoking should significantly elevate levels. Carbon monoxide has a half-life of 4 to 6 hours and is a major constituent of cigarette smoke that can be used as a reliable and valid measure of exposure to cigarette smoking (Stookey, Katz, Olson, Drook, & Cohen, 1987), comparable in accuracy to blood carboxyhaemoglobin levels (Jarvis, Tunstall-Pedoe, Feyerabend, Vesey, & Saloojee, 1987). The Bedfont EC-50 device has been demonstrated to give reliable and valid assessments of smoking status (Irving, Clark, Crombie, & Smith, 1988) and been used with adolescent samples (Zack, Belsita, Scher, Eissenberg, & Corrigal, 2001). Because of the skewed nature of this measure a median split was performed to create groups of nonsmokers ($N = 268$) and smokers ($N = 37$) and this dichotomous measure was used in all subsequent analyses.

Analyses

High attrition rates have been reported in implementation intention studies using self-report measures (e.g., Gratton, Povey, & Clark-Cater, 2007, reported a 66% drop out rate). However, only analyzing outcomes from participants who participate at all stages can introduce bias in randomized controlled trials (Dumville, Torgerson, & Hewitt, 2006). In particular, exclusion of participants lost to withdrawal or noncompliance limits the analyses leading to reduced generalizability and potential inflation of Type 1 errors (Fergusson, Aaron, Guyatt, & Herbert, 2002). This represents a particular problem in relation to studying smoking where smoking is related to absence from school and participation in any school-based smoking intervention. One way to guard against such biases is to compare participants according to the group to which they were allocated regardless of compliance or withdrawal (Fergusson et al., 2002). Such analyses treat nonresponders as nonchangers and is referred to as intention to treat (ITT) analyses. ITT is the gold standard for analyzing RCTs because it permits noncompliance and protocol deviations that are likely to be reflected in real-life applications of an intervention, hence yielding more realistic findings (Fergusson et al., 2002; Moher, Schulz, & Altman, 2001). ITT was the analysis method used in relation to testing the effects of implementation intentions on the self-reported smoking data reported here at 48 months postbaseline. Participants were assumed to remain in the same condition they were allocated to at baseline and to have received the same intervention at each of the first seven rounds of data collection (months 0, 4, 8, 12, 16, 20, and 24). For the self-reported smoking measures, where data was missing we carried forward the value from the most recent assessment when self-reported smoking had been recorded (from months 0, 4, 8, 12, 16, 20, or 24). This procedure assumes no change in self-reported smoking unless a change is reported. For the analyses of objective measures of smoking ITT was not possible because objective smoking was not assessed at baseline.

In our initial analyses we compared the four conditions on baseline measures and follow-up smoking rates using chi-square analysis (Table 1). Based on these analyses we collapsed the two control conditions and the self-efficacy condition to form one group to compare against the implementation intention condition in multivariate analyses.

In the multivariate analyses we used multilevel modeling using HLM6 (Raudenbush, Bryk, Cheong, & Congdon, 2004) to control for the fact that our data were grouped into a three level hierarchical structure. As our outcome variables (smoking at 48 months) were dichotomized we used logistic multilevel modeling (the Bernoulli model) and conducted our analyses separately for the two smoking measures. Our Level 1 variables were the baseline predictors (Table 2; β_{10} to β_{50}) and the outcome variables. Level 1 variables were not centered as they were dichotomized. Our Level 2 variable was classes and our Level 3 variable was schools. We dummy coded implementation intention condition (1 = implementation condition, 0 = other conditions) and included this as an uncentered Level 2 variable (Table 2; β_{01}). We report the population average model (Raudenbush et al., 2004) that controls for the effects of our Level 3 variable. For our baseline predictors and condition we report unstandardized coefficients along with standard errors and p values after controlling for Level 2 and 3 effects. In addition, we report odds ratios and 95% confidence intervals for the odds ratios as an index of effect size. We do not report R^2 values given the problems with such measures in relation to models other than random intercept models (Kreft & De Leeuw, 2006).

