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How Well Does The Index Of Receptivity To Tobacco Industry Promotion Discriminate Between Smoking And Never Smoking Adolescents?

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Abstract

Tobacco advertising is often named as the culprit that causes children to start smoking (Lancaster & Lancaster, 2003). This belief can partly be attributed to the Index of Receptivity to Tobacco Industry Promotion (IRTIP) developed by Evans, Farkas, Gilpin, Berry, & Pierce (1995). IRTIP was later modified and used by Pierce, Choi, Gilpin, Farkas, & Berry (1998) in a longitudinal study that claimed to have found a causal link between advertising and adolescent cigarette trial. The model is advertised by the American National Cancer Institute (2004) as being able to measure the likelihood of an adolescent starting smoking. Because of Pierce's causality claim and this endorsement, IRTIP has been widely adopted by tobacco-control researchers. Consequently, the results from IRTIP based surveys have played a central role in influencing tobacco control policy. Based on the logic that a model used to predict the chances of a non-smoker becoming a smoker should be able to distinguish between these two groups, discriminant analysis with dummy coded variables was used to validate IRTIP. The results show that while IRTIP classifies never-smokers well, it grossly misclassifies smokers. This leads to questions about the validity of the model and of studies using IRTIP.

Keywords: adolescent, smoking, tobacco industry promotion, validation

Introduction

In the 1998 Pierce et al. published an article called "*Tobacco Industry Promotion of Cigarettes and Adolescent Smoking*" in the *Journal of the American Medical Association*. This article made a claim that cigarette advertising and promotion causes adolescents to start smoking. In the same article, Pierce also put forth the thesis that family and peers were co-contributing causal agents, but later discounted these influencers. To our knowledge, this is the first (and only) such claim of advertising directly leading to behavior. This causality claim resulted from using the Index of Receptivity to Tobacco Industry Promotion (IRTIP) predict the likelihood of an adolescent trialing cigarettes. These predictions were then used to classify the adolescents into different categories of increasing susceptibility to smoke.

IRTIP has been used in tobacco studies from Norway (Wakefield & Chaloupka, 2000) to the United States. In fact, a quick search of the ISI Web Knowledge (Web of Science) in March 2005 revealed that the Evans et al. (1995) article has been cited by 302 scholarly works, and the Pierce et al. (1998) article was referenced by 341 authors. This suggests that the findings and methods of both articles form an important part of anti tobacco marketing studies. Validation of this model is important because IRTIP drives much of our understanding into why adolescents start smoking, it directly affects how countries formulate their tobacco control policies; these policies then determine how tobacco control strategies are operationalized and how budgets are allocated.

