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Temporal Effects of Message Congruency on Attention to and Recall of Pictorial Health Warning Labels on Cigarette Packages

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Abstract

Objectives: Recent research has shown that message congruency is beneficial to recall of pictorial health warning label (PWL) content after initial exposure. Despite less attention to the text warning, smokers exposed to congruent PWLs were more likely to recall the text and the message. This study aimed to replicate these findings and to examine whether congruency also affects recall after multiple exposures over time.

Methods: A total of 320 daily smokers (39.7% female; cigarettes/day: $M = 15.31$, $SD = 7.15$) were randomized to one congruent or incongruent PWL and attended 4 laboratory sessions over 10 days. During each session, eye movements were recorded while viewing the PWL and open-ended recall of label content was assessed after exposure.

Results: Smokers who were exposed to a congruent PWL were more likely to recall the text ($p = .01$) and the message ($p = .02$) and less likely to recall the image ($p = .003$) of the PWL after initial exposure. By day 4, incongruent PWLs were recalled equally well as congruent PWLs. Independent of condition, image recall was initially high and remained high whereas text and message recall was relatively low initially but increased over time. It was not until day 7 that about 80% of text and message recall was observed.

Conclusions: Even when exposed to the same PWL over time, smokers require multiple exposures to recall the text and the message of a PWL. More research on the effects of congruency in the natural environment, where smokers are exposed to multiple PWLs, is needed.

Implications: The findings of this study, and of previous work showing that message congruency in PWLs is beneficial to initial recall of PWL content, could potentially help to address legal challenges regarding the implementation of PWLs in the United States. Factually correct text warnings have been uncontested on US cigarettes packages since 1966. Congruent PWLs simply provide a means to visually support the same information as the existing text using a medium that better garners attention to the health information. Investigating and understanding longer-term effects of congruency are important and can empirically inform future warning label development, both in the United States via the Family Smoking Prevention and Tobacco Control Act, and via other governing bodies.

Introduction

As cigarette smoking is still the most preventable cause of death in the United States,[1] it is imperative that the public is properly informed about the risks of tobacco consumption. One effective tool to communicate the dangers of smoking is warning labels on cigarette packages.[2,3] Since the implementation of the Family Smoking Prevention and Tobacco Control Act of 2009, the US Food and Drug Administration (FDA) has the legal authority to regulate tobacco products, including the requirement that cigarette packages and advertisements have larger and more visible pictorial health warning labels (PWLs).[4] However, litigation by several tobacco companies has delayed the initiation of the FDA-proposed PWLs. Therefore, it will be critical to increase the evidence for the impact of PWLs by identifying and testing design features, such as message congruency, to optimally communicate the risk messages of smoking.[5]

Message congruency refers to the degree to which visual and textual information of PWLs convey the same message.[6] Congruent PWLs portray an image (eg, lungs) and textual information (eg, "Cigarettes cause fatal lung disease") that reflect a common theme. Messages communicated by the image or the text in incongruent PWLs (eg, the image portrays a tracheotomy releasing smoke, whereas the text states "Cigarettes are addictive") are not considered to be incorrect, however, their processing might require more inferential steps with the effect of greater cognitive load.

Our previous work showed that smokers who have a one-time exposure to incongruent PWLs spent more time focusing on the text warning of the PWL than smokers who were exposed to congruent PWLs.[5] However, despite shorter dwell time on the text warning, smokers in the congruent condition were more likely to correctly recall the text warning and the risk message of the PWLs immediately after exposure than smokers in the incongruent condition. These results are consistent with previous advertising research,[6–11] which suggest that positive congruency effects on memory may be due to semantic priming effects that increase processing fluency and improve memory for the information. Overall, this research suggests that congruent PWLs require less effortful processing than incongruent PWLs and may offer an advantage in terms of effectiveness. Moreover, our previous work also showed that, independent of congruency group, smokers recall the image (on average 87% of smokers) and the message (65.5%) relatively well, although having greater difficulties recalling the text (36%) of a PWL after a single exposure.[5]

