ORIGINAL INVESTIGATION

Changes in Effectiveness of Cigarette Health Warnings Over Time in Canada and the United States, 2002–2011

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ABSTRACT

Introduction: Article 11 of the World Health Organization's Framework Convention on Tobacco Control (FCTC) requires countries to implement health warnings on tobacco products. The Article 11 guidelines advise countries to periodically rotate warnings to prevent “wearout” of the health warnings. This study investigates potential wearout of cigarette health warnings during a period of 9 years in 2 countries: Canada, where larger pictorial warnings were implemented approximately 1 year prior to the study, and in the United States, where small text-only warnings were in place for 17 years at the beginning of the study.

Methods: Data were drawn from national samples of smokers from the International Tobacco Control (ITC) Surveys in Canada ($N = 5,309$) and the United States ($N = 6,412$) who were originally recruited by telephone with random digit dialing. Changes in 4 measures of health warning effectiveness and in a composite Labels Impact Index were examined over 8 waves of survey data (2002–2011). Analyses were conducted in 2012.

Results: The health warning effectiveness measures and the Labels Impact Index indicated that the effectiveness of both the Canadian and the U.S. warnings declined significantly over time. The Canadian warnings showed greater declines in effectiveness than the U.S. warnings, likely due to the initial novelty of the Canadian warnings. Despite the greater decline in Canada, the Canadian pictorial warnings were significantly more effective than the U.S. text-only warnings throughout the study.

Conclusions: Health warnings decline in effectiveness over time. Health warnings on tobacco products should be changed periodically to maintain effectiveness.

INTRODUCTION

Tobacco use is the leading cause of preventable disease in high-income countries (World Health Organization, 2009). Approximately half of all long-term smokers will die of a smoking-related disease, and it is estimated that smoking could kill 1 billion people this century (Mathers & Loncar, 2006; Peto et al., 1996). To address the harms caused by tobacco, the World Health Assembly adopted the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) in 2003 (World Health Organization, 2005).

Article 11 of the FCTC covers the use of health warning labels to communicate information about the harms of tobacco. The Article 11 Guidelines, adopted in November 2008 (World Health Organization, 2008), recommend the implementation of pictorial health warnings that cover at least 50% of the top of the front and back of the package. The Article 11 Guidelines

are consistent with research showing that larger pictorial warnings are more effective than smaller text warnings for informing people about the health risks of smoking and encouraging smokers to quit (Hammond, 2011).

The Article 11 Guidelines imply that the same health warnings will not remain effective over long periods of time, in other words, their effectiveness will “wearout.” The Guidelines state that warnings should be rotated to maintain warning saliency (Fiske & Morling, 1996) and enhance impact. This concern arises from communication research showing that although messages may become more persuasive as they approach a moderate level of exposure, they tend to become increasingly less persuasive as they approach a high level of exposure (Appel, 1971; Calder & Sternthal, 1980; Craig, Sternthal, & Leavitt, 1976; Gorn & Goldberg, 1980; Grass & Wallace, 1969; Schumann & Clemons, 1989; Winter, 1973). The Article 11 Guidelines specify that “rotation can be implemented by [1]

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having multiple health warnings and messages appearing concurrently or [2] by setting a date after which the health warning and message content will change. Parties should consider using both types of rotation.” The Article 11 solution to wearout is supported by research that suggests that varying aspects of the message could help maintain effectiveness (Gorn & Goldberg, 1980; Grass & Wallace, 1969; McCullough & Ostrom, 1974).

This paper focuses on examining the failure to implement the second type of rotation, specifically the consequences of leaving the same set of health warnings and messages appearing concurrently for an extended period of time in two countries—Canada and the United States.