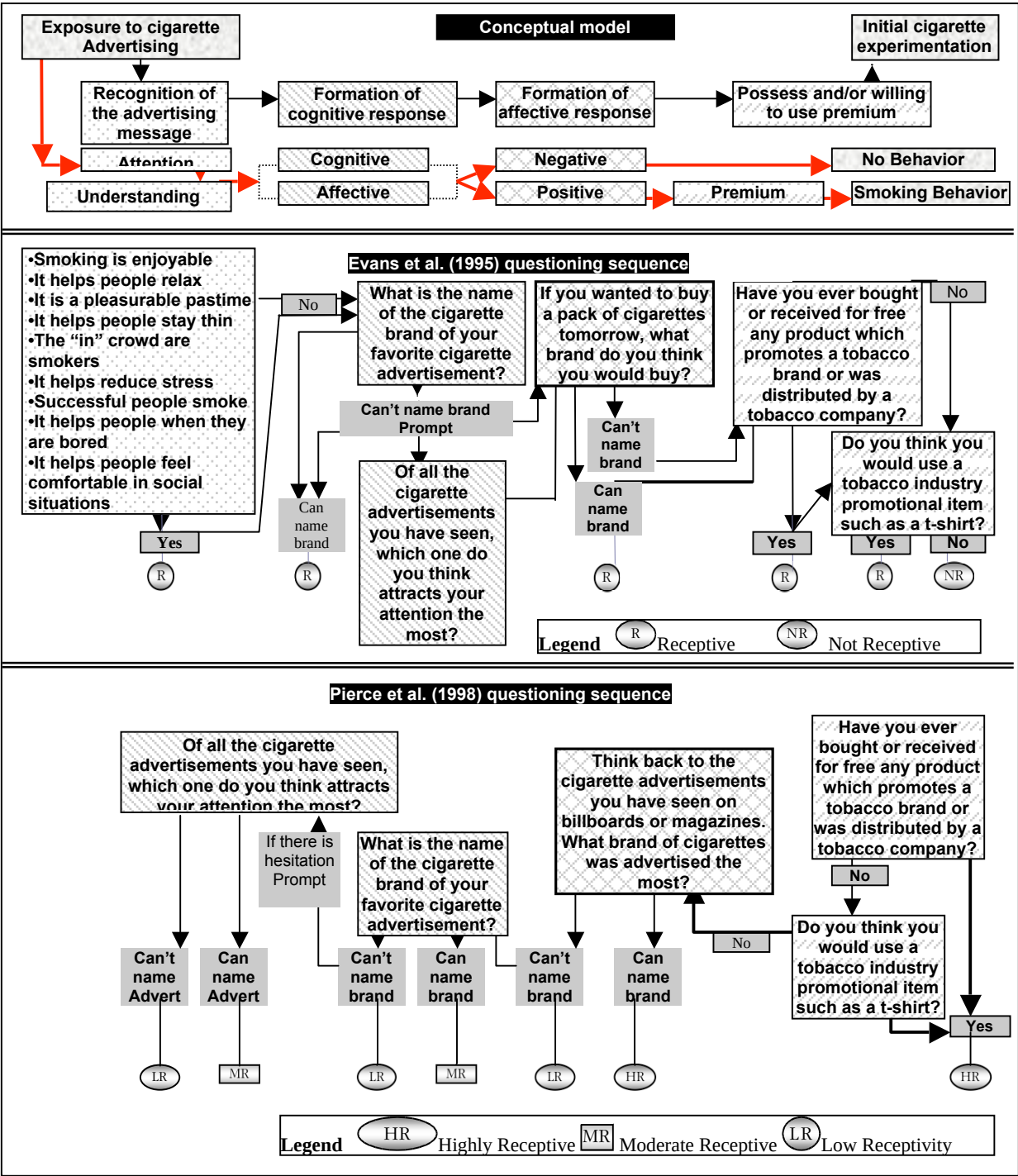
The logic behind our validation is: for a model whose purpose is to predict the likelihood of a never-smoker becoming a smoker, it should have the basic ability to distinguish between these two classes. If A is to become B, then this measure should be able to correctly identify and classify both conditions. A review of tobacco-control literature has yielded no such test on this

model. Implications from this validation affect the claimed link between advertising and smoking. If the model is not valid, then the claim may be based on shaky research.

Evans et al (1995)

IRTIP is based loosely on the AIDA framework (Attention, Interest, Desire, and Action). Evans et al. designed IRTIP to measure “the relative influence of tobacco marketing and exposure to other smokers on the susceptibility to take up smoking” (1995, p.1538). They believe that adolescents do not just suddenly start smoking, but are influenced by cigarette advertising and escalate through a series of steps that result in trying their first cigarette (see Figure 1).

Figure 1: Evans et al. and Pierce et al. receptivity conceptual model and questioning sequence



Evans et al. state that the main purpose of this model is to catalog “*the process of becoming a smoker [specifically to] identify a state prior to experimenting with cigarettes*” (1995, p. 1539) (emphasis added). If we refer to Figure 1, Evans et al. proposes that exposure to advertising will build up desire to smoke in an adolescent. This desire cumulates in the willingness to use or own a tobacco premium, with the premium functioning as the ultimate device that pushes them to start smoking.

In order to “*ascertain whether adolescents cognitively attend to and interpret the messages communicated by tobacco advertising*” Evans et al. (1995, p. 1539) devised a measure for the **attention** adolescents paid to tobacco advertising. They were asked if they agreed with any of the following statements: *Smoking is enjoyable, It helps people relax, It is a pleasurable pastime, It helps people stay thin, The “in” crowd are smokers, It helps reduce stress, Successful people smoke, It helps people when they are bored, It helps people feel comfortable in social situations.* Those who provided affirmative answers were seen as exhibiting “a basic level of cognitive awareness to tobacco advertising” (p. 1539).

Following this, in order to measure the adolescent’s **interest** in cigarette advertising, they were asked “*What is the name of the cigarette brand of your favorite cigarette advertisement?*” Those who were unable or unwilling to answer this question were prompted with “*Of all the advertisements you have seen, which you think attracts your attention the most?*” Those able to name a brand of cigarettes were classified as being receptive to the notion of smoking.

To test for **desire**, adolescents were asked “*If you were to buy a pack of cigarettes tomorrow, what brand do you think you would buy*” Respondents were seen as receptive if they were able to name a brand. **Action** was measured by: “*Have you ever bought or received for free any product which promotes a tobacco brand or was distributed by a tobacco company?*”, and “*Do you think that you would use a tobacco industry promotional item such as a t-shirt?*” Owning and-or willingness to use a premium signaled receptivity and susceptibility to the tobacco advertising.