These results of the effects of initial PWL exposure raise the questions as to whether correct recall of PWLs increases after multiple exposures over time and how the congruency effect develops temporally. As smokers would be exposed to the same PWL more than once in their natural environment, multiple exposures to PWLs over time reflect the real-life setting better. Therefore, the results of this study will provide an important first step in investigating whether exposure to PWLs over time improves recall of label content, particularly recall of incongruent PWLs. The aims of the current study were (1) to replicate the congruency effect that was found in previous research after initial PWL exposure,[5] and (2) to examine whether congruency also affects recall of label content after multiple exposures over time. On the basis of previous research,[5] we expected congruency to affect initial attention and recall after a single exposure on day 1. Independent of congruency group, we hypothesized recall to increase with multiple exposures over time.[12,13] We also expected the congruency effect to wane with multiple exposures over time; however, we had no a priori hypotheses on the duration of the effect. As a secondary aim, we investigated the effect of utilizing a shorter viewing time (7 seconds vs. 20 seconds) that more closely approximates real-world viewing behavior. This secondary aim was an examination of a more pragmatic approach to assessing viewing patterns in a duration closer approximating real-world encounters. Similar to a 20-second exposure, we expected smokers exposed to an incongruent PWL to focus longer on the text warning than smokers in the congruent condition during the first 7 seconds of exposure. During this initial time of exposure, smokers exposed to an incongruent PWL might spend more overall time fixating on the text warning than smokers exposed to a congruent PWL by alternating their attention between the image and the text more often in order to produce a complete mental model of the overall message.[14]

Methods

Sample and Procedure

A total of 360 daily cigarette smokers enrolled in the study. Inclusion criteria were consistent with our previous eye-tracking research[5,15,16] and included: currently smoking at least five cigarettes/day for at least one year; not using any forms of nicotine other than cigarettes; not currently undergoing smoking cessation treatment or trying to quit; no history or current treatment of substance abuse; no serious or unstable disease within past year; not currently pregnant or breastfeeding; drinking less than 25 alcohol-containing drinks per week; not currently suffering from depression or previously diagnosed for schizophrenia disorder; between 21 and 65 years old; speaking English fluently; no visual impairments; carbon monoxide > 5 ppm at intake session (baseline carbon monoxide breath samples were assessed to biochemically verify smoking status).

Participants responding to digital and print media advertisements were phone screened for eligibility. Data collection took place between 2014 and 2017. The study consisted of a 10-day duration protocol where participants returned to the research laboratory on days 4, 7, and 10. Participants were randomly assigned to one of the nine PWL conditions (one of the nine FDA-proposed PWLs) (Figure 1, Supplementary material), and were exposed to the same PWL during each of the four laboratory visits. In addition, during the 10-day period, at each visit, participants were provided with their own brand cigarettes with their assigned PWL affixed to each of their cigarette packages (results on smoking behavior will be reported elsewhere).[17,18] On day 1, a research assistant explained the procedure, participants gave informed consent, and completed smoking history and demographic assessments. At each visit, participants were seated in front of the eye-tracking device, were calibrated and viewed the PWL for 20 seconds.[5,16,19] After viewing, recall of label content was assessed. In addition, on day 10, participants were debriefed to the purpose of the study, had any questions answered and received $250 compensation. This protocol was approved by the University of Pennsylvania Institutional Review Board.

Congruency Conditions

Participants were randomly assigned to one of the nine FDA-proposed PWLs, stratified by gender and daily cigarette consumption (<15). To determine message congruency of each PWL, three trained raters evaluated the nine PWLs in their congruency between image and text.[5] While exposed to the PWLs, they answered the question "To what extent does the image convey the same information as the text?" (the categories of answer were: "same message," "different message," "somewhat similar message," "not certain").