Canada was the first country to implement pictorial warnings on cigarette packages in 2001 (Hammond, 2012). One of 16 different warnings covered 50% of the front and back of the package (see: <http://www.tobaccolabels.ca/packimages/country/canada>, for Canadian pack images and warnings from 2000 to 2011) (Hammond, 2012). The same 16 warnings remained in place until June 2012, when new regulations were implemented. The new regulations require a set of 16 pictorial warnings that cover 75% of the front and back of the package.

The current U.S. warnings began appearing on cigarette packages in 1984 (Hammond, 2012). One of four warnings appears on the side of the package in small text and covers approximately 8% of the package (see: <http://www.tobaccolabels.ca/packimages/country/usa>, for U.S. pack images and warnings from 1984 to present). A new set of nine pictorial warnings that would cover 50% of the front and back of the package was issued following the 2009 U.S. Food and Drug Administration’s (FDA) Family Smoking Prevention and Tobacco Control Act. The warnings were to be implemented by September 2012; however, implementation of new warnings is uncertain following a legal case launched by R.J. Reynolds Tobacco Co. against the FDA that ended in a ruling in favor of the tobacco companies (U.S. Food and Drug Administration, 2012). The FDA recently announced that it will not appeal the case, and will begin a process to design a new set of warnings.

Several studies have compared the effectiveness of the U.S. style small, text-only health warnings and the larger pictorial Canadian style warnings (Bansal-Travers, Hammond, Smith, & Cummings, 2011; Borland, Wilson, et al., 2009; Borland, Yong, et al., 2009; Hammond, Fong, McNeill, Borland, & Cummings, 2006; Hammond et al., 2007; Kees, Burton, Andrews, & Kozup, 2006; O’Hegarty et al., 2006; Partos, Borland, Yong, Thrasher, & Hammond, 2012). Overall these studies show that the Canadian style pictorial health warnings are more effective than the U.S. style text-only warnings at communicating the health risks of smoking, increasing perceptions of the risks of smoking, and encouraging smokers to quit (Fong, Hammond, & Hitchman, 2009; Hammond, 2011).

This paper presents analyses of how the effectiveness of the health warnings changed over a period of 9 years (2002–2011) in the United States, where the same set of four small text warnings on the side of the pack have been in place since 1984, and Canada, where the same set of 16 pictorial warnings covered 50% of the pack from 2001 to 2012. This study differs from previous studies because it systematically examines wearout over a longer time period. Wearout of the health warnings was evaluated using four key measures of health warning effectiveness and a composite measure, the Labels Impact Index (Hitchman et al., 2012).

Previous research suggests that health warning wearout may be affected by (a) time of implementation, typically showing an initial “novelty effect,” (b) design differences between the old and new warnings, and (c) warning design, with larger, pictorial warnings showing less wearout (Borland, Wilson, et al., 2009; Hammond et al., 2007).

The Canadian pictorial health warnings, were expected to be highly effective at outset, but show steep declines in effectiveness over time as wearout set in. The smaller U.S. text-only warnings were not expected to show large wearout effects, due to a floor effect (low initial effectiveness).

METHODS

Respondents

Respondents were drawn from the International Tobacco Control (ITC) Surveys in Canada and the U.S. Respondents were aged 18 and older and were current smokers (smoked more than 100 cigarettes in their lifetimes and smoked at least once in the past 30 days). Quitters were dropped after quitting, and added back in if they relapsed. Quitters were more likely to be <39 years, have higher education, and higher income.

The ITC Canada and U.S. surveys are nationally representative, random-digit dial, longitudinal cohort surveys of smokers that began in 2002. Yearly follow-up surveys replenished respondents lost to attrition. Data are available from eight survey waves that were conducted approximately annually, from Wave 1 (2002) to Wave 8 (2011). This study is based on 11,721 unique respondents who participated in a least one wave: 5,309 from Canada and 6,412 from the United States. Overall, wave-to-wave attrition tended to be higher among younger, low income respondents, and non-White respondents (mainly United States), attrition was rarely related to smoking behavior. Wave-to-wave attrition rates were higher in the United States (35% most waves) than in Canada (approximately 27% all waves). Further details on survey methodology can be found elsewhere (Fong et al., 2006; ITC Project, 2004, 2011; Thompson et al., 2006).

