ORIGINAL INVESTIGATION

Evidence of Telescoping in Regular Smoking Onset Age

Brianna C. Bright MA, Julia N. Soulakova PhD

*Department of Statistics, University of Nebraska-Lincoln, Lincoln, NE*Corresponding Author: Brianna C. Bright, MA, Department of Statistics, University of Nebraska-Lincoln, 340 Hardin Hall North, Lincoln, NE 68583-0963, USA. Telephone: 402-472-7231; Fax: 402-472-5179; E-mail: brianna.bright@gmail.com

Received August 20, 2013; accepted November 28, 2013

ABSTRACT

Introduction: We examined the evidence of telescoping bias in self-reports of regular smoking onset age. Since the exact year of the onset was not available, the discrepancy (termed shift) in self-reports was explored. The study was targeted at establishing the relationships between the prevalence and the magnitude of shifting and respondent and survey characteristics and identifying the key factors contributing to forward and backward shifting.

Methods: The 2002–2003 Tobacco Use Supplement to the Current Population Survey was administered using phone and in-person interviews to the same respondents in 2002 and 2003. The regular smoking onset age, reported by current and former smokers during both years, was used. All statistical analyses incorporated replicate weights to adjust for the complex survey design.

Results: In our sample, about 31.6% (31.8%) of respondents forwardly (backwardly) shifted the smoking onset age, with the mean magnitude of discrepancy about 2.7 years (both directions). The elapsed time since the onset was shown to be the most important considered predictor of prevalence of shifting. The prevalence of forward (backward) shifting tends to increase (decrease) as elapsed time increases. Furthermore, the discrepancy in forwardly shifted responses tends to increase, on average, with elapsed time.

Conclusions: The findings indicate that both forward and backward shifting may be prevalent in reports on smoking onset age. The extent of shifting depends on elapsed time since the onset (and therefore, the respondent's age) and other respondent and survey characteristics. The findings are consistent with presence of both forward and backward telescoping biases.

INTRODUCTION

Background

Determining the age of onset of cigarette smoking helps create a timeline for the history of smoking behaviors and assess the risk of smoking-related illnesses and conditions. When a current or former smoker reports his/her smoking onset age, the respondent first has to perform the memory search, then integrate the recalled information, and finally, report the summary of this information (Cowling, Johnson, & Holbrook, 2003; Holbrook, Green, & Krosnick, 2003; Krosnick, 1991, 1999; Krosnick et al., 2002; Tourangeau, Rips, & Rasinski, 2000). Since the event can be entirely forgotten or misplaced in time due to the compression-of-time memory error (Sudman & Bradburn, 1973), the retrospectively reported smoking onset age is subject to potential response bias. One such bias that pertains to the reporting of past events is telescoping, where the respondent reports the event to have taken place more recently or farther in the past than is actually true (Cohen & Conway, 2008; Tourangeau et al., 2000). In particular, if a respondent reports the event as more recent than it actually is, then the respondent is said to forwardly telescope

the event, while if the respondent reports the event as farther in the past, then the respondent is said to backwardly telescope the event.

Many studies have found evidence that reported events related to smoking and other health-risk behaviors are subject to forward telescoping. First, we review several studies that have used data from the National Household Surveys on Drug Abuse (NHSDA) (U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Office of Applied Statistics, 2008), now known as the National Survey on Drug Use and Health. Johnson and Schultz (2005) used the 1979–1998 NHSDA to investigate forward telescoping with respect to early initiation of smoking, that is, smoking initiation prior to age 12, and early onset of daily smoking, that is, daily smoking initiation prior to age 15. Significant evidence of forward telescoping was found in relation to both measures. Golub, Johnson, and Labouvie (2000) examined forward telescoping in reported onset age of tobacco, alcohol, marijuana, and hard drug use, based on the 1982–1995 NHSDA and the Rutgers Health and Human Development Project. The highest level of forward telescoping was detected with respect to reported alcohol use onset age, followed by both reported

doi:10.1093/ntr/ntt220

Advance Access publication December 30, 2013

© The Author 2013. Published by Oxford University Press on behalf of the Society for Research on Nicotine and Tobacco. All rights reserved. For permissions, please e-mail: journals.permissions@oup.com.

tobacco use onset age and marijuana use onset age. Another study, conducted by [Johnson, Gerstein, and Rasinski \(1997\)](#), investigated recall decay (a decreased ability to retrieve information from memory as time since the event increases) and forward telescoping in self-reports of age of first use of alcohol and marijuana using the 1979–1995 NHSDA. It was shown that subjects born in the 1950s and 1960s tended to forwardly telescope their alcohol use onset age and that respondents who first used alcohol or marijuana at an early age (between 10 and 14 years old) were more likely to experience recall decay than were the other respondents.