Intra-class correlation coefficient (ICC) between raters was excellent [ICC (7,14) = 0.85, 95% confidence interval (CI) = 0.53 to 0.97, $p < .001$]. Four PWLs were rated as congruent and four were rated as incongruent (Figure 1, Supplementary material). The image of a baby with a wisp of smoke nearby with text stating: "Tobacco smoke can harm your children," was the least consistently scored PWL. Therefore, data from 40 participants assigned to this PWL were excluded from the analyses resulting in a final sample of 320 smokers. For the analyses, the 4 congruent and the 4 incongruent PWLs were grouped, resulting in a 2 (congruency group) × 4 (time) experimental design.

Measures

Demographic and Smoking History Measures

Age, gender, race, educational background, years smoking, daily cigarette consumption, age of first cigarette, craving,[20] readiness to consider smoking cessation,[21] intention to quit smoking,[22] and nicotine dependence,[23] were assessed before the exposure to control for possible baseline differences between congruency groups.

Eye-Tracking

Gazetracker software (v.07.01.243.128, Eye Response Technologies Inc., Charlottesville, VA) was used to display the PWLs. Eye-movements were measured using an Eye-Trac 6 control unit with an R6 pan/tilt optics system and video head tracker (Applied Science Laboratories, Boston, MA). Data transfer was linked using the Eye-Trac 6 User Interface Program (v.1.30.8.0). Areas of interest (AOIs) were identified a priori for each PWL and consisted of the image and the text areas. For each AOI, we assessed the latency (time to first viewing of AOI; in seconds) and two measures of dwell time. The first duration measure was the total time viewed in the AOI (in seconds) over the whole course of the 20-second exposure.[5,16,19] Previous research has suggested that warnings receive limited visual attention and have an average viewing time of approximately 7 seconds..[24–26] In order to increase external validity and more closely approximate real-world behavior, we also investigated whether the same effects on attention were found when taking only the first 7 seconds of exposure into account. In addition, to control for variability in total viewing time due to device data loss or intermittent participant distraction, we used the ratio of duration to total viewing time. Fixations were operationalized as any 60-pixel-diameter space with three consecutively sampled observations with a minimum cumulative duration of 200 ms, consistent with previous viewing images and reading tasks.[27]

Open-Ended Recall

Participants were asked to recall the image (eg, "Describe the picture in the warning label"), the text (eg, "What did the text read?"), and the risk message (eg, "In your own words, what is the main health or risk message of the warning label?") of the viewed PWLs. Three trained coders unaware of the study hypothesis scored each statement as correct or incorrect. In the incongruent condition, the risk message was scored as correct if the participant recalled the message that either the image or the text conveyed. This recall measure and its scoring are derived from standard open-ended recall procedures.[5,19,28] ICC for recall of the text was 0.63 (95% CI = 0.35 to 0.73); for message recall was 0.73 (95% CI = 0.64 to 0.80); and for image recall was 0.81 (95% CI = 0.75 to 0.91); all $p < .01$. These ICC values all exceed the minimum for good reliability,[5,29,30] and are consistent with our previous PWL work.[5]

Analysis Plan

Data were analyzed in Stata (v14). Descriptive statistics were used to characterize the overall sample and each congruency group. Independent samples t tests and chi-square tests (χ^2) were conducted to identify potential baseline group differences. Using independent samples t tests and chi-square tests, we first tested whether conditions differed in attention measures and in recall measures after the initial PWL exposure on day 1. Independent mixed-effects models were performed to examine the effects of congruency and time on attention measures. Three independent random-effects logistic regression models tested the effects of congruency and time on recall of the image, the text and the message. Overall interactions were tested using Wald chi-square statistics, and interaction terms were tested using corresponding z-statistic.

Results

Descriptive Statistics and Randomization Verification

Supplementary Table 1 reports sample characteristics by congruency. Participants were on average age of 43.2 years old (SD = 11.67; range = 21–65). The sample was predominantly male (60%) and mostly African American (52.2%) or White (38.8%). Most participants had completed a high school degree (83.4%); 13.4% had completed college. Participants reported starting to smoke when they were 15.80 (SD = 4.08) years old and reported smoking 15.14 cigarettes/day (SD = 6.66) with an average nicotine dependence score of 5.34 (SD = 2.15). There were no significant differences between congruency conditions in descriptive and smoking characteristics.

