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Feasibility and Reliability of a Mobile Tool to Evaluate Exposure to Tobacco Product Marketing and Messages Using Ecological Momentary Assessment

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Abstract

Introduction—Existing measures of tobacco marketing and messaging exposure are limited, relying on recall, recognition, or proxy measures. This study aimed to determine the feasibility and reliability of a mobile application for the measurement of tobacco and e-cigarette marketing and message exposure using ecological momentary assessment (EMA).

Methods—Young adults from Austin, TX (n=181, ages 18–29) were instructed to use a mobile application to record all sightings of marketing or social media related to tobacco (including e-cigarettes) in real-time for 28 days (Event EMAs). Tobacco product use and recall of message encounters were assessed daily using an app-initiated EMA (Daily EMAs).

Results—The mobile app was a feasible and acceptable method to measure exposure to tobacco messages. The majority of messages (45.0%) were seen on the Internet, and many were user-generated. Thirty-day recall of messages at baseline was poorly correlated with messages reported via Event EMA during the study period; however, the correlation between post-study 30-day recall and Event EMA was much stronger ($r=0.603$ for industry-sponsored messages, $r=0.599$ for user-generated messages). Correlations between Daily EMAs and 30-day recall of message exposure

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Contributors

All authors substantively contributed to the development, analysis, and/or writing of the manuscript.

Conflict of Interest

The authors have no conflicts of interest to disclose.

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(baseline and post-study) were small (baseline: $r=0.329-0.389$) to large (post-study: $r=0.656-0.766$).

Conclusions—These findings suggest that EMA is a feasible and reliable method for measuring tobacco message exposure, especially given the prevalence of messages encountered online and on social media. Recall measures are limited in their ability to accurately represent marketing exposure, but might be improved by a period of priming or clearer response categories.

Keywords

Tobacco; Marketing; Ecological Momentary Assessment; Social Media

1. Introduction

A large body of evidence links awareness and receptivity to pro-tobacco marketing and media to initiation, experimentation, and use of cigarettes among youth and young adults.¹⁻⁴ Many have concluded that this evidence is sufficient to support a causal, dose-response relationship between exposure to tobacco marketing and adolescent smoking behaviors.^{1,5,6} However, the validity of common marketing exposure measures has yet to be established. Increasing validity of these measures would strengthen causal inferences that have been made from this research to date.^{5,7,8}

There is currently no “gold standard” for measuring exposure to pro-tobacco messages. The majority of marketing exposure measures rely on participant recall; for example, asking how frequently during the past 30 days participants saw tobacco ads in various locations (i.e., print media, billboards, point of sale, and the Internet).^{9,10} Yet, recall measures have several limitations. Studies have demonstrated that when participants are asked to summarize experiences over an interval of time, recent experiences are more influential than distant experiences.^{11,12} In addition, ecological factors have been shown to bias recall, such as mood at the time of the survey,¹³ and how much the viewer likes the marketing.¹⁴ Other methods of measuring advertising exposure are less ideal. They include evaluating recognition of tobacco brands, ownership of tobacco promotional items, or proxy measures such as gross impressions calculated from participants’ favorite magazines.¹⁴⁻¹⁶ At best, such methods are an indirect measure of marketing exposure, and at worst, a measure of a completely different construct.⁷

These weaknesses have become more problematic given the changing landscape of tobacco marketing. Numerous studies have demonstrated that tobacco products (including e-cigarettes) have an increasingly strong online presence.¹⁷⁻¹⁹ While some social networking sites such as Facebook and Twitter have policies preventing paid advertisement for tobacco products,^{20,21} the proliferation of user-generated pro-tobacco content remains unfettered. User-generated pro-tobacco content, especially about hookah, cigars and e-cigarettes,^{22,23} has been observed on a multitude of social networking sites such as YouTube,²⁴ Instagram,²⁵ and Facebook.²⁶ The new wave of social media messaging is particularly effective at targeting adolescents and young adults, as it utilizes peer acceptance, social interaction, and identity development.²⁷

Although many agree that online advertising is an important target for regulations and counter-marketing efforts,^{28,29} the extent of online tobacco marketing exposure is poorly understood. Thus far, research has been limited to descriptive studies,^{24,30–32} studies that examine overall trends in online marketing^{17,33} or qualitative content analyses^{23,34,35} rather than quantifying specific exposure.

