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Extreme Response Bias in Measuring Susceptibility to Smoking

Alvin Y.C. Lee, Richard W Mizerski, The University of Western Australia

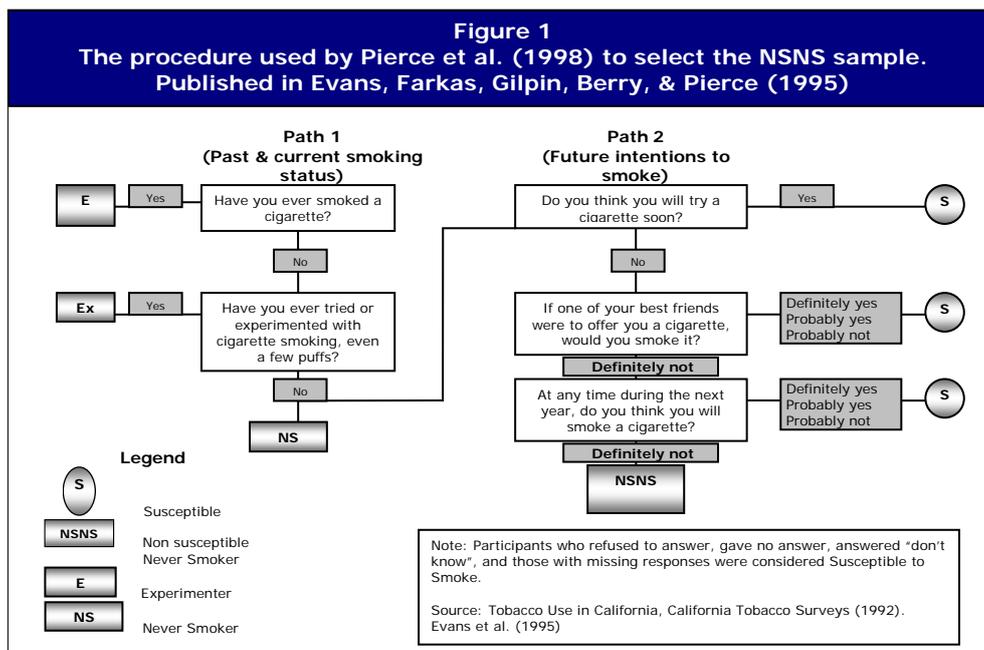
Abstract

Pierce, Choi, Gilpin, Farkas, and Berry (1998) were the first to claim that they could provide causal evidence that tobacco industry advertising and promotion caused adolescent smoking. This claim continues to significantly influence the theory and conceptualization of how youth react to tobacco marketing. The Pierce et al. (1998) methodology has been used by many researchers to establish the influence of tobacco marketing on adolescent smoking (Goldberg, 2003; NCI, 2006; Sargent, Dalton, & Beach, 2000). Pierce et al. (1998) selected respondents for only the second of their two survey longitudinal study because they chose the extreme-negative response. This choice could be the result of the tendency of some significant number of sample members exhibiting extreme-response bias. The results from an analysis of several questions from the original data used by Pierce et al. (1998) has suggested that there is a significant extreme-response style pattern in the Pierce et al. data. This unaccounted for bias in the responses of their sample was due to the procedure used by Pierce et al. (1998) in the selection of their respondents. The Pierce et al. (1998) sample selection procedure requires more research before the causal link can be claimed.

Key words: extreme response bias, tobacco, adolescent smoking trial, sampling procedure

How Pierce et al. Selected their Sample

Pierce et al. (1998) selected their sample of Non-Susceptible Never-Smokers (NSNS) by asking five questions to determine their smoking status and their future intentions to smoke. These questions are depicted in Figure 1.



Two questions were used to distinguish never-smokers from smokers. These questions from Path 1 (Figure 1) asked “*Have you ever smoked a cigarette?*” and “*Have you experimented with cigarette smoking, even a few puffs?*” Adolescents who answered “NO” to both questions were considered to have never smoked cigarettes before (never-smokers).

Path 2 (Figure 1) asked adolescents who were classified as never-smokers about their future intentions to smoke. The three questions from Path 2 of Figure 1 were used to determine if the respondent was susceptible to smoking. The questions were “*Do you think you will try a cigarette soon?*”, “*If one of your best friends were to offer you a cigarette, would you smoke it?*”, and “*At any time during the next year do you think you will smoke a cigarette?*” An adolescent who answered “NO” or “Definitely Not” to **all** of the Path-2 questions was considered as a Non-Susceptible Never Smoker (NSNS). NSNS adolescents were chosen by Pierce et al. (1998) for a longitudinal study about the effects of tobacco advertising and promotion on smoking. Interviews for this longitudinal study were carried out in 1993 and in 1996. The data from these two interviews was used to establish the claim that tobacco advertising and promotional efforts caused smoking trial (Pierce et al., 1998).