Congruency Effects on Attention and Recall After Initial PWL Exposure

Over the course of a 20-second viewing period, smokers who were exposed to an incongruent PWL spent more time focusing on the text AOI than smokers who were exposed to a congruent PWL (M = 3.26s, SD = 2.95 vs. M = 2.18s, SD = 2.81; $t(1,273) = 3.11$; $p = .002$). The same pattern of results was found when examining only the first 7 seconds of exposure (M = 1.34s, SD = 1.24 vs. M = 0.86s, SD = 1.09; $t(1,273) = 3.34$; $p = .001$). No effects of condition on the dwell time of the image AOI (20 and 7 second measure), on the latency to the image AOI or on the latency to the text AOI were found.

We found differences between congruency groups in all three recall measures on day 1. In the congruent group, 93.1% of smokers correctly recalled the image of the PWL compared to 99.4% of smokers in the incongruent group ($p = .003$). However, smokers in the congruent group were better at correctly recalling the text (39% vs. 25.6%, $p = .01$) and the message (57.2% vs. 44.4%, $p = .02$) of the PWL after the initial exposure.

Congruency Effects on Attention and Recall After Multiple Exposures Over Time

The three models examining the effects of congruency and time on dwell time of the image AOI (20 and 7 seconds) and on latency to the image AOI found no significant effects (data not shown).

The model examining the effects of congruency and time on dwell time of the text AOI (20 seconds) found no significant interaction effects, but a significant effect of congruency (b = – .59, z = – 2.32, $p = .02$) and of time (see Table 1). Dwell time of the text AOI increased from day 1 to day 4 and returned to baseline levels on days 7 and 10. Overall, smokers in the incongruent condition focused longer on the

Table 1. Results From the Three Independent Multilevel Mixed-Effects Models

	Odds ratio	SE	*z*	*p*	95% CI
Dwell time text AOI					
20 s					
Intercept	2.93	0.22	13.50	.00	2.50, 3.35
Congruency					
Incongruent	REF				
Congruent	−0.59	0.25	−2.32	.02	−1.09, −0.09
Time					
1	REF				
4	0.40	0.20	1.99	.05	0.01, 0.80
7	0.10	0.21	0.49	.62	−0.30, 0.51
10	0.06	0.21	0.28	.78	−0.35, 0.47
Dwell time text AOI					
7 s					
Intercept	0.39	0.02	15.96	.00	0.34, 0.44
Congruency					
Incongruent	REF				
Congruent	−0.04	0.03	−1.60	.11	−0.09, 0.01
Time					
1	REF				
4	−0.05	0.02	−2.04	.04	−0.09, −0.001
7	−0.06	0.02	−2.72	.01	−0.11, −0.02
10	−0.08	0.02	−3.15	.01	−0.12, −0.03
Latency text AOI					
Intercept	1.78	0.29	6.13	.00	1.21, 2.34
Congruency					
Incongruent	REF				
Congruent	1.06	0.30	3.56	.00	0.48, 1.65
Time					
1	REF				
4	−0.14	0.33	−.42	.67	−0.78, 0.51
7	0.65	0.33	1.95	.05	−.001, 1.31
10	0.64	0.34	1.89	.06	−0.02, 1.30

Models without interaction terms (nonsignificant interaction terms were dropped).
AOI = area of interest, CI = confidence interval, SE = standard error.

text AOI than smokers in the congruent condition. The model examining the effects of congruency and time on dwell time of the text AOI (7 seconds) found no significant interaction or congruency effects, but a significant effect of time. Dwell time of the text AOI in the first 7 seconds of exposure decreased over time (see Table 1).