Measures

Demographics

Sex, age group, ethnicity, net household income (low, moderate, or high), and education (low, moderate, or high) were included as covariates. Age was categorized as 18–24, 25–39, 40–54, and 55 plus. Ethnicity was categorized as white versus non-White. Education was categorized as: low = high school or less, medium = technical, trade school, or community college (some or completed), or some university, and high = at least a university degree. Net household income (in each country’s dollars) was categorized as: low = under \$30,000, moderate = \$30,000–\$59,999, and high = \$60,000 or higher. Because there were high numbers of refusal/don’t know responses to the income question, a fourth “no answer” category was added.

Smoking Behavior

Measures included: smoking status (daily vs. weekly/monthly), cigarettes per day (0–10, 11–20, 21–30, or >30), time to first cigarette after waking (5, 6–30, 31–60, or >60 min), and intentions to quit (in the next 6 months vs. sometime beyond 6 months/no plans to quit).

Health Warning Label Effectiveness

Changes in health warning effectiveness were examined using: (a) a dichotomized version of four individual 4- to 5-point measures of health warning effectiveness, and (b) by combining continuous versions of the four individual measures into a composite Labels Impact Index (Hitchman et al., 2012).

Measures of Health Warning Effectiveness

Warning salience (Fiske & Morling, 1996) (SALIENCE) was measured by asking respondents: In the last month, how often, if at all, have you noticed the warning labels on cigarette packages (never, rarely, or sometimes, vs. often or very often). The extent to which the warnings led smokers to think about the harms of smoking (HARM) was measured by asking smokers: To what extent, if at all, do the warning labels make you think about the health risks of smoking (not at all, a little, or somewhat vs. a lot)? The extent to which the warnings led smokers to think about quitting (QUITTING) was measured by asking respondents: To what extent, if at all, do the warning labels on cigarette packs make you more likely to quit smoking (not at all, a little, or somewhat, vs. a lot)? The frequency in which the warnings led smokers to forgo a cigarette (FORGO) was measured by asking respondents: In the last month, have the warning labels stopped you from having a cigarette when you were about to smoke one (many times, a few times, or once vs. never)?

Warning Label Impact Index (LII)

The four individual measures of health warning effectiveness were combined into a single index, the Warning Label Impact Index (LII) (Hitchman et al., 2012). The LII was constructed for each respondent at each point in time by standardizing each of the four measures of effectiveness and then forming a weighted composite (the original 4- or 5-point scales of the measures were standardized—not the dichotomized versions). The measures were weighted according to each indicator's impact on quit attempts based on a previous study conducted by Borland, Yong, et al. (2009). In that longitudinal analysis of ITC data from Australia, Canada, the United States, and the United Kingdom (same dataset as the current study), Borland, Yong, et al. found that health warning salience was not a significant predictor of quit attempts (although there was a bivariate association, the relation was inconsistent or nonsignificant in multivariable models), that thoughts of harm and thoughts of quitting were significant predictors of quit attempts in the multivariable regression that included quit intentions, and that forgoing cigarettes seemed to be the strongest direct predictor. Thus, the LII was thus calculated as follows, $LII = (SALIENCE \times 1) + (HARM \times 2) + (QUITTING \times 2) + (FORGO \times 3)$, with higher scores on the LII signifying greater health warning impact. Note that the analyses using the LII only used Waves 2–8 because some measures were not asked in Wave 1.