Extreme Response Bias

The sample selection procedure employed by Pierce et al. (1998) could have given rise to the possibility that a significant proportion of NSNS sample members’ responses would suffer from extremity response bias. Gruber & Lehmann (1983) have cautioned that extremity bias will distort the results of analyses using regression techniques. Pierce et al. (1998) used logistic regression to support their causal claim that advertising causes smoking.

Extreme response bias (ERB) will also adversely affect the results of studies that use response patterns for segmentation (Greenleaf, 1992). Pierce et al. (1998) used only respondents who provided extreme negative responses in the second survey of the two survey study. This is a form of segmentation by choosing only adolescents who could definitively rule ever smoking in the future. If there is extreme response bias in the Pierce et al. sample, then the causal claim by Pierce et al. (1998) could be inaccurate because it is based on distorted data.

Yea and nay saying and ERB are the two main types of response bias. This is where a respondent exhibits polarized response patterns. Respondents exhibiting these types of biases are likely to exhibit the same biased response pattern across the whole range of questions in a survey (Bachman & O'Malley, 1984; Hui & Triandis, 1985; Merrens, 1970). Of course, there is the possibility that respondents who respond to the extreme of answer categories are accurately reporting a strongly felt opinion. However, Greenleaf (1992) showed that if a respondent exhibits the same pattern of extreme responses throughout a survey, then they are unlikely to be reporting a strongly felt opinion, but suffer from extreme response style bias.

Yea and nay saying is also known as acquiescence bias (Couch & Kenniston, 1960). Yea-saying is where the respondent wishes to please the interviewer, or be seen as being socially desirable. The respondent provides a socially popular answer, or an answer which they perceive as being one that the interviewer wishes to receive.

Nay-saying is the opposite of Yea-Saying. This is where the respondent provides answers which they think would be the opposite of what the interviewer wants, or which may not be socially popular. Respondents suffering from yea or nay saying will often exhibit a pattern of responses which are either consistently positive, or consistently negative, but do not need to

be to the extremes of the categories. Yea or nay saying can be detected through the use of the means for responses across a range of variables in a survey.

Extreme response bias (ERB) is a condition where respondents provide consistently extreme responses (Greenleaf, 1992; Hair, Anderson, Tatham, & Black, 1998; Zikmund & Babin, 2007). ERB is closely associated with standard deviation bias. ERB is when respondents answer with only to the extremities of an answer scale. Standard deviation bias is a situation where respondents consistently show high standard deviations in their answers, but may not favor the extremities of the answer scales. ERB and standard deviation bias sufferers tend to exhibit high standard deviations or variance (range) in their responses.

This article reports the findings of an investigation of the possible existence of ERB in the Pierce et al. (1998) sample. While it is unreasonable to expect all of the respondents in this sample to exhibit ERB, there could be a significant proportion of respondents who exhibit ERB due to the sample selection procedure used by Pierce et al. (1998) to establish the cohort of their study.

Methodology

The data used for this article was the same data used by Pierce et al. (1998) to report their causal claim. This data formed part of the 1993 Youth Survey of the California Tobacco Study (California Department of Health Services, 2006). The California Tobacco Study consists of a series of tobacco use surveys carried out between 1991 and 2003. All analyses for this article were performed using SAS 8.2, an updated version the same software used by Pierce et al. (1998) for their analyses.

Three mutually exclusive sub-samples of respondents were established according to the classification method used by Pierce et al. (1998). These represented three types of respondents: Smokers (n=1000), NSNS – Non-Susceptible Never-Smokers (n=1000), and SNS –Susceptible Never Smokers (n=68). The response patterns for these three groups were compared for evidence of the existence of extremity bias.

A list of questions was drawn from the 1993 Youth Survey for testing. These questions were selected from different areas of the survey. If any of the three test groups exhibited response bias, the response style patterns were likely to be prevalent throughout the survey, and were likely to be present in sections about different topics.

The test questions that were selected had to meet three criteria. These were, (1) the questions must not have been originally used by Pierce et al. (1998) to select respondents for segmentation into the NSNS cohort. (2) The questions must not ask about the respondent's views on their own smoking, and (3) the questions must have similar types of response scales (ordinal-type scales) as the questions used by Pierce et al. (1998) for their sample selection purposes. The questions which were selected for testing are depicted in Table 1.