The changing landscape of tobacco marketing has created new challenges for measurement. Measuring exposure to online advertising is notoriously difficult due to the targeted and personalized nature of online marketing.³⁶ Targeted advertising dramatically changes the online experience of each individual, and 62% of young adults between the ages of 18 and 29 reported noticing advertisements online directly related to recently visited sites or search terms.³⁷ The implication of this marketing practice is that there is no way to accurately determine the types of pro-tobacco messages seen by an individual unless computer monitoring software is installed or the individual reports ad exposure themselves. Although some studies have attempted to summarize online tobacco advertising by examining marketing expenditures and conducting broad internet searches to determine general characteristics of ads,¹⁷ at best, this method captures only industry-sponsored messages.

One potential solution is the use of methods such as ecological momentary assessment (EMA). EMA utilizes the repeated collection of real-time data on participants' behavior and experience in their natural environment.¹³ This method accounts for environmental characteristics of the measurement, while simultaneously avoiding the data distortion inherent in retrospective accounts.¹² Several pilot studies have demonstrated the feasibility of using EMA to capture tobacco and alcohol marketing exposure;^{8,38} however, participants were required to carry a separate device (i.e., not their own smartphone), and they only reported industry-sponsored messages.

In this study, we examined the feasibility and reliability of a mobile application to evaluate exposure to tobacco product marketing and messages via EMA. We utilized an application that participants could download to their own smartphone, and gathered data on exposure to and perceptions of tobacco-related marketing and messages, including both industry-sponsored and user-generated content.

2. Methods

2.1 Participants

Participants were young adults aged 18–29 living in Austin, Texas. Participants were recruited via printed flyers and online ads placed on Craigslist and the University of Texas at Austin events calendar. Participants were enrolled after completing a brief eligibility questionnaire, requiring that they speak English and own a smartphone capable of accessing the Internet. One hundred and eighty-one participants completed a baseline survey. Of those participants, 148 completed all 28 days of the study, 10 dropped out, and 23 were dropped due to inactivity.

2.2 Procedure

The study was approved by the Institutional Review Board at The University of Texas Health Science Center at Houston. Data collection took place between March and June 2015. At baseline, participants provided informed consent and installed a free application (SurveySwipe by SurveyAnalytics) onto their personal smartphone. Participants were given study instructions via e-mail, and completed a baseline survey assessing demographic information, use of social media and the internet, use of tobacco (including e-cigarettes), and perceptions of tobacco advertising.

Participants were instructed to record all sightings of marketing, messages, or social media related to tobacco seen during the study period. Products of interest were defined as: cigarettes, cigars, little cigars, or cigarillos, chewing tobacco, snuff, snus, or dip, hookah, dissolvables (such as Camel orbs, sticks, or strips), and e-cigarettes, vape pens, or personal vaporizers. Participants were asked to report both industry-sponsored marketing (defined as printed ads, flyers, billboards, coupons or promotional-email offers, online ads, and industry-sponsored social media such as an official Facebook page), and user-generated messages (defined as Facebook posts, Instagram photos, Vines, or Tweets, and online discussion threads).

2.2.1 Daily EMA—Tobacco use and recall of message sightings were evaluated every 24 hours via a push notification delivered to participants' phones each day at 12 P.M. Participants who did not complete the daily survey by 9 A.M. the following morning also received a reminder via e-mail. Participants who were inactive for 7 consecutive days were sent an e-mail reminding them of the participation requirements, contact information for the research team, and a link to unsubscribe from the study if they desired. Participants who remained inactive after 14 days were dropped from the study.

2.2.2. Event EMA—Real-time encounters with tobacco marketing and/or messages were submitted via a participant-initiated, repeatable survey in the application. Upon seeing a message, participants could start the survey and upload a photograph or screenshot of the message as a question response through the app. Because we were interested in exploring what marketing and messages participants noticed without any kind of external influence or incentive, participants were not prompted or reminded by the mobile app to report these events.

2.2.3. Incentives and study completion—After completing 28 Daily EMA surveys, participants were asked to complete a follow-up survey in which they reported their marketing or message recall and past 30-day tobacco use. Participants also answered usability questions related to the mobile app and study protocol. Participants received a gift card via e-mail for every 7 daily surveys completed during the study period. Due to the possibility that participants might alter their reporting behavior in order to increase a financial reward, the decision was made not to award incentives based on the submission of Event EMAs. A \$10 was awarded for completion of the 7 daily surveys in week 1, \$15 for week 2, \$25 for week 3, and \$30 for week 4. In addition, 10 randomly selected participants were given a \$150 gift card for participating in the full four weeks of the study.