Second, we review results of studies that examined telescoping bias in youth and adults using the National Longitudinal Survey of Youth (NLSY) ([U.S. Department of Labor, Bureau of Labor Statistics, 2013](#)). [Johnson and Mott \(2001\)](#) evaluated the reliability of reported onset age of use with respect to several substances (cigarettes, alcohol, marijuana, cocaine, and crack). The surveys were administered to youth and their parents, and comparison of responses to consecutive waves of the 1984–1998 NLSY was performed. It was shown that youth-reported onset age of cigarette, alcohol, monthly alcohol, and marijuana use were subject to forward telescoping. Some evidence of forward telescoping was also found with respect to parent-reported onset age of their daily cigarette smoking, marijuana, and cocaine use.

Third, we review some studies where evidence of backward telescoping was found. Although most prior research on telescoping of events related to smoking and other health-risk behaviors has been focused on detecting forward telescoping, several NLSY studies have also found evidence of backward telescoping. A general finding was that while backward telescoping is not as prevalent as is forward telescoping, the proportion of backwardly telescoped events can be substantial: for example, this was found for onset age of cigarette smoking, alcohol, and marijuana use ([Shillington & Clapp, 2000](#); [Shillington, Reed, & Clapp, 2010](#); [Shillington, Woodruff, Clapp, Reed, & Lemus, 2012](#)).

Fourth, we review some findings regarding influence of demographic and other respondent characteristics on the prevalence and extent of telescoping. Effect of respondent's age, gender, and race/ethnicity on telescoping was explored by [Shillington and Clapp \(2000\)](#), [Johnson and Schultz \(2005\)](#), and [Shillington et al. \(2010, 2012\)](#), and significant influence of some of these factors was demonstrated. For example, it was shown that the magnitude of forward telescoping of reported onset age of smoking differed significantly by gender and the magnitude of forward telescoping of reported age of onset of daily smoking differed significantly by race ([Johnson & Schultz, 2005](#)); also, the extent of backward telescoping of the onset age of alcohol and marijuana use was shown to increase with respondent age ([Shillington & Clapp, 2000](#)). Additionally, the effect of age of onset of smoking, substance use characteristics (frequency of substance use, number of substances used), and the time since reported age of onset were explored by [Johnson et al. \(1997\)](#) and [Shillington et al. \(2012\)](#). [Shillington et al. \(2012\)](#) showed that the elapsed time since reported age of onset was the most consistent predictor among gender, ethnicity, and substance use characteristics of backward telescoping.

Finally, we note the importance of proper accounting for the potential impact of telescoping, because ignoring the possible telescoping effect can lead to misleading findings. For

example, early onset of smoking was shown to be associated with a higher risk of alcohol abuse, heavier and longer smoking careers ([Grant, 1998](#)), as well as future illicit substance use ([Kandel, Yamaguchi, & Chen, 1992](#)). Thus, the early onset of smoking is an important marker for public policy decisions and designs of prevention programs. However, if the age of smoking onset is reported with telescoping error (and the error is overlooked in the analyses), then the average age of onset could be incorrectly estimated, leading to improper definition of the early onset. Thus, the use of this factor, that is, early onset, in smoking prevention programs could be inappropriate. Therefore, telescoping has the potential to have a high impact on research conclusions and direct implications for prevention service administration.

Rationale and Study Goals

As is indicated in the Background section, there have been many studies targeted at investigating the evidence and extent of forward and backward telescoping biases with respect to smoking-related events. However, the occurrence of forward and backward telescoping errors can be determined directly only if the true date of the event is known, for example, in studies targeted at examining telescoping with respect to autobiographical events where the exact time of the events is known to investigators ([Burt, Kemp, & Conway, 2001](#); [Gaskell, Wright, & O'Muircheartaigh, 2000](#); [Huttenlocher, Hedges, & Bradburn, 1990](#); [Janssen, Chessa, & Murre, 2006](#); [Prohaska, Brown, & Belli, 1998](#); [Raphael & Marbach, 1997](#); [Rubin & Baddeley, 1989](#); [Thompson, Skowronski, & Lee, 1988](#)). To the best of our knowledge, there have been no studies where the true onset age of smoking was known to investigators. Therefore, all prior studies examined the evidence of telescoping rather than telescoping effect itself. This limitation was also mentioned by [Shillington et al. \(2012\)](#).

To highlight the importance of differentiating between instances when the exact time of the event is known and unknown, and to deal with the latter instances, we propose to use “shift” as the proper term characterizing the difference between the responses at two assessments. We say that a respondent, who is a current or former smoker, forwardly (backwardly) shifts his/her onset age of smoking if he/she reports the onset age of smoking older (younger) at a later assessment than he/she did at an earlier assessment. In fact, other authors have already used similar measures ([Golub et al., 2000](#); [Johnson & Mott, 2001](#); [Shillington et al., 2010, 2012](#)), but in our opinion, the underlying difference between the “telescoping bias” and “shift” has not been sufficiently emphasized in the literature. Note that if it is assumed that the onset age of smoking reported at the first assessment is truthful, then the “shift” measure defined above reduces to the corresponding telescoping measure. However, whether this assumption is reasonable needs further study and in general the notions of shifting and telescoping are conceptually different.