Table 1: Variates selected for identification of response style artifacts

Question label	Question wording
OBJSMOK	How many people you know who are about your age, object to second hand smoke?
FRENAPPR	How do you think your best friends would feel about you smoking on a daily basis?
FRENCHW	How do you think your best friends would feel about you using chewing tobacco or snuff regularly?
SENRSMOK	How many high school seniors do you think smoke cigarettes?
NOFUTUR	During the last 12 months, how often have you felt hopeless about the future?
OCARE	Do you think people your age care about staying off cigarettes?

An ANOVA (Analysis of Variance), with a Bonferroni adjustment for multiple comparisons, was used to test for a main effect in the response patterns for the three test groups. The Bonferroni test was used to control for experiment wide Type 1 error (Hair et al., 1998).

ANOVA provides significance testing for the differences in the means of responses to individual test questions and compares them between the three test groups. This enables the identification of extreme response patterns by observing the differences in the variance, standard deviation, and mean values between the groups. Bartlett’s test for sphericity was used as a test for co-linearity among the test questions. A significant result in the Bartlett’s test indicates non-co-linearity, which is desirable situation in our case (Hair et al., 1998).

A non-hierarchical Correlation Measures Cluster analysis (with pre-specified groups) was then used to represent the “similarity by the correspondence of patterns across the characteristics” (Hair et al., 1998, p.484). Correlation Measures Cluster analysis inverts the respondent’s X variable matrix so that the columns represent the respondents and the rows represent the questions (hierarchical cluster analysis functions in the opposite manner). This results in identification of the pattern of responses for the test groups.

Results and Discussion

ANOVA – All of the test questions except for NOFUTUR reported a significant value for Bartlett’s test in the ANOVA (Table 2). This suggests that the test questions are empirically independent and represent different dimensions of the questionnaire (i.e. they are questions asking about different things).

Levene’s test for homoscedasticity was used to assess whether the variance of a test question was equal across the three test groups (Hair et al., 1998). A significant Levene’s indicates similarity in response styles. Levene’s was non- significant for all test questions except SENRSMOK. This suggests that response patterns were different between the three test groups.

From Table 2, Group 2 (NSNS) appear to exhibit a different response pattern from the other groups. The highlighted rows for Mean and Variance statistics help to visually highlight this pattern. Group 2 report higher variances for all test questions except FRENAPPR, suggesting more response variation when compared to Groups 1 and 3. The mean response values of Group 2 were also lower/higher than those of Groups 1 and 3 across all test questions, suggesting that there may be response style effects operating in Group 2. The lower/higher means also suggest that more Group 2 respondents gave more extreme answers.

Table 2: ANOVA to establish patterns in responses of different groups

Test Question and scale range	Sig. Diff. btw groups (Bonferroni) **p<0.05	Group number	Mean	Variance	Bartlett't (B) Levene (L)	F- Statistic using Welch's ANOVA
OBJSMOK 4 item scale (0-3)	1 – 2 **	1	1.49	1.32	B ≤ 0.05 L > 0.05	3.69 (p≤0.05)
		2	1.64	1.82		
		3	1.55	1.16		
FRENAPPR 3 item scale (1-3)	1 – 2 **	1	2.27	2.05	B ≤ 0.05 L > 0.05	14.6 (p≤0.05)
		2	1.99	1.42		
		3	2.28	0.26		
FRENCHEW 3 item scale (1-3)	1 – 2 **	1	2.18	0.83	B ≤ 0.05 L > 0.05	8.04 (p≤0.05)
		2	2.01	0.91		
		3	2.17	0.18		
SENRSMOK 4 item scale (0-3)	1 – 2 **	1	2.08	1.10	B ≤ 0.05 L ≤ 0.05	20.81 (p≤0.05)
	2 – 3 **	2	1.73	2.17		
		3	2.15	0.64		
NOFUTUR 4 item scale (1-4)	1 – 2 **	1	2.74	1.12	B > 0.05 L > 0.05	65.31 (p≤0.05)
	2 – 3 **	2	3.29	1.15		
		3	2.94	0.94		
OCARE 4 item scale	1 – 2 **	1	1.98	1.27	B ≤ 0.05 L > 0.05	13.78 (p≤0.05)
	2 – 3 **	2	1.64	1.83		
		3	2.33	0.53		

From the higher variance and more extreme mean values reported by ANOVA, it appears that significant numbers of Group 2 respondents consistently chose more extreme responses for all the questions tested. As the test questions were selected from different areas of the survey, the extreme response pattern may also be consistent for the entire 1993 Youth Survey. This finding, that there is evidence of an extreme response style bias in Group 2 responses suggests a significant proportion of these individuals were not merely indicating a strong opinion (Greenleaf, 1992), but exhibited a systematic response style bias for all questions in the questionnaire.