Results

Comparisons Across the Four Conditions

Table 1 shows the distribution of baseline and follow-up measures across the four conditions. Examination of the frequencies indicated few differences between the two control conditions and the self-efficacy condition on any of the baseline measures, χ^2s(2) < 4.05, ps $> .13$ (two-tailed), or follow-up smoking measures, χ^2s(2) < 1.58, ps $> .45$ (two-tailed). However, the implementation intention condition did significantly differ from the other three conditions combined on friends smoking, $\chi^2(1) = 19.51$, $p < .001$ (two-tailed), and follow-up self-reported smoking, $\chi^2(1) = 4.72$, $p < .05$ (two-tailed), and marginally significantly on baseline smoking, $\chi^2(1) = 3.33$, $p = .07$ (two-tailed), and follow-up objective smoking, $\chi^2(1) = 3.39$, $p = .07$ (two-tailed). Examination of these differences (see Table 1) indicated that baseline smoking (respectively, 6 and 3% for implementation intentions condition and the other three conditions combined) and friends smoking (54 vs. 40%) were higher in the implementation

Table 1
Descriptive Statistics for Key Study Variables Split by Condition (N = 1338)

	Condition							
	Control 1 (*N* = 387)		Control 2 (*N* = 371)		Self-efficacy (*N* = 265)		Implementation intention (*N* = 315)	
	n	%	*n*	%	*n*	%	*n*	%
Sex (males)	182	47.0	189	50.9	138	52.1	159	50.5
Baseline self-report smoking	14	3.6	13	3.5	8	3.0	18	5.7
Baseline positive attitude to smoking	119	30.7	122	32.9	94	35.5	110	34.9
Baseline friends smoking	166	42.9	134	36.1	111	41.9	171	54.3
Baseline family smoking	196	50.6	187	50.4	131	49.4	167	53.0
Self-report smoking (48 months)	118	30.5	128	34.5	90	34.0	83	26.3
Objective smoking (48 months)	13	12.9	14	13.7	8	14.8	2	4.2

Note. Sample size for objective smoking measure is 305 (*N*s = 101, 102, 54, and 48 for control 1, control 2, self-efficacy and implementation intention groups, respectively).

intention condition compared to the other conditions combined. In contrast, follow-up self-reported (26 vs. 33%) and objective (4 vs. 14%) smoking was lower in the implementation intention condition compared to the other conditions combined. There were no differences between the implementation intention condition and the other three conditions combined on sex, attitudes, or family smoking, χ^2s(1) $< .74$, *p*s $> .39$ (two-tailed). Based on these differences our subsequent multivariate analyses focused on testing the impact of the implementation intention condition compared to the other three conditions (control Condition 1, control Condition 2, self-efficacy condition) combined.

Multilevel Modeling Analyses

Table 2 reports the results of the multilevel analyses for the self-reported and objectively measured smoking at 48 months postbaseline. For the self-reported measure of smoking (Table 2, upper panel), the analysis indicated that after controlling for the multilevel nature of the data there were significant effects for past smoking, sex, attitude, friends smoking, family smoking, and condition. Greater self-reported smoking at 48 months was associated with being in the control condition and being female, and by past smoking, having more positive attitudes to smoking, and having more friends and family who smoked at baseline. Examination of the odds ratios indicated that being in the implementation intention condition reduced the chances of being a smoker at 48 months by 0.649 (95% confidence interval: 0.446 to 0.945). Using the translation suggested by Chinn (2000) this roughly equates to a small effect size (Cohen, 1992), $d_+ = .24$. Additional analyses indicated that condition remained significant when comparing the implementation intention condition against just the two control conditions (*Coefficient* = −0.468, *SE* = 0.187, $p < .05$) or just the self-efficacy condition (*Coefficient* = −0.524, *SE* = 0.234, $p < .05$).

Table 2
Multilevel Model To Predict Smoking at 48 Months

				Odds ratio	
	Symbol	Coefficient	*SE*	Estimate	95% CI
Self-reported smoking (*N* = 1338)					
Intercept	β_{00}	−2.511***	0.243		
Past smoking	β_{10}	1.245***	0.329	3.472***	1.821–6.620
Sex	β_{20}	0.722***	0.126	2.059***	1.609–2.635
Attitude	β_{30}	0.386**	0.134	1.470**	1.132–1.911
Friends smoking	β_{40}	0.568***	0.135	1.765***	1.355–2.298
Family smoking	β_{50}	0.486***	0.132	1.625***	1.254–2.105
Condition	β_{01}	−0.432*	0.188	0.649*	0.446–0.945
Objective smoking (*N* = 305)					
Intercept	β_{00}	−2.749**	0.672		
Past smoking	β_{10}	2.344*	1.025	10.42*	1.391–78.06
Sex	β_{20}	0.198	0.360	1.210	0.601–2.475
Attitude	β_{30}	−0.323	0.429	0.724	0.312–1.682
Friends smoking	β_{40}	1.061**	0.374	2.889**	1.387–6.018
Family smoking	β_{50}	0.456	0.373	1.578	0.759–3.282
Condition	β_{01}	−1.892*	0.821	0.151*	0.029–0.792

* $p < .01$. ** $p < .01$. *** $p < .001$.