2.3 Measures

2.3.1. Tobacco use—Use of cigarettes, cigars, and smokeless tobacco was assessed at baseline and at the study conclusion by asking participants how many days in the last month they had used the product.³⁹ For other products, including hookah, snus, dissolvables, and e-cigarettes, participants were asked if they had used the product in the last month. From these items, we created a new variable to define tobacco use categories (nonuser, tobacco only, e-cigarette only, or dual user (both tobacco and e-cigarettes)). Participants who had not used a product on even one day in the last month were considered nonusers for analysis.

2.3.2. Exposure to tobacco marketing and messages—Marketing and message exposure was evaluated in several ways (Table 1). At baseline and at study conclusion, 6 items were used. The first two items asked participants to recall the number of industry-sponsored and user-generated messages they encountered in the past 30 days. The final four items asked participants how often they saw ads or promotions for tobacco or e-cigarettes when they used the Internet, read newspapers or magazines, went to a convenience store, supermarket, or gas station, or saw an outdoor billboard or sign outside of a store, using a 5-point scale from never (0) to always (4).³⁹ On the Daily EMA, participants were asked to recall the number of industry-sponsored and user-generated messages they encountered in the past 24 hours. Participants were not able to review their responses to the Daily EMAs after submission to avoid influencing the recall measures at post-study.

On the Event EMA, participants were asked to upload a photo or screenshot of the message, or give a reason if they were unable. Participants who chose the “I am unable to take a picture or screenshot” option were prompted with an open-ended text response to explain. Participants were asked six questions upon submission of a message, including whether it was industry-sponsored or user-generated, its location (e.g., magazine, billboard, inside a bar or restaurant, on the Internet, etc.), the website or social network if seen online, the type and brand of product shown, and if the participant regularly uses the displayed product.

2.3.3. Covariates—Several covariates known to influence tobacco behaviors were measured, including age,⁵ gender,⁴⁰ ethnicity (Hispanic),⁴¹ race (White, Black or African American, Asian, and Other/More than one race), and enrollment in a 2- or a 4-year college/university. Participants also indicated if they used browser extensions that block ads on their computer or smartphones.

2.4 Data Analysis

To evaluate the feasibility of the mobile application, descriptive statistics were used to describe participant characteristics and study compliance, including Daily EMA response rates, submission of tobacco marketing and message encounters, and patterns of attrition. Pearson’s Chi-Square tests and t-tests were performed to identify demographic differences among those who completed the baseline survey only versus those who completed all components of the study.

To evaluate the reliability of the Event EMA as a measure of exposure to tobacco messages, we created aggregate variables for Daily and Event EMA message exposure for each

participant by summing the total number of messages seen over the study period via each measure. For the perceived frequency measure, we treated values of “N/A” as missing, and assigned values of 0 to 4 for “never,” “rarely,” “sometimes,” “most of the time,” and “always.” Because of the non-parametric nature of the data, we then calculated Spearman correlation coefficients between baseline, Daily and Event EMA exposure; between post-study, Daily, and Event EMA exposure; and between Daily and Event EMA exposure. Finally, we conducted paired samples t-tests to compare the mean number of reported messages at baseline versus post-test. Analyses were conducted using IBM SPSS Statistics for Windows, Version 22.0.

3. Results

3.1 Sample Characteristics

Participant characteristics are described in Table 2. Pearson’s Chi-Square and t-tests revealed no significant differences in age, gender, race/ethnicity, student status, or tobacco use status across those who submitted at least one Event EMA versus those who did not, nor across those who completed all 28 days of the study versus those who did not ($p>0.05$).

3.2 Study Participation and Compliance

Overall, 81.8% ($N = 148$) of participants completed all 28 days of the study. Of the 33 participants who dropped out before completion, the majority (57.6%) dropped within the first week. Participants were largely compliant with the Daily EMA survey prompts. Eighty percent of all Daily EMAs ($N = 4,224$) were submitted on consecutive days. Of the 20% of surveys ($N = 814$) submitted on non-consecutive days, 80% were two days apart, 5% were separated by less than a day, and the remaining 15% were submitted between 3 and 11 days apart.

Ninety-two participants submitted at least 1 Event EMA report. On average, each participant submitted a total of 1.37 industry-sponsored marketing encounters ($SD=3.89$, median = 0, range = 0–36) and 1.03 user-generated messages ($SD=3.52$, median = 0, range = 0–30) over the 28-day assessment period. Spearman correlation coefficients were used to examine concurrence between the total number of messages reported over the study period via Daily EMA and the total number of messages reported over the study period via Event EMA. The correlation between Daily and Event EMA report was 0.745 ($p<.001$) for industry-sponsored messages, and 0.639 ($p<.001$) for user-generated messages.