Our study is targeted at investigating the prevalence and magnitude of forward and backward shifting with respect to the onset age of fairly regular smoking based on the 2002–2003 Tobacco Use Supplement to the Current Population Survey (TUS-CPS; U.S. Department of Commerce, Census Bureau, 2004, 2006), where the onset age of regular smoking is defined as the response to TUS-CPS question “How old were you when you first started smoking cigarettes fairly regularly?”

The TUS-CPS is commonly used to obtain estimates of the national and state level smoking rates in the United States and gather information regarding the type of tobacco products used (Backinger et al., 2008; Osypuk & Acevedo-Garcia, 2010; Soulakova, Davis, Hartman, & Gibson, 2009; Tindle, Shiffman, Hartman, & Bost, 2009; U.S. Department of Commerce, Census Bureau, 2007a, 2007b). Prior research by Soulakova, Hartman, Liu, Willis, and Augustine (2012), which was targeted at investigating the TUS-CPS data reliability, revealed that the difference in the smoking onset age responses can be positive as well as negative, suggesting that both forward and backward shifting may occur. However, no investigation of the prevalence and/or magnitude of shifting has been yet reported in the literature.

Our study has two primary goals (goals 1 and 2) and one secondary goal (goal 3). Goal 1 is to identify the demographic subpopulations and survey characteristics that are likely to contribute to forward or backward shifting. While there are no studies examining the evidence of telescoping using the TUS-CPS data, we expect to confirm that the elapsed time since the smoking onset age is one of the most important predictors. Goal 2 is to identify the relationship between the prevalence of both forward and backward shifting and demographic and survey characteristics, as well as their joint effects, then based on the relationships perform some specific comparisons. Goal 3 is to examine the magnitude of both forward and backward shifting with respect to respondents who did forwardly or backwardly shift their responses and perform some specific comparisons.

METHODS

Our study involves a subsample of the data corresponding to current and former smokers who reported their age of fairly regular smoking onset at both assessments, in 2002 and 2003. There are 5,371 such respondents. Table 1 presents the weighted descriptive statistics for the sample; baseline data, that is, 2002 data, are used for all demographic characteristics.

Since the 2002–2003 TUS-CPS involved a complex survey design, all analyses, including obtaining sample descriptive statistics, incorporated the replicate weights (Davis, Hartman, & Gibson, 2007) and used the balanced repeated replication method for variance estimating. All computing was done in SAS® (Version 9.3) using the built-in procedures.

For assessing primary goals 1 and 2, a forward (backward) shift is defined as a binary measure differentiating between those subjects who reported their regular smoking onset age in 2003 older (younger) than the one reported in 2002 and those that did not. The parameters of interest are the prevalence of forward and backward shifting. For assessing goal 3, the difference in reported smoking onset age was constructed as the 2002 response minus the 2003 response, where negative values of the difference correspond to forward shifting and positive values correspond to backward shifting. The magnitude, or extent, of shifting is defined as the absolute value of the negative difference in the case of forward shifting and as the positive difference in the case of backward shifting. The corresponding primary parameters are the mean values of the magnitude.

The following factors were considered in the analyses: the smoking onset group (defined below), demographic characteristics (respondent's age, gender, race/ethnicity, metropolitan

Table 1. Descriptive Statistics of the Sample

Characteristic	Count	Weighted mean (SE) or percentage
Age (mean, SE)	5,371	48.82 (0.144)
Smoking onset age reported in 2002 (mean, SE)	5,371	17.75 (0.042)
Smoking onset age reported in 2003 (mean, SE)	5,371	17.71 (0.040)
Forwardly shifted smoking onset age	1,695	32.24%
Backwardly shifted smoking onset age	1,708	32.27%
Gender		
Male	2,579	50.54%
Female	2,792	49.46%
Race/ethnicity		
Non-Hispanic White	4,776	84.39%
Other	595	15.61%
Metropolitan status		
Metropolitan	3,784	77.23%
Nonmetropolitan	1,587	22.77%
Geographical region		
Northeast	1,187	18.79%
Midwest	1,517	25.96%
South	1,463	33.87%
West	1,204	21.38%
2002 interview type		
Phone	3,351	61.27%
In-person	2,020	38.73%
2003 interview type		
Phone	3,872	70.99%
In-person	1,499	29.01%
Smoking onset group		
Group 1 (<10 years ago)	443	12.05%
Group 2 (11–30 years ago)	2,046	38.21%
Group 3 (31–50 years ago)	2,121	35.78%
Group 4 (>50 years ago)	761	13.96%

status, and geographical region), and the 2002 and 2003 interview type (over the phone or in-person). We defined smoking onset group to represent the elapsed time from the smoking onset age until the first assessment, where group 1 corresponds to respondents who started smoking fairly regularly no more than 10 years ago, group 2 corresponds to respondents who started smoking between 11 and 30 years ago, group 3 corresponds to respondents who started smoking between 31 and 50 years ago, and group 4 corresponds to respondents who started smoking more than 50 years ago.