The model examining the effects of congruency and time on latency to the text AOI found no significant interaction effects, but a significant effect of congruency (b = 1.06, z = 3.56, p = .001) and of time. Latency to the text AOI increased over time, however, smokers in the incongruent condition focused faster on the text AOI than smokers in the congruent condition (see Table 1). Table 2 presents the adjusted means for dwell times (over 20 seconds) and latency of initial fixations by congruency groups at days 1–10.

Table 3 reports the percentage of correct recall of the image, the text, and the message by congruency groups at days 1–10. Three independent models tested the effects of congruency and time on recall of the image, the text and the message, respectively (Table 4). In the prediction of recall of the image, there was a significant interaction effect between congruency and time (Wald $x^2(3)$ = 12.83, p = .012). Smokers in the incongruent condition were more likely to correctly recall the image on day 1 than smokers in the congruent condition, but this difference disappeared after repeated exposure. To note, correct recall of the image was high initially in both groups, remained high and did not differ across time; unsurprisingly, images were recalled well early and the effect persisted. In the prediction of recall of the text, there was a significant interaction effect between congruency and time (Wald $x^2(3)$ = 15.24, p = .002). The same pattern of results was found for recall of the message (see Table 4). Smokers in the congruent condition were more likely to correctly recall the text and the message on day 1 than smokers in the incongruent condition (Wald $x^2(3)$ = 8.91, p = .03). Recall of the text and the message increased in both conditions over time but there were no significant differences between congruency groups at the other time points.

Discussion

This study examined the effects of message congruency on attention and recall of PWL content and observed two important findings. First, we showed that congruency affects immediate attention and is beneficial to recall of label content after initial PWL exposure, replicating our previous work.[5] Second, we extended these findings by showing that the initial advantage of congruency diminishes with multiple exposures over time.

With regard to initial exposure, although smokers in the congruent condition focused less on the text warning than smokers in the incongruent condition, they were more likely to correctly recall the text and the message of the PWL. In addition to these findings that are consistent with previous research,[5] this study also found that

Table 2. Adjusted Means (SD) for Dwell Times and Latency of Initial Fixations by Congruency Groups at Days 1–10

Attention measures in seconds		Day 1	Day 4	Day 7	Day 10
Dwell time image AOI (over 20 s)	Congruent	7.63 (0.42)	7.41 (0.41)	7.92 (0.43)	8.26 (0.43)
	Incongruent	7.82 (0.41)	6.91 (0.41)	8.22 (0.42)	8.23 (0.44)
Latency image AOI	Congruent	1.60 (0.27)	1.41 (0.27)	1.52 (0.28)	1.47 (0.28)
	Incongruent	1.52 (0.27)	1.44 (0.27)	1.78 (0.27)	2.13 (0.28)
Dwell time text AOI (over 20 s)	Congruent	2.08 (0.25)	2.69 (0.25)	2.68 (0.26)	2.48 (0.26)
	Incongruent	3.17 (0.25)	3.37 (0.25)	2.79 (0.25)	2.89 (0.26)
Latency text AOI	Congruent	2.67 (0.36)	2.60 (0.35)	3.59 (0.36)	3.67 (0.37)
	Incongruent	1.94 (0.35)	1.74 (0.35)	2.33 (0.36)	2.22 (0.37)

AOI = area of interest.

Table 3. Percentage Correct Recall of the Image, the Text, and the Message by Congruency Groups at Days 1–10

		Day 1	Day 4	Day 7	Day 10
Image	Congruent	93.1*	95.4	96.6	98.6
	Incongruent	99.4*	98.7	98.6	99.3
Text	Congruent	39.0**	54.6	72.4	76.8
	Incongruent	25.6**	52.3	79.9	84.4
Message	Congruent	57.2*	71.7	81.4	88.7
	Incongruent	44.4*	65.4	86.8	88.7

*Indicates significant differences between congruency groups at $p < .05$ level; ** $p < .01$.