3.3 Message Characteristics

Based on the Daily EMA, 62.1% of marketing and messages were user-generated, and 37.9% were industry-sponsored. Detailed information about location and product was available for the Event EMA submissions. The majority of messages reported via Event EMA (45.0%) were seen on the Internet, followed by 32.7% seen at the retail point of sale (inside or outside a convenience store, gas station, grocery store, drug store, or smoke shop). The majority of Event EMA messages depicted traditional cigarettes (47.2%), followed by e-cigarettes (31.3%), cigars (7.3%), hookah (7.0%), and smokeless tobacco (3.4%). In the remaining 3.9% of messages categorized as “other,” the product was not recognizable (for

example, smoke was depicted without showing the source). Although most messages submitted were pro-tobacco, 10.1% of messages included counter-marketing campaigns or articles shared on social media emphasizing the health risks of tobacco and/or e-cigarettes.

3.4 Reliability of EMA Measures of Marketing and Messaging Exposure

One of the assumptions of research examining the relationship between advertising exposure and tobacco use is that past 30-day recall reported at baseline is representative of a participant's typical exposure to ads.¹ We compared both baseline and post-study 30-day recall of tobacco messages to summaries of Daily and Event EMAs using Spearman correlation coefficients (Table 3). Correlations between the number of messages reported via 30-day recall at baseline and the sum of the actual number of messages reported via Daily and Event EMA were small but significant ($p's < .05$). Correlations between the EMA measures (both Daily and Event) and post-study 30-day recall were much stronger (all $p's < .001$). In particular, the correlations between post-study 30-day recall and Event EMA were much higher than the baseline measures, with a correlation of 0.603 for industry-sponsored messages, and 0.599 for user-generated messages.

We also compared the perceived frequency of tobacco ads seen in print media, billboards, point of sale, and the Internet with the actual number of ads reported in these locations via Event EMA (Table 3). Overall correlations between the perceived frequency of messages seen and the actual number of messages reported via Event EMA were poor at both baseline and post-study. Only the correlation between messages seen at the point of sale at post-study was significantly related to Event EMAs ($r = 0.332$, $p < .01$).

One concern about the study design was the possibility that by virtue of participating in the study, participants would be "primed" or more observant of tobacco or e-cigarette messages, thus reporting more messages than they would normally observe. Paired samples t-tests revealed that the mean number of messages reported was lower at the post-study assessment than at baseline for every measure (both recalling the number of messages and recalling the perceived frequency of messages) (Figure 1). These differences were significant for the frequency of ads seen in print media ($p < .01$), point of sale ($p < .001$), and billboards ($p < .001$). Paired-samples t-tests were conducted to compare the number of messages reported via 30-day recall at baseline and post-study to the total number of messages reported from the Daily EMAs (Figure 1). There were no significant differences between the mean number of messages reported via 30-day recall and the mean number of total messages reported via the Daily EMA, for either baseline or post-study recall.

4. Conclusions

In this study, we examined the feasibility and reliability of measuring tobacco message exposure via EMA. This research expands the work of Martino et al.,⁸ that demonstrated the feasibility of using EMA to measure pro-tobacco media; however, to our knowledge, this is the first study to assess direct exposure to user-generated pro-tobacco messages on social media, in addition to tobacco industry-sponsored marketing.

There were several key findings. First, although the repeated-measures nature of EMA can be demanding on participants, we found that the majority (81.8%) of participants were able to complete all 28 days of the study and were largely compliant with the Daily EMA prompts. Unlike previous EMA studies that have measured marketing exposure, we sought to reduce the burden on participants by utilizing a mobile application installed on participant-owned smartphones. This eliminated the need to carry a separate device and the need for device training. Since many young adults use social media primarily on their smartphones, the decision to use a mobile app also had the benefit of making it easier for participants to take screenshots of social media message encounters.