Cluster analysis - Preliminary screening for outliers was conducted for cluster analysis. Group 2 (NSNS) fit the profile of an outlier group. However, since the focus of this article is to ascertain if extreme response style bias operates in Group 2, this group is retained for the cluster model. As reported earlier, Bartlett's test indicated no multicollinearity among the test questions. This satisfies the requirements for cluster analysis (Hair et al., 1998).

The cluster model is statistically significant and differences were found between all three groups (Table 3). The clusters sizes were relatively similar (Group 1: n=403; Group 2: n=250; Group 3: n=383).

The standard deviation (SD) statistic in Cluster analysis measures the magnitude-of-diversity in response patterns (i.e. how big were the differences in the response styles between the groups). Groups 1 and 3 reported similar SD of 0.75 and 0.71 respectively, indicating that they have relatively similar response patterns. Group 2's SD was 1.64 (more than twice that of the other groups). This indicates that Group 2 has more variation, and a more diverse pattern of responses. From the SD statistic in Table 3, Group 2 provided more polarized responses when compared with Groups 1 and 3. This is an indication of extreme response bias.

Table 3: Results of cluster analysis for Smokers, Susceptible Never Smokers, and Non-Susceptible Never-Smokers

	Group 1 (Smokers)	Group 2 (NSNS)	Group 3 (SNS)
Frequency	367	250	383
Std Deviation	0.75	1.64	0.71
Max dist: seed to cluster	14.88	18.16	10.21
Dist btw centroids	2.05	2.27	2.05
Cluster means. Note: means with different patterns are highlighted: 4 point scale			
OBJSMOK	0.57	1.16	2.58
FRENAPPR	2.57	1.60	2.40
FRENCHEW	2.33	1.91	2.23
SENRSMOK	2.11	2.03	2.08
NOFUTUR	3.28	1.50	3.03
OCARE	2.12	1.50	2.10

Group 2 was also the farthest group from the point of origin of the cluster seed (Group 2=18.16; Group 1=14.88; Group 3=10.21; Table 3). This indicates that Group 2 exhibited a different response pattern. An examination of the distance between cluster centroids indicates that Group 2 at 2.27 is farther away than the other groups, and appears to be an outlier group. Group 1 (2.05) and Group 3 (2.05) were equidistant. When the distance from seed to cluster and the distance between cluster-centroids are mapped in Euclidian space, Group 2 appear to be the least similar group. Examination of the cluster means (highlighted) from Table 3 further indicate that Group 2 gave responses which were clustered more towards the extremities of the answer categories. This suggests that Group 2 gave markedly different responses when compared to Groups 1 and 3. The results also suggest that Group 2 respondents exhibit more extreme responses styles throughout the questionnaire.

Conclusion and limitations

The results suggest that Group 2, the second survey (NSNS) respondents, exhibit significantly different response patterns when compared to other groups of respondents from the 1993 Youth Survey. The cluster analysis confirms the findings from the ANOVA analysis that the Group 2 respondents tend to exhibit an ERB pattern in their choice of responses. Because the test questions were chosen from different areas of the survey, this finding suggests that the observed ERB bias may be a survey-wide problem. This observation suggests that it was unlikely that the NSNS respondents from Group 2 were voicing their opinion on the issue of their susceptibility to smoking, but were responding to questions throughout the questionnaire by selecting answer choices in the extremity of the answer categories.

Extreme response bias would be expected to seriously distort the results of the Pierce et al. (1998) analysis. This was because the Pierce et al. study exclusively relied on the responses of Group 2 NSNS respondents in the follow-up survey. These responses were used to determine the change in susceptibility to smoking in these NSNS respondents.

Other researchers adopting Pierce et al.'s method of determining susceptibility would also be expected to suffer from the same type of extreme response style bias. The Pierce et al. article has been "...cited scores of times in academic literature and introduced as evidence in Congressional testimony and in arguments before the Supreme Court" (Geweke & Donald, 2002). This calls into question the body of work that is based on the Pierce et al. (1998)

paradigm of adolescent movement toward smoking trial and use. Clearly, further research is needed in this important area.

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