Table 4. Results From the Three Independent Random-Effects Logistic Regression Models

	Odds ratio	SE	*z*	*p*	95% CI
Recall image					
Intercept	398.5	491.2	4.86	.00	35.57, 4463.6
Time					
4	0.46	0.58	–.62	.54	0.04, 5.40
7	0.43	0.55	–.66	.51	0.04, 5.11
10	0.89	1.28	–.08	.94	0.05, 15.08
Congruency by time					
Congruent at time 1	0.06	0.07	–2.43	.02	0.01, .59
Congruent at time 4	0.22	0.20	–1.68	.09	0.04, 1.28
Congruent at time 7	0.33	0.30	–1.22	.22	0.05, 1.98
Congruent at time 10	0.42	0.55	–.67	.51	0.03, 5.31
Recall text					
Intercept	0.19	0.05	–5.90	.00	0.11, .33
Time					
4	5.86	1.85	5.58	.00	3.15, 10.89
7	42.35	16.73	9.48	.00	19.53, 91.87
10	66.32	28.23	9.85	.00	28.79, 152.7
Congruency by time					
Congruent at time 1	2.56	0.95	2.53	.01	1.23, 5.31
Congruent at time 4	1.22	0.44	.54	.59	0.60, 2.46
Congruent at time 7	0.51	0.21	–1.61	.11	0.23, 1.16
Congruent at time 10	0.46	0.20	–1.75	.08	0.19, 1.10
Recall message					
Intercept	0.71	0.17	–1.46	.15	0.44, 1.13
Time					
4	3.60	1.06	4.37	.00	2.03, 6.40
7	21.52	8.33	7.92	.00	10.07, 45.97
10	26.91	10.97	8.07	.00	12.10, 59.85
Congruency by time					
Congruent at time 1	2.20	0.74	2.32	.02	1.13, 4.27
Congruent at time 4	1.54	0.55	1.20	.23	0.76, 3.12
Congruent at time 7	0.54	0.24	–1.41	.16	0.23, 1.27
Congruent at time 10	0.93	0.45	–.15	.88	0.36, 2.41

CI = confidence interval, SE = standard error.

smokers in the incongruent condition were better at recalling the image after initial PWL exposure than smokers in the congruent condition. Besides the fact that image recall was high in both conditions (93.1% vs. 99.4%), the interpretation of this effect is questionable in the context of smokers' difficulty to correctly recall the text and the message. That smokers, for example, might more easily remember the image of a crying woman (PWL "incongruent 3") loses weight when at the same time they have greater difficulty interpreting this image in the context of health consequences of smoking (ie, message recall).

Of note, the initial advantage of congruency on text and message recall diminished by the PWL exposure in the laboratory on day 4. Incongruent PWLs were recalled equally well as congruent PWLs. This suggests that incongruent PWLs require additional exposure to achieve the same amount of recall, although the exact amount remains unclear given the variation in number of times the PWLs were viewed outside the laboratory when affixed to their cigarette packages. Although the congruency effect waned after multiple exposures over time, interpreting these findings requires consideration of some points.

First, initial exposure to warning labels as well as the initial viewing time may be important in information processing. In their natural environment, smokers' attention to PWLs competes against many other things, and therefore smokers spend only limited time on the warning label, thus emphasizing the value of the quick, initial impression.[24–26,31–34] In this study, smokers were exposed to the PWLs for 20 seconds, which likely exceeds the average total viewing time of a PWL in a real-life situation.[24] Due to a longer exposure time to the PWL, smokers might have processed the warning label more intensely and might therefore require more exposures to incongruent PWLs to achieve the same amount of recall in a real-life situation. In order to address this important issue, we also tested whether the same effects on attention were found when examining only the first 7 seconds of exposure, which have been suggested as an average viewing time for warning labels.[24–26] The findings of smoker's viewing patterns in this initial period showed the same group differences as after a PWL exposure of 20 seconds highlighting the importance of initial viewing time. Second, previous research has shown that initial recall of label content in PWLs was strongly associated with distal recall after a 5-day period in which smokers were not exposed to PWLs.[5] This indicates that when correctly recalling the message after initial exposure, smokers seem to remember it over a longer-term period. Third, incongruent PWLs caught up in recall after multiple exposures but only after smokers had been exposed to the same, and only one PWL for a period of 10 days. In their natural environment, smokers would not be continuously exposed to the same, but rather to a variety of PWLs. Therefore, outside of the laboratory smokers might possibly need more exposures to incongruent PWLs to recall them as well as congruent PWLs. Further, this stemming of recall difference would likely be diminished in the real world, as smokers would be exposed to many varieties of PWLs. Fourth, although the recall of congruent and incongruent PWLs increased over time, incongruent PWLs did not outperform congruent ones over the course of 10 days. These reasons might speak for the implementation of congruent messages on cigarette packaging.