Statistical Analysis

To test for health warning wearout using the individual binary measures of health warning effectiveness, separate logistic regression models were estimated using generalized estimating equations (GEE) (Horton & Lipsitz, 1999; Liang & Zeger, 1986) to test (a) whether there was a linear decline in effectiveness between Wave 1 and Wave 8, and (b) whether

there was a difference in effectiveness at Wave 8 versus Wave 1. Two of the four measures were not included in the Wave 1 survey and analyses, thus the HARM and QUITTING analyses could only include Wave 2 to Wave 8. A similar approach was used to test changes in the composite LII over time using linear GEE regression models with Wave 2 to Wave 8. To account for within-subject correlation that arises from subjects being asked the same questions over several waves, GEE models were estimated using an unstructured working correlation matrix in SAS Version 9.2. Analyses were conducted in 2012.

All regression models controlled for demographic variables assessed at each respondent's first interview (sex, age group, ethnicity, income, education), and smoking behaviors assessed at each wave (daily vs. nondaily smoking status, cigarettes/day, time to first cigarette after waking, and intentions to quit smoking). Demographic control variables were treated as time-invariant while smoking characteristics were time-varying. Time-in-sample (number of survey waves completed by each respondent) was controlled in all models. The analysis incorporated sampling weights to ensure that the results were representative of smokers in the two countries.

To provide a visual depiction of changes in health warning effectiveness over time, SAS Version 9.2 was used to estimate the (a) proportion of smokers having positive responses to the health warning effectiveness measures (e.g., % of smokers who noticed the warnings often or very often), and (b) average scores on the LII over time. These percentages and scores are model-based adjusted estimates, controlling for all factors in the model.

To test if the health warnings were significantly more effective in Canada compared to the United States over time, the main effect of country on each of the four measures of health warning effectiveness and the LII was also examined.

RESULTS

Characteristics of the Sample

There were significant differences in the sample characteristics between the two countries for wave of recruitment, time-in-sample, age group, ethnicity, income, education, cigarettes per day, time to first cigarette, and intention to quit smoking (Table 1). Differences in wave of recruitment and time-in-sample reflect the lower attrition rate in Canada versus the United States.

Health Warning Effectiveness: Canada Versus United States (Wave 1 to Wave 8)

Analyses of the four measures of health warning effectiveness indicated that the Canadian warnings were significantly more effective than the U.S. warnings throughout the study period, SALIENCE (Log $OR = 1.06$, $\chi^2 = 975.86$, $p < .001$), HARM (Log $OR = 0.64$, $\chi^2 = 156.74$, $p < .001$), QUITTING (Log $OR = 0.49$, $\chi^2 = 48.01$, $p < .001$), FORGO (Log $OR = 0.48$, $\chi^2 = 99.31$, $p < .001$) (Supplementary Figure 1). The composite Labels Impact Index also indicated that the Canadian warnings were significantly more effective than the U.S. warnings throughout the study period ($B = 2.06$, $\chi^2 = 361.91$, $p < .001$) (Figure 1).

Table 1. Sample Characteristics at Recruitment (First Wave Surveyed for Each Respondent)