The significance level was fixed at 2.5% to account (at least partially) for the analyses being performed on two outcomes, forward and backward shifting. Additional Bonferroni adjustments were used for pairwise comparisons among the four smoking onset groups. To assess goal 1, simple logistic regressions were fitted and results of the “Type 3 effects” tests were noted to identify the most important factor. To assess goal 2 with respect to forward shifting, the logit of forward shifting was modeled as a function of the respondent and survey characteristics mentioned above. To identify the final model, the backward elimination approach was used as follows. In the first step, the full model with all two-way interactions was considered. Then one, nonsignificant at the 2.5% level, interaction, which was

identified as the least significant interaction among all remaining interactions (in terms of the p value), was excluded in each step while controlling for all of the main effects and remaining interactions. The final model included the main effects (despite their significance) and remaining significant interactions. Next, based on the identified relationships, the prevalence of forward shifting was obtained with respect to the key respondent and survey characteristics of interest (smoking onset groups, gender, race/ethnicity, and interview type), and comparisons of the prevalence of both types of shifting were performed. Similarly, goal 2 was assessed with respect to backward shifting. To assess goal 3, simple regressions were used and comparisons of the mean magnitude were performed with respect to the key respondent and survey characteristics of interest.

RESULTS

First, we briefly describe the sample. In our sample, there are 1,695 (31.56%) respondents who forwardly shifted the smoking onset age, that is, reported their onset age as younger in 2002 than they did in 2003; 1,708 (31.80%) respondents who backwardly shifted the smoking onset age, that is, reported their onset age as older in 2002 than they did in 2003; and 1,968 (36.64%) respondents who reported precisely the same onset age at the two assessments. The corresponding weighted percentages of shifting are given in Table 1. The mean magnitude of forward shift is 2.56 years ($SE = 0.04$) and the mean magnitude of backward shift is 2.68 years ($SE = 0.04$).

Next, we describe the results with respect to each goal.

Goal 1 Results

In the case of forward shifting, the most important predictor (in terms of statistical significance) is the smoking onset group ($p = .0002$), followed by gender ($p = .0003$), 2002 method of interview ($p = .0032$), 2003 method of interview ($p = .0045$), geographical region ($p = .0091$), age ($p = .0660$), race/ethnicity ($p = .1170$), and metropolitan status ($p = .5171$). In the case of backward shifting, there are three factors that are detected as highly important (all p values are less than .0001), which are smoking onset group (Wald statistic = 80.89, $df = 3$), age (Wald statistic = 22.49, $df = 3$), and race/ethnicity (Wald statistic = 22.89, $df = 1$). These factors are followed in significance by metropolitan status ($p = .0026$), 2003 method of interview ($p = .0180$), 2002 method of interview ($p = .1334$), geographical region ($p = .2443$), and gender ($p = .2907$). Thus, in both cases, smoking onset group is one of the most important predictors of shift out of the ones considered. As was expected, the elapsed time from reported onset age of regular smoking is highly positively correlated with respondent's age (Pearson correlation coefficient is 0.96, $p < .0001$), thus respondent age was not further explored in the analyses.

Goal 2 Results

The corresponding main effects and two-way interactions, along with associated p values for each model, are reported in Table 2. The forward and backward shift models are significant (likelihood ratio test statistic = 911635.18, $df = 33$, $p < .0001$ and likelihood ratio test statistic = 1408582.63, $df = 35$, $p < .0001$, respectively) and contain several significant interactions.

Table 2. Survey Logistic Regression Models: Effect and Corresponding Type 3 Analysis p Value

Effect	Model outcome	
	Forward shift	Backward shift
Main effects		
Smoking onset group	.0001	.0001
Gender	.0903	.0762
Race/ethnicity	.0055	.1091
Metropolitan status	.0001	.2870
Geographical region	.0002	.0001
2002 interview type	.0001	.4056
2003 interview type	.0001	.6288
Two-way interactions		
Smoking onset group and race/ethnicity	.0001	.0166
Smoking onset group and geographical region	.0001	
Smoking onset group and 2002 interview type	.0001	.0001
Smoking onset group and 2003 interview type		.0001
Gender and 2002 interview type	.0020	
Gender and 2003 interview type	.0039	
Race/ethnicity and metropolitan status	.0001	.0006
Race/ethnicity and geographical region		.0001
Race/ethnicity and 2002 interview type	.0001	.0001
Metropolitan status and geographical region		.0136
Metropolitan status and 2002 interview type		.0007
Geographical region and 2002 interview type		.0060
Geographical region and 2003 interview type	.0001	.0001

Note. All p values less than .0001 were rounded to .0001.

Note that none of the models contain the interaction between the 2002 and 2003 interview types indicating that the effect of the 2002 interview method on the logit of shifting is similar for respondents who had a phone or in-person interview in 2003.