Overall, the majority of smokers correctly recalled the image even after initial exposure. Smokers focused longer and faster on the image than on the text indicating that the image draws smoker's attention to the warning label, which is consistent with findings of previous research.[5,16,19] Although recall of the text and the message increased over time, smokers had difficulties recalling the text and the message of PWLs and it was not until day 7 that about 80% of recall of the text and the message was observed. In comparison to text, images are significantly more likely to capture and hold attention,[14,35–37] easier and less cognitively taxing to understand,[38] better able to facilitate information processing,[39,40] and thus likely to be better recalled. However, although graphic images increase attention to a warning, the text is a necessary requirement[41] and correct comprehension of the message often requires the understanding of the text. Accompanying text may also be necessary to convey more precise meaning[14] and to provide arguments that support and enhance the believability of a message.[42,43] Thus, given that smokers largely ignore the text warning,[16,25,31–34] textual information that conveys the same message as the image might be helpful in recall of information.[42] Previous and this work have shown that smokers require less attention to the text warning in order to understand the message if the text complements the message of the image.

Some limitations and their subsequent implications for future research need to be discussed. First, recall of PWL content among nontreatment-seeking, daily smokers from a single city may not represent the larger U.S. smoking population. Second, the study was not designed to investigate the trend of viewing patterns of PWLs over time. Smokers were exposed to their assigned PWL on provided cigarette packages between laboratory visits. The study design did not control for this additional exposure, which likely varied between smokers and may have affected their subsequent viewing patterns (during the following laboratory visits). Understanding how smoker's viewing patterns change after multiple exposures to the same PWL may identify important features of PWLs and may shed light on the importance of the initial exposure to PWLs. Third, smokers were asked to view the PWLs for 20 seconds. In future research it may be important to consider a more refined measure of exposure (7 seconds) that more closely mimics real-life situations[24–26] or to leave the time of exposure up to the participant. Fourth, we tested congruency effects of the nine existing FDA-proposed PWLs to increase external validity. However, these PWLs differ in other features than in their level of congruency (eg, location, structure or length of the text, framing of the message,[44] and image type[45]) which could account for the associations between congruency and recall. To address this issue, future research should create congruent and control (incongruent) PWLs by manipulating the text and the image to systematically test congruency effects in experimental designs. Creating congruent images to accompany the already existing text warnings on current labels might be less challenging for concrete messages (eg, "Cigarettes cause fatal lung disease") than for messages that communicate more abstract health consequences (eg, "Cigarettes are addictive"). Future research could also help answer the question of how to optimize message congruency in PWLs by testing different images in order to evaluate how to visually best portray, for example, the concept of "addiction."

In sum, results from this study and from previous work[5] show that message congruency in PWLs is beneficial to initial recall of the text and the message of PWLs. This initial advantage diminishes after multiple exposures to the PWL, suggesting that incongruent PWLs require additional exposure to achieve the same rate of recall as congruent ones. Independent of congruency group, smokers had difficulties recalling the text and the message of the PWL; about 80% of text and message recall was only observed after multiple exposures on day 7. More research on the effects of congruency over time in the natural environment is needed to fully understand how health information can be best communicated on PWLs.

Supplementary Material

Supplementary data are available at *Nicotine & Tobacco Research* online.

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Declaration of Interests

None declared.

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