The affirmative answers that were provided were added up to form an index. This index contained levels ranging from 0 for all to 4+, with higher levels of the index indicating that the adolescent was more likely to start smoking (Evans et al., 1995, p.1544).

Pierce et al. (1998)

Pierce et al. (1998) modified IRTIP by eliminating the nine statements used to measure **attention** (see Figure 1). These were replaced with: “*Think back to the cigarette advertisements that you have recently seen on billboards or in magazines. What brand of cigarettes was advertised the most?*” (**Attention**), “*What is the name of the brand of your favorite advertisement?*” (**Interest**), “*Of all the cigarette advertisements you have seen, which do you think attracts your attention the most?*” (**Interest**), “*Some tobacco companies provide promotional items to the public that you can buy or receive for free. Have you ever bought or received for free any product which promotes a tobacco brand or was distributed by a tobacco company?*” (**Action**), and “*Do you think that you will ever use a tobacco industry promotional item such as a t-shirt?*” (**Action**).

The measurement index was changed from the 0 to 4+ classifications used by Evans et al. (1995) to a categorical classification scheme with the names *Minimally Receptive, Moderately Receptive, Receptive, and Highly Receptive* (Pierce et al., 1998). The category of “not

receptive” contained in the original Evans et al. (1995) study was omitted and replaced with the *Minimally Receptive* category in the Pierce et al. (1998) treatment.

Respondents to this questionnaire were tracked through a three year study of which part of the baseline results were reported in Evans et al. (1995). It was with these results that Pierce et al. (1998) made the claim of a causal link between cigarette advertising and adolescent smoking. The refined IRTIP was then, and still is promoted as *the* measure for predicting adolescent cigarette experimentation (National Cancer Institute, 2004).

Validation of the Index of Receptivity to Tobacco Industry Promotion

This paper forms the third in a series of studies replicating and validating IRTIP. We present a brief synopsis of two previous validation studies; this paper forms the third link in this validation process. Using the same data and sample used in the Pierce et al. (1998) study, Lee, Mizerski & Mizerski (2004) performed a replication of Pierce et al.’s study.

In this study, Pierce et al. reported on a table (p. 513) containing the percentages and probabilities of adolescents who had never smoked before progressing along a scale of increased susceptibility to smoke. Lee et al. discovered that Pierce et al. had classified any response other than a “definitely not” answer (these included *missing*, *refused*, and *don’t know* answers) as a “yes” answer. By treating the responses in the normal way, i.e. missing was assigned to missing, and refused and don’t know were treated as non-yes responses, Lee et al. (2004) found that a much lower percentage of the adolescents had progressed along the scale.

Space does not permit extended comment on the methodology used in Pierce et al. (1998) (see Lee et al. (2004)). It suffices to indicate that for most people, perhaps more so for 12-17 year olds, it would be very difficult to definitively rule out some possible future behavior. Perhaps certain groups of adolescent non-smokers are more likely to answer “don’t know” or “maybe” if they were faced with the question of whether they were likely to try a cigarette sometime in their life.

Using the same data and sample used by Pierce et al. (1998) and Evans et al. (1995), Lee, Mizerski, Mizerski & Lam (2005) used factor analysis to analyze the dimensionality and stability of IRTIP through longitudinal tracking data. They found that the model did not yield consistent dimensions over time, even when tracking the same respondents. The way that the adolescents thought about the questions asked in IRTIP also differed greatly from the way Pierce et al. and Evans et al. operationalized the model. This suggests that IRTIP is a poor measure for how adolescents actually thought about cigarette advertising and promotion.

Given that other studies have found different reasons for why adolescents start smoking, it is even more important to ascertain the validity of the claim that cigarette advertising and promotion is the sole cause for adolescent smoking initiation (Pierce et al., 1998). Some of the other reasons proposed include genetically determined testosterone levels (Bauman, Foshee, & Haley, 1992; Dai, Gutai, Kuller, & Cauley, 1988; Kendel & Udry, 1999; Martin et al., 2001), doing poorly in school (Albers & Biener 2003), peer and parental smoking, depression (Vogel, Hurford, Smith, & Cole, 2003, and liking of risky activities (Flint, Yamada, & Novotny; Lando et al., 1999).