The models result in the following predicted prevalence of forward shifting (with the corresponding standard errors): 0.261 (0.012) for smoking onset group 1, 0.326 (0.007) for group 2, 0.326 (0.007) for group 3, and 0.336 (0.009) for group 4. The predicted prevalence of backward shifting is 0.397 (0.014) for group 1, 0.335 (0.006) for group 2, 0.296 (0.007) for group 3, and 0.267 (0.010) for group 4. Thus, the prevalence of forward shift tends to increase in smoking onset group, while the prevalence of backward shift tends to decrease in smoking onset group. Odds ratios for pairwise onset group comparisons are presented in Table 3. The common finding is that group 1 significantly differs from the other groups in terms of prevalence of forward or backward shifting, where group 1 respondents are less likely to forwardly shift and more likely to backwardly shift the smoking onset age than the other respondents. In

Table 3. Predicted Odds Ratios With Corresponding Adjusted *p* Values

Effect	Forward shift	Backward shift
Gender: male versus female	1.100 (.0009)*	1.038 (.3130)
Race/ethnicity: non-Hispanic White versus other	0.950 (.3861)	0.810 (.0001)*
2002 interview type: phone versus in-person	0.922 (.0108)*	1.073 (.0246)*
2003 interview type: phone versus in-person	1.139 (.0010)*	0.925 (.0441)
Smoking onset group: group 1 versus group 2	0.729 (.0001)*	1.311 (.0001)*
Smoking onset group: group 1 versus group 3	0.730 (.0001)*	1.570 (.0001)*
Smoking onset group: group 1 versus group 4	0.698 (.0001)*	1.807 (.0001)*
Smoking onset group: group 2 versus group 3	1.000 (1.0000)	1.197 (.0001)*
Smoking onset group: group 2 versus group 4	0.957 (1.0000)	1.379 (.0001)*
Smoking onset group: group 3 versus group 4	0.956 (1.0000)	1.151 (.0966)

Note. All *p* values less than .0001 were rounded to .0001 and all *p* values greater than 1.0000 were truncated to 1.0000; * denotes significant (at 2.5% level) result.

addition, group 2 respondents are more likely to backwardly shift their responses than the group 3 and 4 respondents.

Table 3 also depicts the odds ratios for the other key factors. The common significant comparisons all result in different conclusions for forward and backward shifting, that is, if one subpopulation is more likely to forwardly shift their responses than is the other subpopulation, then it is also less likely to backwardly shift their responses, for example, respondents who had a phone interview in 2002 are less likely to forwardly and more likely to backwardly shift their responses than those with an in-person interview. In addition, there are some other common results, that is, males are more likely to forwardly or backwardly shift their responses than are females (but the odds ratio is not significant in the case of backward shifting), and non-Hispanic White respondents are less likely to forwardly or backwardly shift than the other respondents (but the odds ratio is not significant in the case of forward shifting).

Goal 3 Results

Table 4 presents the mean magnitude of shifting for each subpopulation of interest. Comparisons between the subpopulations result in significant differences in terms of the mean magnitude of forward shift associated with race/ethnicity ($p = .0033$), 2002 interview method ($p = .0207$), and the smoking onset group. Supplementary Figure 1 presents the simultaneous 95% CIs around the means for the smoking onset groups. As is illustrated, group 1 is significantly different from groups 2–4 (all adjusted *p* values are less than .0006), and group 2 is significantly different from group 4 ($p = .0012$). Among the planned comparisons with respect to the mean magnitude of backward shift, there was only one, that is, across the 2002 interview methods ($p = .0023$), that resulted in a significant difference. Supplementary Figure 2 illustrates the simultaneous 95% CIs around the means for the smoking onset groups; none of the pairwise comparisons were detected to be significant.

DISCUSSION

Importance of Accounting for Shifting (Telescoping) Effect

As is mentioned in the Rationale and Study Goals section, there is a conceptual difference between shifting and telescoping. However, the findings with respect to shifting presented

Table 4. Mean Magnitude (With SE) of Shifting in Years

	Forward shift (absolute value)	Backward shift
Smoking onset group		
Smoking onset group		
Group 1 (<10 years ago)	1.705 (0.059)	2.738 (0.127)
Group 2 (11–30 years ago)	2.480 (0.049)	2.711 (0.076)
Group 3 (31–50 years ago)	2.702 (0.064)	2.665 (0.059)
Group 4 (>50 years ago)	3.029 (0.115)	2.538 (0.088)
Gender		
Male	2.513 (0.053)	2.624 (0.052)
Female	2.619 (0.058)	2.738 (0.049)
Race/ethnicity		
Non-Hispanic White	2.490 (0.038)	2.626 (0.040)
Other	2.942 (0.139)	2.878 (0.117)
2002 interview type		
Phone	2.642 (0.052)	2.767 (0.053)
In-person	2.448 (0.058)	2.537 (0.051)
2003 interview type		
Phone	2.534 (0.041)	2.627 (0.043)
In-person	2.642 (0.082)	2.801 (0.080)

in this article are consistent with properties of telescoping (Shillington et al., 2012) and therefore provide some evidence of presence of telescoping bias when regular smoking onset age is assessed.