	Canada		United States		Overall	
	(n = 5,309)		(n = 6,412)		(n = 11,721)	
	Frequency	%	Frequency	%	Total	%
Wave of recruitment***						
1	2,157	40.6	2,060	32.1	4,217	36.0
2	502	9.5	659	10.3	1,161	9.9
3	538	10.1	866	13.5	1,404	12.0
4	507	9.5	717	11.2	1,224	10.4
5	570	10.7	722	11.3	1,292	11.0
6	537	10.1	690	10.8	1,227	10.5
7	306	5.8	359	5.6	665	5.7
8	192	3.6	339	5.3	531	4.5
Time-in-sample***						
1	1,950	36.7	3,095	48.3	5,045	43.0
2	1,240	23.4	1,492	23.3	2,732	23.3
3	788	14.8	769	12.0	1,557	13.3
4	461	8.7	445	6.9	906	7.7
5	308	5.8	265	4.1	573	4.9
6	208	3.9	158	2.5	366	3.1
7	155	2.9	99	1.5	254	2.2
8	199	3.7	89	1.4	288	2.5
Sex						
Female	2,846	53.6	3,505	54.7	6,351	54.2
Male	2,463	46.4	2,907	45.3	5,370	45.8
Age***						
18–24	654	12.3	709	11.1	1,363	11.6
25–39	1,597	30.1	1,642	25.6	3,239	27.6
40–54	1,959	36.9	2,363	36.9	4,322	36.9
55–max	1,099	20.7	1,698	26.5	2,797	23.9
Ethnicity***						
White	4,729	89.1	5,093	79.4	9,822	83.8
Non-White	580	10.9	1,319	20.6	1,899	16.2
Income***						
Low	1,500	28.3	2,369	36.9	3,869	33.0
Moderate	1,817	34.2	2,117	33.0	3,934	33.6
High	1,561	29.4	1,500	23.4	3,061	26.1
No answer	431	8.1	426	6.6	857	7.3
Education**						
Low	2,572	48.4	2,916	45.5	5,488	46.8
Moderate	1,951	36.7	2,463	38.4	4,414	37.7
High	786	14.8	1,033	16.1	1,819	15.5
Smoking status						
Daily smoker	4,930	92.9	5,976	93.2	10,906	93.0
Nondaily smoker	379	7.1	436	6.8	815	7.0
Cigarettes smoked per day***						
<10	1,665	31.4	2,005	31.3	3,670	31.3
11–20	2,270	42.8	2,966	46.3	5,236	44.7
21–30	1,133	21.3	845	13.2	1,978	16.9
≥31	241	4.5	596	9.3	837	7.1
Time to first cigarette (min)***						
>60	870	16.4	963	15.0	1,833	15.6
31–60	887	16.7	1,093	17.0	1,980	16.9
6–30	2,404	45.3	2,767	43.2	5,171	44.1
≤5	1,148	21.6	1,589	24.8	2,737	23.4
Intention to quit smoking***						
Within next 6 months	2,277	42.9	2,297	35.8	4,574	39.0
In the future/no intention to quit	3,032	57.1	4,115	64.2	7,147	61.0

** Pearson χ^2 test, $p < .01$.*** Pearson χ^2 test, $p < .001$.

Figure 1. Label Impact Index in Canada and the United States, Wave 2 (2003) to Wave 8 (2011), model-based adjusted estimates, controlling for all factors in the model. ^aHigher scores indicate greater warning label effectiveness. ^bThe tick marks on the x-axis represent January 1st of each year; the plotted estimates represent the median survey date for each survey wave. See Figure 1 in supplementary files for the individual measures of health warning effectiveness.

Warning Salience (SALIENCE)

There was a significant linear decline in smokers' reports of noticing the warnings in Canada while there was a small increase in noticing the warnings in the United States from Wave 1 to Wave 8 (Table 2 and Supplementary Figure 1i). As an example to aid interpretation, the log odds of noticing warning labels decreased among Canadian smokers (log *OR* = -0.05). In other words, for each additional wave, Canadian smokers had 5% lower odds of noticing the warning labels (odds ratio [*OR*] = 0.95). Canadian smokers were less likely to report noticing the labels at Wave 8 versus Wave 1 whereas there was no difference among U.S. smokers.

Thoughts of Harm (HARM)

There were significant linear declines in smokers' reports of thinking about the health risks of smoking because of the health warnings in Canada and the United States; the decline was similar in both countries (Table 2 and Supplementary Figure 1ii). Canadian smokers were less likely to report thinking about the health risks because of the health warnings at Wave 8 versus Wave 2. However, for smokers in the United States, there was no difference at Wave 8 versus Wave 2. The difference between Wave 8 versus Wave 2 was not significantly greater in Canada than the United States.

Thoughts of Quitting (QUITTING)

There was a significant decrease in smokers' reports of thinking about quitting because of the health warnings in Canada (Table 2 and Supplementary Figure 1iii). However, there was only a marginally significant decline in the United States, and there was no difference in the trend between the two countries. Canadian and U.S. smokers were similarly less likely to think about quitting because of the health warnings at Wave 8 versus Wave 2.