Methodology

Multiple Discriminant Analysis (MDA) was used to determine the ability of IRTIP to predict, distinguish, and correctly assign smokers and never smokers to their respective categories. Because MDA uses of a linear combination of two or more independent variables to predict a single dependent variable, it is somewhat similar to multiple regression. MDA is suited for our purposes because it is often used to predict group membership, and to identify the most useful variables in discriminating between groups (Hair, Anderson, Tatham, & Black, 1998). Data came from the California Tobacco Studies (CTS 1993-1996 teen extended interview datasets) which is a publicly available dataset. This is the same dataset used by Evans et al. and Pierce et al. in developing the IRTIP model. Due to MDA's well documented sensitivity to unequal sample size (a function of the number of independent variables used), we randomly sampled the data to obtain roughly equal numbers of smokers and never smokers (Hair et al., 1998, p. 258). This resulted in estimation (95 model n=2123; 98 model n=1585) and holdout samples (95 model n=2129; 98 model n=1577). The minimum ratio of 20 observations for each predictor variable was met (Hair et al., 1998, p.258). We realize that this is a very large sample for the number of variables contained in IRTIP, however, we thought it better to err on the side of caution and have higher chance of misclassification with the use of a larger sample. As our main objective is to determine the discriminating abilities of the entire set of measures, the variables were entered into the model simultaneously. For ease of interpretation, the results have been split into the Evans et al. and Pierce et al. models.

Results and discussion

The F-statistic, which can be used to determine statistically significant group differences returned values of 0.88 ($p < 0.00$, $df = 14$) for the 95 model and 0.94 ($p < 0.00$, $df = 4$) for the 98 model, suggesting that the groups discriminate within the models (this is good). However, due to the large group sizes involved, and MDA's well documented sensitivity of giving false positive results with large sample sizes, further analysis of the discriminant functions was undertaken. Looking at Table 1, most of the differences between the group means of the significant predictor variables are small, denoting not much difference between the groups. This suggests that the significance found may be an effect of the large sample size.

Table 1: Discriminant analysis results for Evans et al 1995 and Pierce et al. 1998 models

		Group means			Standardized discriminant functions
		F-Ratio	Smoker	Never smoker	
1995 Evans et al. Model					
	Promoted enjoyment	2.36	.84	.86	-.16
	Promoted relaxation	.31	.77	.76	.09
	Social situation	.45	.79	.77	.09
	Leisurely time	2.13	.80	.79	.02
	Stay slim	12.49*	.41	.49	-.18
	Reduce stress	2.371	.77	.74	.11
	Reduce boredom	.53	.58	.57	.08
	Be part of in crowd	3.96**	.70	.74	-.11
	Successful people smoke	4.16**	.59	.64	-.05
	Promoted Others	.47	.27	.25	.07
	Favorite cigarette ad	48.03*	.85	.71	.32
	What brand do you think you would buy	.05	.51	.51	-.11
	Received a promotional item	83.09*	.20	.07	.37
	Would you use a promotional item	185.01	.44	.18	.70
	Canonical discriminant functions (centroids)		.52	-.25	
1998 Pierce et al model					
	Cigarette brand most advertised	2.05	.98	.97	.10
	Favorite cigarette brand	36.81*	.82	.68	.51
	Received a promotional item	30.95*	.16	.07	.41
	Would you use a promotional item	54.95*	.35	.18	.60
	Canonical discriminant functions (centroids)		.37	-.17	

Further inspection of the standardized discriminant functions reveals extremely weak loadings of below 0.37 with the exception of “*would you use a cigarette premium*” (95 model=0.70, 98 model=0.60). These loadings are interpreted much like factor loadings, where the loading is squared to obtain its explanation power. Hair et al. (1998) suggests that only loadings of above 0.70 be considered worthy of attention. Only one loading that meets this criterion, “*would you use a tobacco premium question*” in the 1995 model. At this point, it appears that the models do not discriminate well between smokers and non-smokers. Validation is continued with construction of classification matrices (Table 2). These matrices provide an assessment of the function’s discriminant ability by revealing the proportion of units that were (in)correctly classified.

Table 2: Results of classification matrix Predicted group membership

Actual group		N of cases	Smoker n(%)	Never smoker n(%)
95 estimation sample	Smoker	689	252 (36.6%)	437 (63.4%)
	Never smoker	1434	156 (10.9%)	1287 (89.1%)
95 holdout sample	Smoker	710	174 (24.5%)	536 (75.5%)
	Never smoker	1419	149 (10.5%)	1270 (75.5%)
Hit ratios 1995 percentage of “grouped” cases correctly classified in estimation sample: 72.49% [(252+1287)/2123= 0.7249] 1995 percentage of “grouped” cases correctly classified in holdout sample: 67.82% [(174+1270)/2129= 0.6782]				
98 estimation sample	Smoker	500	45 (9%)	455 (91%)
	Never smoker	1085	28 (2.6%)	1057 (97.4%)
98 holdout sample	Smoker	501	63 (12.6%)	438 (87.4%)
	Never smoker	1076	36 (3.3%)	1040 (96.7%)
Hit ratios 1998 percentage of “grouped” cases correctly classified in estimation sample: 69.52% [(45+1057)/1585= 0.6952] 1998 percentage of “grouped” cases correctly classified in holdout sample: 69.94% [(63+1040)/1577= 0.6994]				