To illustrate the importance of proper accounting for shifting (telescoping) effect, we present a short example, where two different estimates of age of onset of regular smoking were obtained depending on what survey wave was used. Suppose there are two investigators who want to estimate the age of onset of regular smoking for the Western U.S. residents, that is, residents of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming, for the purpose of designing a smoking prevention program. One investigator chooses to use the 2002 responses, while the second one chooses to use the 2003 responses provided by the Western U.S. residents. Then the first investigator would find that the respondents started smoking fairly regularly, on average, at the age of 19 (more specifically, at the age of 18.90, $SE = 0.31$), while the second investigator would find that the respondents started smoking

fairly regularly, on average, at the age of 18 (more specifically, at the age of 17.95, $SE = 0.23$). Therefore, these investigators would use diverse estimates for the age of onset of regular smoking with a year difference in the estimated values, when designing the smoking prevention programs.

The above example used the actual data corresponding to the Western U.S. residents. It highlights possible dissimilarities in conclusions if shifting (telescoping) bias is ignored. We note that the presented differences were not consistently observed with respect to the other subpopulations.

Discussion

The prevalence of forward shifting appears to increase as the elapsed time since the onset of smoking (categorized into four groups) increases, while the prevalence of backward shifting appears to decrease as the elapsed time increases. These findings are consistent with prior research results indicating that more remote events are typically displaced forwardly in memory, while more recent events are displaced backwardly (Janssen et al., 2006; Rubin & Baddeley, 1989). In addition, among respondents who forwardly shift their onset age, the mean magnitude tends to increase as the elapsed time increases. Therefore, as elapsed time increases, respondents become more likely to forwardly shift their smoking onset age, and when they do, the discrepancy in the reports tends to increase, on average. While among respondents who backwardly shift their onset age, the mean magnitude appears to decrease as the elapsed time increases, none of the comparisons resulted in statistically significant differences.

In addition, our findings indicate that gender, race/ethnicity, and interview type (as well as their joint effects) may influence the prevalence of forward and backward shifting. For example, we observed that males are more likely to forwardly shift their age of onset of regular smoking than are females, which could be due to dissimilar patterns in memory processing between male and female respondents.

Taking into account that the TUS-CPS is a national multistage survey, the overall magnitude of discrepancy (with the maximum average difference of about 3 years) is concluded to be satisfactory, especially with respect to older respondents. Also, the patterns of forward and backward shifting are somewhat close to being symmetric (i.e., the errors tend to cancel each other), thus we did not detect any evidence against the overall data quality of the TUS-CPS (Soualakova et al., 2012). However, as is illustrated in the example, care must be taken when analyses are limited to a particular subpopulation. In this case, the self-reported smoking information should be used with caution, especially with respect to younger respondents, where even a small discrepancy (e.g., 1 year in reported smoking initiation age) leads to questionable validity of the self-reported information.

Study Limitations

Because the elapsed time since any event in the past is expected to be highly positively correlated with the respondent's age, our study examined only the elapsed time (categorized into four smoking onset groups), because the elapsed time has been shown to be the most important predictor (out of several considered) of telescoping (Shillington et al., 2012), and our results confirmed this finding. However, we point out that the smoking onset groups correspond to subpopulations with

different age groups, for example, subjects who claim to start smoking more than 50 years ago are primarily elderly. Another limitation is that the TUS-CPS data used in the study are all based on self-reports and therefore, the smoking onset group is defined using the self-reported elapsed time from when the onset of regular smoking is claimed to have occurred until the 2002 assessment. Finally, values of the potential forward and backward telescoping errors might depend on other characteristics that were not considered in this study. Therefore, it is important for studies that examine smoking behaviors based on self-reports to assume the potential presence and mechanisms of telescoping and if possible, perform additional sensitivity studies to investigate to what degree the research findings depend on these assumptions.

Potential Future Research Goals

Our study revealed that the relationship between the respondent and survey characteristics and prevalence of shifting appears to be more complex than initially anticipated. Although in the study the models were built for obtaining more accurate estimates that can be used to test specific hypotheses of interest, they indicated significance of several two-way interactions. Thus, future research can be targeted at more detailed investigating of the prevalence of shifting as well as magnitude of shifting. Moreover, future research can be targeted at examining the evidence of forward and backward telescoping in other surveys on smoking and other adverse health behaviors.

SUPPLEMENTARY MATERIAL

Supplementary Figures 1 and 2 can be found online at <http://www.ntr.oxfordjournals.org>

FUNDING

JNS was supported by the National Cancer Institute of the National Institutes of Health award number R03CA165831.