Forgoing of Cigarettes (FORGO)

There was a significant decline in smokers' reports of forgoing a cigarette at least once because of the health warnings in Canada (Table 2 and Supplementary Figure 1iv). However, there was no significant decline in the United States nor was there any difference in the trend between the two countries. There were no significant differences in reports of forgoing a cigarette at least once between Wave 8 versus Wave 1 in either country.

Labels Impact Index (LII)

For the linear trend, there was a significant decline in scores on the LII in Canada and United States between Wave 2 and Wave 8 (Table 2 and Figure 1). The decline in scores on the LII was significantly greater in Canada. Comparisons of LII scores at Wave 2 versus Wave 8 showed that the LII was significantly lower in Canada and United States at Wave 8 compared to Wave 2, and that the difference in the scores on the LII at Wave 8 compared to Wave 2 was no different in Canada compared to the United States.

DISCUSSION

This is the first study to systematically examine wearout of cigarette health warnings. Overall, this study found evidence of significant warning wearout in Canada, and the United States over the 9-year study period. The significant decline in the United States was unexpected because the warnings were in place for 17 years at the beginning of the study, and because their effectiveness was low to begin with. These findings suggest that the U.S. warnings became even less effective during the study period.

The findings also showed that the decline in effectiveness on the Labels Impact Index was greater in Canada than in the United States, possibly because of (a) the hypothesized floor effect for the U.S. warnings, and (b) the novelty effect of the Canadian warnings at introduction just prior to the

Table 2. Changes Over Time in Measures of Warning Label Effectiveness and the Labels Impact Index (LII)^{a,b}

Measure	Linear trend				Last wave vs. first wave			
	Comparison	Log OR	χ^2	p value	Comparison	Log OR	χ^2	p value
SALIENCE: Often/very often noticed warning labels	CA: Linear trend	-0.050	19.81	<.001	CA: Wave 8 vs. Wave 1	-0.490	25.80	<.001
	US: Linear trend	0.026	4.72	.030	US: Wave 8 vs. Wave 1	-0.037	0.11	.736
	Diff in linear trend by country?	-0.076	29.30	<.001	CA vs US relative diff @ W8 vs. W1?	-0.454	11.94	<.001
HARM: Labels make me think about risks a lot	CA: Linear trend	-0.057	9.77	.002	CA: Wave 8 vs. Wave 2	-0.320	5.45	.020
	US: Linear trend	-0.043	4.53	.033	US: Wave 8 vs. Wave 2	-0.178	1.24	.266
	Diff in linear trend by country?	-0.014	0.33	.565	CA vs US relative diff @ W8 vs. W2?	-0.142	0.54	.462
QUITTING: Labels make me a lot more likely to quit	CA: Linear trend	-0.071	8.05	.005	CA: Wave 8 vs. Wave 2	-0.504	6.47	.011
	US: Linear trend	-0.057	3.77	.052	US: Wave 8 vs. Wave 2	-0.448	4.05	.044
	Diff in linear trend by country?	-0.014	0.15	.694	CA vs. US relative diff @ W8 vs. W2?	-0.056	0.04	.840
FORGO: Gave up a cigarette at least once because of labels	CA: Linear trend	-0.049	9.42	.002	CA: Wave 8 vs. Wave 1	-0.213	2.66	.103
	US: Linear trend	-0.011	0.33	.564	US: Wave 8 vs. Wave 1	-0.036	0.06	.810
	Diff in linear trend by country?	-0.039	3.39	.066	CA vs. US relative diff @ W8 vs. W1?	-0.177	0.99	.319
LII: Labels Impact Index	Comparison				Comparison			
	β				β			
LII: Labels Impact Index	CA: Linear trend	-0.178	24.48	<.001	CA: Wave 8 vs. Wave 2	-1.034	18.80	<.001
	US: Linear trend	-0.083	5.25	.022	US: Wave 8 vs. Wave 2	-0.518	4.33	.038
	Diff in linear trend by country?	-0.095	5.60	.018	CA vs US relative diff @ W8 vs W2?	-0.516	3.36	.067

Note. OR = odds ratio, diff = difference, W8 = Wave 8, W1 = Wave 1, W2 = Wave 2, CA = Canada, US = United States.