For the objective measure of smoking (Table 2, lower panel), the analysis indicated that after controlling for the multilevel nature of the data there were significant effects for past smoking, friends smoking, and condition. Greater objectively assessed smoking at 48 months was associated with being in the control condition, and by past smoking, and having more friends who smoked at baseline. Examination of the odds ratios indicated that being in the implementation intention condition reduced the chances of being a smoker at 48 months by 0.151 (95% confidence interval 0.029 to 0.792). Using the translation suggested by Chinn (2000) this roughly equates to a large effect size (Cohen, 1992), $d_+ = 1.04$. Removal of the nonsignificant predictors did not substantively alter the effect for condition (*Coefficient* = −1.895, *SE* = 0.918, $p < .05$). Additional analyses again indicated that condition remained significant when comparing the implementation intention condition against just the two control conditions (*Coefficient* = −2.311, *SE* = 1.099, $p < .05$) and marginally significant when compared to just the self-efficacy condition (*Coefficient* = −1.849, *SE* = 1.040, $p < .10$).

Discussion

The present study tested the effects of forming implementation intentions about how to resist offers of cigarettes on subsequent smoking in a sample of adolescents. Intention to treat analyses on self-reported smoking showed that after controlling for baseline measures of smoking, sex, attitudes to smoking, friends smoking, family smoking, and the multilevel nature of the data that the implementation intervention group reported significantly lower levels of smoking at 48 months postbaseline. This effect was confirmed in objective measures of smoking. These findings demonstrate the power of implementation intentions in reducing smoking in a sample of adolescents over a time period (between the ages of 12 and 16 years) in which smoking initiation is prevalent. The effects suggest that repeatedly forming implementation intentions about how to refuse offers of cigarettes could be a simple but effective intervention to reduce smoking in adolescents. It adds to existing research showing the value of implementation intentions in relation to avoidance health goals in general (Sullivan & Rothman, 2008) and smoking in particular (Armitage, 2008).

There are a number of issues worth further comment in relation to the present research. First, in relation to testing the effects of implementation intentions on self-reported smoking we used ITT. ITT is used for analyzing RCTs because it permits noncompliance and protocol deviations likely to occur in real-life applications of an intervention, hence yielding more realistic findings (Fergusson et al., 2002; Moher et al., 2001). The conservatism of the ITT approach may partly explain the differences in the effect sizes for the self-reported and objective measures of smoking at 48 months. In the self-report data analyses, using ITT, the effect size was small ($d_+ = .24$; Cohen, 1992). In the objective data, not using ITT, this equated to a large effect size ($d_+ = 1.04$). It should be noted that the sample completing the objective smoking measure were biased compared to the overall sample in terms of baseline measures of friends or family who smoked (i.e., they reported higher numbers of friends and family smoking). Although these variables were controlled for in the analyses and there was no evidence of differences between conditions this could have influenced the effect size observed for the objective measure. While several studies have validated self-report measures of smoking against more objective measures (e.g., Klesges, Klesges, & Cigrang, 1992; Patrick et al., 1994; Petitti, Friedman, & Kahn, 1981) it is still reassuring to observe that the intervention had significant effects on both sets of measures. Gollwitzer and Sheeran (2006) in their review of the effects of implementation intentions reported no significant differences between studies reporting objective ($k = 58$, $d_+ = .67$) or self-report ($k = 36$, $d_+ = .65$) outcomes. The present data support the conclusions of Gollwitzer and Sheeran (2006) that the effects of implementation intentions are not smaller for objective compared to self-report behavior measures.

A second issue is that the present study evaluated the effects of implementation intentions on subsequent smoking behavior over a substantially longer period of time than previous studies. This is of importance in relation to smoking because the major health benefits are associated with significant delays in initiation of smoking (The Royal College of Physicians, 1992) and particularly with never smoking. The present findings support and extend the effects observed for implementation intentions on other health behaviors over time intervals as long as 6 months in several studies (e.g., Chapman & Armitage, 2010; Luszcznska, Scholz, & Sutton, 2007; Luszcznska, Tryburcy, & Schwarzer, 2007; Prestwich et al., 2005) and 1 year in a single study (Milne & Sheeran, 2002; see Sheeran et al., 2005, for details). Importantly, unlike previous longer-term tests of implementation intentions, the present study indicated effects for objective and self-reported behavior measures. The present findings also contrast with Koestner et al. (2008) who suggested that implementation intentions need to be supplemented with other interventions (e.g., targeting self-efficacy) to have long-term effects. However, the power of supplementing implementation intentions by also targeting variables such as self-efficacy in producing long-term change were not specifically tested here (for one such test see Wieber, Odenthal, & Gollwitzer, 2010). Two key differences between the current study and that of Koestner et al. (2008) are the use of repeated implementation intentions and motivational materials in the present study. The frequency with which repeated implementation intentions are formed may be a useful focus for future research, while the use of motivational materials has been shown to improve the effectiveness of implementation intentions (e.g., Prestwich, Lawton, & Conner, 2003). Indeed the effect size reported here for objective measures of smoking is larger than the average effect size ($d_+ = .59$) reported by Gollwitzer and Sheeran (2006) for health behaviors in general and is comparable to that reported by Armitage (Armitage, 2007, 2008; Armitage & Arden, 2008) in relation to smoking cessation.