DECLARATION OF INTERESTS

None declared.

ACKNOWLEDGMENTS

The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. We also would like to thank A. Hartman (Risk Factors Monitoring and Methods Branch, Applied Research Program, Division of Cancer Control and Population Sciences, National Cancer Institute) and T. Gibson (Senior Programmer Analyst, Information Management Services, Inc.) for providing the dataset and replicate weights that were used in this article.

REFERENCES

Backinger, C. L., Lawrence, D., Swan, J., Winn, D. M., Breen, N., Hartman, A., ... Farrell, S. (2008). Using the National

- Health Interview Survey to understand and address the impact of tobacco in the United States: Past perspectives and future considerations. *Epidemiologic Perspectives & Innovations*, 5, 3. doi:10.1186/1742-5573-5-8
- Burt, C. D., Kemp, S., & Conway, M. (2001). What happens if you retest autobiographical memory 10 years on? *Memory & Cognition*, 29, 127–136.
- Cohen, G., & Conway, M. A. (Eds.). (2008). *Memory in the real world* (3rd ed.). New York, NY: Psychology Press.
- Cowling, D. W., Johnson, T. P., & Holbrook, B. C. (2003). Improving the self reporting of tobacco use: Results of a factorial experiment. *Tobacco Control*, 12, 178–183. doi:10.1136/tc.12.2.178
- Davis, W. W., Hartman, A. M., & Gibson, J. T. (2007). Weighting the overlap sample obtained from two Tobacco Use Supplements to the Current Population Survey. Retrieved from http://appliedresearch.cancer.gov/studies/tus-cps/TUS-CPS_overlap.pdf (last accessed on December 16, 2013)
- Gaskell, G. D., Wright, D. B., & O'Muircheartaigh, C. A. (2000). Telescoping of landmark events: Implications for survey research. *Public Opinion Quarterly*, 64, 77–89. doi:10.1086/316761
- Golub, A., Johnson, B. D., & Labouvie, E. (2000). On correcting bias in self-reports of age at first substance use with repeated cross-section analysis. *Journal of Quantitative Criminology*, 16, 45–68. doi:10.1023/A:1007573411129
- Grant, B. F. (1998). Age at smoking onset and its association with alcohol consumption and dependence: Results from the national longitudinal alcohol epidemiologic survey. *Journal of Substance Abuse*, 10, 59–73. doi:10.1016/S0899-3289(99)80141-2
- Holbrook, A. L., Green, M. C., & Krosnick, J. A. (2003). Telephone versus face-to-face interviewing of national probability samples with long questionnaires: Comparisons of respondent satisficing and social desirability response bias. *Public Opinion Quarterly*, 67, 79–125. doi:10.1086/346010
- Huttenlocher, J., Hedges, L. V., & Bradburn, N. M. (1990). Reports of elapsed time: Bounding and rounding processes in estimation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16, 196–213.
- Janssen, S. M., Chessa, A. G., & Murre, J. M. (2006). Memory for time: How people date events. *Memory & Cognition*, 34, 138–147.
- Johnson, E. O., & Schultz, L. (2005). Forward telescoping bias in reported age of onset: An example from cigarette smoking. *International Journal of Methods in Psychiatric Research*, 14, 119–129. doi:10.1002/mpr.2
- Johnson, R. A., Gerstein, D. R., & Rasinski, K. A. (1997). Recall decay and telescoping in self-reports of alcohol and marijuana use: Results from the National Household Survey on Drug Abuse (NHSDA). Retrieved from: http://www.amstat.org/sections/srms/Proceedings/papers/1997_166.pdf (last accessed on December 16, 2013).
- Johnson, T. P., & Mott, J. A. (2001). The reliability of self-reported age of onset of tobacco, alcohol and illicit drug use. *Addiction*, 96, 1187–1198. doi:10.1046/j.1360-0443.2001.968118711.x
- Kandel, D. B., Yamaguchi, K., & Chen, K. (1992). Stages of progression in drug involvement from adolescence to adulthood: Further evidence for the gateway theory. *Journal of Studies on Alcohol*, 53, 447–457.
- Krosnick, J. A. (1991). Response strategies for coping with the cognitive demands of attitude measures in surveys. *Applied Cognitive Psychology*, 5, 213–236. doi:10.1002/acp.2350050305
- Krosnick, J. A. (1999). Survey research. *Annual Review of Psychology*, 50, 537–567. doi:10.1146/annurev.psych.50.1.537
- Krosnick, J. A., Holbrook, A. L., Brent, M. K., Carson, R. T., Hanemann, W. M., Kopp, R. J., ... Conaway, M. (2002). The impact of “No Opinion” response options on data quality: Non-attitude reduction or an invitation to satisfy? *Public Opinion Quarterly*, 66, 371–403.
- Osypuk, T. L., & Acevedo-Garcia, D. (2010). Support for smoke-free policies: A nationwide analysis of immigrants, US-born, and other demographic groups, 1995–2002. *American Journal of Public Health*, 100, 171–181. doi:10.2105/AJPH.2009.160218
- Prohaska, V., Brown, N. R., & Belli, R. F. (1998). Forward telescoping: The question matters. *Memory*, 6, 455–465. doi:10.1080/741942604
- Raphael, K. G., & Marbach, J. J. (1997). When did your pain start?: Reliability of self-reported age of onset of facial pain. *The Clinical Journal of Pain*, 13, 352–359.
- Rubin, D. C., & Baddeley, A. D. (1989). Telescoping is not time compression: A model of the dating of autobiographical events. *Memory & Cognition*, 17, 653–661.
- Shillington, A. M., & Clapp, J. D. (2000). Self-report stability of adolescent substance use: Are there differences for gender, ethnicity and age? *Drug and Alcohol Dependence*, 60, 19–27.
- Shillington, A. M., Reed, M. B., & Clapp, J. D. (2010). Self-report stability of adolescent cigarette use across ten years of panel study data. *Journal of Child & Adolescent Substance Abuse*, 19, 171–191. doi:10.1080/10678281003635089
- Shillington, A. M., Woodruff, S. I., Clapp, J. D., Reed, M. B., & Lemus, H. (2012). Self-reported age of onset and telescoping for cigarettes, alcohol, and marijuana across eight years of the national longitudinal survey of youth. *Journal of Child & Adolescent Substance Abuse*, 21, 333–348. doi:10.1080/1067828X.2012.710026
- Soulakova, J., Davis, W. W., Hartman, A., & Gibson, J. (2009). The impact of survey and response modes on current smoking prevalence estimates using TUS-CPS: 1992–2003. *Survey Research Methods*, 3, 123–137.
- Soulakova, J. N., Hartman, A. M., Liu, B., Willis, G. B., & Augustine, S. (2012). Reliability of adult self-reported smoking history: Data from the Tobacco Use Supplement to the Current Population Survey 2002–2003 cohort. *Nicotine & Tobacco Research*, 14, 952–960. doi:10.1093/ntr/ntr313
- Sudman, S., & Bradburn, N. M. (1973). Effects of time and memory factors on response in surveys. *Journal of the American Statistical Association*, 68, 805–815. doi:10.1080/01621459.1973.10481428
- Thompson, C. P., Skowronski, J. J., & Lee, D. J. (1988). Telescoping in dating naturally occurring events. *Memory & Cognition*, 16, 461–468.
- Tindle, H. A., Shiffman, S., Hartman, A. M., & Bost, J. E. (2009). Switching to “lighter” cigarettes and quitting smoking. *Tobacco Control*, 18, 485–490. doi:10.1136/tc.2008.029314
- Tourangeau, R., Rips, L. J., & Rasinski, K. (2000). *The psychology of survey response*. Cambridge, UK: Cambridge University Press.
- U.S. Department of Commerce, Census Bureau. (2004). National Cancer Institute and Centers for Disease Control and Prevention Co-sponsored Tobacco Use Supplement to the Current Population Survey (2001–2002). Data files (AND/OR) technical documentation (technical documentation web site: www.census.gov/cps/methodology/techdocs.html). Retrieved from <http://appliedresearch.cancer.gov/studies/tus-cps/> (last accessed on December 16, 2013)
- U.S. Department of Commerce, Census Bureau. (2006). National Cancer Institute and Centers for Disease Control and Prevention Co-sponsored Tobacco Use Special Cessation Supplement to the Current Population Survey (2003). Data