The results reveal that the 95 and 98 models grossly misclassifies smokers, with the 95 model only correctly classifying 36.6 percent of smokers and the 98 model only nine percent. This misclassification adds evidence to our earlier observation of IRTIP’s lack of discrimination between the groups.

Hair et al. (1998) suggests that the classification accuracy should be better than chance alone and suggests the calculation of hit ratios (Table 2). The hit ratios (HR) for 95 were 72.49% (estimation) and 67.82% (holdout). Hit ratios for 98 were 69.52% (estimation) and 69.94% (holdout). The hit ratios are substantially lower than the maximum chance criterion of 75.70% and 82.01% respectively. This suggests that the model does not discriminate. The maximum chance criterion is where the hit ratio is compared with the proportion of the biggest group plus a threshold value of 25 percent (1995 HR 72.49% < 75.77%; 1998 HR 69.52% < 82.01%). As the final fit measure, the C proportional chance criterion (CPro) is calculated. This measure is suitable in our case as there are different group sizes (Hair et al., 1998). The value of CPro is compared to the hit ratio (HR) plus 25% of the holdout sample to reduce upward bias of the estimation. If the HR exceeds the CPro value, then there is good fit (Hair et al., 1998, p.269). CPro values for the 95 model (HR 72.49% > 69.43% CPro) and 98 model (HR 69.52% < 70.68% CPro) both indicate poor fit.

Given the negative results from the fit tests, it appears that the IRTIP model fails to discriminate between smokers and never smokers. It classifies never smokers well, but misclassifies smokers. This finding is troublesome as the main reason for employing IRTIP is to predict the progression of never smokers to becoming smokers. If the model is unable to correctly distinguish between smokers and non-smokers, then it is questionable in its ability to track their

progress along the “smoking uptake continuum” (Pierce et al, 1998, p. 513) and its usefulness in predicting smoking behavior.

Conclusion

This paper set out to test the ability of the Index of Receptivity to Tobacco Industry Promotion (IRTIP) to discriminate between adolescent smoker and never smoker cohorts. It is important to validate and verify this model because of IRTIP’s wide adoption by the tobacco control community as a measure of the effect of advertising on smoking behavior.

This paper finds that the model does not discriminate between smokers and non-smokers. This raises questions about the validity of IRTIP as a tool to measure adolescent receptivity to tobacco marketing efforts. It also calls into question its validity as a predictor for adolescent smoking behavior. This leads us to question Pierce et al.’s (1998) claim about the causal relationship between tobacco promotional activities and adolescent smoking. Our contribution to the ever evolving pool of academic knowledge is that this model is faulty and one dimensional. We stress here that we do not promote smoking, nor dispute that advertising and promotion could act as one of the contributory factors to adolescents starting to smoke. However, it appears IRTIP could not validly measure increased susceptibility to smoke in an adolescent due to its inability to distinguish between smokers and non-smokers in the first place. Without this ability to correctly place an adolescent in the right group, it is doubtful if it is able to correctly measure an adolescent’s place in the steps between.

Because of this faulty model and its resulting findings that were used to drive tobacco control policy, some tobacco control advocates could be barking up the wrong tree by continuing to blame advertising as the cause of adolescent cigarette trial. Empirical evidence of the limited and short lived effects of tobacco advertising bans are the relatively stable smoking rates in countries where tobacco advertising has since been banned (depending on who you ask). If advertising were the sole cause of smoking trial, then a whole generation of children would have grown up without witnessing cigarette advertising media, and should logically not have started to smoke. More importantly, with the additional anti-tobacco advertising re-enforcing that smoking is harmful, they should be extremely anti-smoking. Sadly, they are still experimenting with cigarettes. It is also highly unlikely that current smokers are consuming more cigarettes, therefore keeping the smoking rates up, so the pool of smokers must be replenished from the younger generation.

Without trying to sound like a broken record, there is ample evidence out there that other factors such as socialization by parents and peers, as well as personality factors that are equally, if not more salient than smoking. Perhaps it is time that we look at these factors and try to find ways to address them rather than continuing to heap the blame on advertising.

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