^aAll models adjusted for sex, age, ethnicity, income, education, daily versus nondaily smoking, cigarettes/day, minutes to first cigarette after waking, intentions to quit, and time-in-sample.

^bSeparate logistic models were estimated using GEE for each of the individual measures of warning label effectiveness. For the Labels Impact Index, linear GEE regression models were used.

study. Because the U.S. warnings were in place for 17 years at the beginning of this study, it is not known if the U.S. warnings experienced wearout effects before the study began, or if they had never reached higher levels of effectiveness in the first place.

In line with previous research on the effectiveness of larger pictorial warnings (even over time) (Borland, Wilson, et al., 2009), the Canadian warnings remained more effective than the U.S. warnings throughout the study period.

Examination of the four individual measures of health warning effectiveness showed evidence of differential wearout. In Canada, warning salience showed the greatest degree of wearout. In contrast, forgoing of cigarettes, showed the least. This difference may reflect the comparatively high level of salience when the labels were introduced (i.e., a novelty effect), leaving more room for decline, and/or that behavioral reactions to the warnings (forgoing of cigarettes) may be less sensitive to wearout. Future research should seek to understand these differences because while the salience of the warnings seems to be important for informing smokers about the health risks of smoking (Hammond et al., 2006) forgoing of cigarettes is important for encouraging quitting and quit attempts (Borland, Yong, et al., 2009).

The WHO FCTC Article 11 Guidelines for health warning rotation specify that “rotation can be implemented by having multiple health warnings and messages appearing concurrently or by setting a date after which the health warning and message content will change.” However, our analysis suggests that implementing rotation solely “by having multiple health warnings and messages appearing concurrently,” (as Canada and the United States did during this study) does not prevent wearout. This study, and the principle that countries should have multiple warnings that appeal to different target groups (Devlin, Eadie, Stead, & Evans, 2007), suggest that both types of rotation should be implemented. Periodically changing warning content will also allow countries to incorporate emerging evidence about the health harms of tobacco, and new findings on effective warning design (Hoek et al., 2010).

The current study has limitations. This study used self-report surveys. It might be possible that social desirability led respondents to over-report positive outcomes such as noticing the labels. There was also differential attrition. Despite the above, it seems unlikely that social desirability and differences in attrition resulted in the pattern of results observed here that were in line with the hypotheses. Additionally, previous research has prospectively linked the self-reported measures of warning label effectiveness used in this study with actual quit attempts (Borland, Yong, et al., 2009).

It might be argued that a decline in warning effectiveness could be explained by factors other than wearout. Perhaps an increase in the proportion of respondents in the survey who were resistant to quitting produced a sample of respondents that were increasingly less responsive to the warnings. However, changing characteristics of the sample would be expected to similarly influence warning effectiveness in both Canada and the United States, whereas greater and more consistent wearout was observed in Canada vs. United States. Also, it is possible that events led to changes in warning effectiveness. For example, in the United States there was a peak in warning salience in 2009 that could have been caused by increased interest in the warnings following the FDA's Tobacco Control Act. The exclusion of Wave 1 data from the LII likely decreased the degree of wearout found for Canada on the LII because the novelty effect at Wave 1 would not

have been captured. Lastly, these findings are limited to continuing smokers, and may not generalize to quitters and nonsmokers.

SUPPLEMENTARY MATERIAL

Supplementary Figures 1i–iv can be found online at <http://www.ntr.oxfordjournals.org>

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DECLARATION OF INTERESTS

None declared.

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