Evidence of telescoping in regular smoking onset age

- files (AND/OR) technical documentation (technical documentation Web site: <http://appliedresearch.cancer.gov/studies/tus-cps/info.html>). Retrieved from <http://appliedresearch.cancer.gov/studies/tus-cps/> (last accessed on December 16, 2013)
- U.S. Department of Commerce, Census Bureau. (2007a). National Cancer Institute and Centers for Disease Control and Prevention cosponsored tobacco use supplement to the current population survey. What are the current and past TUS survey findings? Retrieved from <http://appliedresearch.cancer.gov/studies/tus-cps/results.html> (last accessed on December 16, 2013)
- U.S. Department of Commerce, Census Bureau. (2007b). National Cancer Institute and Centers for Disease Control and Prevention co-sponsored tobacco use supplement to the current population survey. Reports & Publications using the TUS-CPS. Retrieved from <http://appliedresearch.cancer.gov/studies/tus-cps/publications.html> (last accessed on December 16, 2013)
- U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Office of Applied Statistics. (2008). National Survey on Drug Use and Health (formerly National Household Survey on Drug Abuse). Retrieved from www.oas.samhsa.gov/nhsda.htm (last accessed on December 16, 2013)
- U.S. Department of Labor, Bureau of Labor Statistics. (2013). National Longitudinal Surveys, The NLSY97. Retrieved from www.bls.gov/nls/nlsy97.htm (last accessed on December 16, 2013)