A third issue was the fact that the implementation intention intervention was tested against an active rather than a passive control. De Vet (2007) has argued that many studies in this area confound the effects of forming the implementation intention with an instruction to change behavior (e.g., Orbell, Hodgkins, & Sheeran, 1997). Some studies that explicitly instruct both the control and intervention group to change have failed to find an effect of implementation intentions (e.g., Jackson et al., 2005). In the present study adolescents in all conditions committed to not smoking so that any effects of condition can be attributed solely to the formation of an implementation intention. In addition, all participants also read antismoking information at each time point (cp. Hafstad et al., 1997). This was designed to increase motivation to

not smoke. Although this aspect of the design did not vary across conditions the possibility remains that the effectiveness of the implementation intervention was attributable to being combined with such motivational information. Several studies have shown that implementation intentions are most effective when combined with motivational interventions (e.g., Milne & Sheeran, 2002; Prestwich, Ayres, & Lawton, 2008). Future research might specifically test the interaction of motivational and implementation intention interventions in relation to smoking in adolescents. It is also worth noting that the implementation intention condition was more effective in reducing smoking than a similar intervention that targeted smoking self-efficacy.

A fourth issue was the fact that known predictors of smoking measured at baseline were controlled for in the analyses. In particular, we controlled for baseline measures of smoking, sex, attitude to smoking, friends smoking, and family smoking. All these factors emerged as significant predictors of self-reported smoking at 48 months, while baseline smoking and friends smoking emerged as a significant predictor of objective smoking at 48 months supporting considerable previous research (e.g., Chassin et al., 1984; Jarvis, 1997; Royal College of Physicians, 1992). Controlling for such predictors of smoking provides more confidence in the observed effects of the intervention. This is also important because the intervention group were both more likely to report smoking and having more friends who smoked at baseline compared to the combined control group. Nevertheless, given the nature of the differences we might expect this bias to have worked against finding an effect for the intervention (i.e., greater smoking and number of friends smoking at baseline in the intervention condition should lead to more smoking in this group). Previous research has examined (goal) intentions to smoke as predictors of smoking (e.g., Chassin et al., 1984). Smoking intentions were assessed at baseline in the present study but are not reported here because they did not emerge as significant predictors of later smoking. Inclusion of such measures in the analyses did not substantively alter the reported findings.

A final aspect of the intervention used in the present research that could have implications for the findings was the fact that repeated implementation intentions were used. In particular we tested the effect of forming up to seven implementation intentions in relation to refusing offers of cigarettes. Previous work (Chapman & Armitage, 2010) has shown that repeating an implementation intention compared to forming one on a single occasion had impacts over a 6 month period (on self-reported fruit and vegetable consumption). The present study was not specifically designed to test the effects of the number of times the implementation instruction was repeated. On average our sample attended 6 out of 8 possible sessions. Exposure to larger number of opportunities to form implementation intentions was not associated with any change in self-reported or objective smoking. A total of 73% of our implementation intention group were present at 6 or more sessions, and 91% were present for at least 3 sessions. Future research might usefully explore the relative value of different numbers of repeated implementation intentions and their timing. An advantage of the current approach was in ensuring that a high percentage of participants repeatedly formed implementation intentions despite adolescents being absent on any one day of testing. A number of factors might influence when repeatedly formed implementation intention effects persist over time. As Sheeran et al. (2005) point out specifying the right cues and responses as well as the strength of the cue-response association are likely to be key factors. Other authors have noted that memory decay for the implementation intention may reduce the long-term effects on behavior change (Koestner et al., 2006). Repeatedly forming the implementation intentions may represent one way to tackle this latter issue. Future research might usefully further explore the factors explaining the extent to which repeated implementation intention effects persist over time.

Conclusions

In summary, the present study found that forming repeated implementation intentions about how to refuse offers of a cigarette between the ages of 12 and 14 years significantly reduced smoking in adolescents aged 15–16. This demonstrates the long-term effects of implementation intentions in relation to smoking. The use of this intervention technique could represent a simple, cost-effective way in which to reduce smoking in adolescents and contribute to reducing smoking related harm.

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