Second, a majority (62.1%) of tobacco and e-cigarette related marketing and messages encountered by our sample were user-generated. Most user-generated images shared in the Event EMA were personal photos or videos featuring tobacco or e-cigarettes, but were not necessarily explicitly promoting their use. For example, “selfies” in which the subject was holding a cigarette were common. These messages, although not directly encouraging tobacco use, may normalize the use of tobacco and e-cigarettes within social networks, which has been shown to predict future tobacco use.^{42,43}

Third, our results demonstrate that pre-EMA recall measures are limited in their ability to accurately represent tobacco marketing and message exposure. Much of the longitudinal research on the relationship between tobacco marketing exposure and tobacco use evaluates exposure via recall only at baseline, making the assumption that an individual’s advertising exposure remains relatively consistent through the follow-up period.¹ Using this same assumption, we compared Daily and Event EMA reports of tobacco messages to 30-day recall and perceived frequency of exposure at baseline and post-study. We found that participants’ baseline 30-day recall was very poorly correlated with actual daily reports during the study period. However, the post-study assessment 30-day recall was much closer to what was reported during Daily EMAs, suggesting that a period of priming in which participants are instructed to record their marketing exposure on a daily or momentary basis may improve the accuracy of recall measures.

The perceived message exposure frequency measure was poorly correlated with actual reports of marketing and message exposure at both baseline and post-study assessments. There are several possible explanations for this discrepancy. First, the scale used for perceived frequency of messages (e.g., never, rarely, sometimes) is highly subjective. Second, the perceived message frequency measure introduces more potential for error, as participants are required to recall both the amount and location of marketing to which they were exposed. Together, these results suggest that measurement of tobacco marketing and message exposure could be improved by having clearer, less subjective response categories, by minimizing recall bias (e.g., by using EMA), or by utilizing a priming period to make participants more aware of the tobacco messages that they encounter.

This study has several limitations. First, our sample was limited to a relatively homogenous group of college students who were primarily white, female, non-tobacco users. Thus, the generalizability of our results may be limited. While college students are an important target for tobacco research, future studies would benefit from a larger, more diverse sample with a

greater proportion of tobacco users. Second, it is unknown to what extent the EMA message submissions described here are representative of the nature and extent of messages actually encountered by participants. Participants were instructed to record all sightings of marketing or social media related to tobacco or e-cigarettes seen in real time, however they were not prompted or reminded by the mobile app to do so. The high burden of recording every exposure to tobacco-related messages may have affected compliance, and some participants reported in the post-study assessment that they forgot to initiate Event EMAs.

Third, it is possible that participating in a study about tobacco message exposure made participants more conscious of message encounters, causing them to report more messages than they would have noticed otherwise. However, paired samples t-tests comparing participants' 30-day message recall measured at baseline with their recall at the post-study visit revealed that participants actually reported seeing significantly more industry-sponsored messages at baseline, suggesting they may have overestimated the frequency of their exposure before closely attending to their exposure during the study. Finally, the stronger concordance between real-time EMAs and end-of-study recall measures versus baseline measures may be due to variability in tobacco marketing and message exposure from month to month. Given this possibility, future research evaluating relationships between tobacco marketing and product use should utilize repeated measurements of marketing exposure to minimize bias.

These results demonstrate a need for additional research on the nature and extent of pro-tobacco and e-cigarette messaging online and on social media, especially among young adults. Given the individualized and varied content on social media, it is important to consider methods such as EMA that can explore the nuances of online messages using objective elements such as submitted photographs or screenshots rather than recall. A deeper understanding of online tobacco marketing is critical so we might identify potential regulatory targets and ideal channels for counter-marketing efforts.

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Highlights

- Commonly used measures of tobacco marketing exposure are subject to recall bias.
- Ecological momentary assessment (EMA) reduces retrospective recall error.
- EMA is a feasible and valid method to measure tobacco marketing exposure.
- Recall measures might be improved with clearer response categories or with priming.

Figure 1.
Mean Number of Messages Reported

Table 1

Measures of exposure to tobacco marketing and messages

Construct	Measure	Baseline	Daily EMA	Event EMA	Post-Study
30-Day Recall	In the past 30 days, about how many times did you see <u>industry-sponsored</u> tobacco or e-cigarette advertisements (e.g. billboards, posters, online banner ads)?				
	In the past 30 days, about how many times did you see <u>user-generated</u> tobacco or e-cigarette content (e.g. social media posts, discussion threads, photos, or videos)?	X			X
Perceived Frequency	How often do you see ads or promotions for tobacco products or e-cigarettes...				
	• When you use the Internet?				
	• When you read newspapers or magazines?				
	• When you go to a convenience store, supermarket, or gas station?	X			X
	• On an outdoor billboard or sign outside of a store?				
SCALE: N/A, Never, Rarely, Sometimes, Most of the time, Always					
24-Hour Recall	In the past 24 hours, how many times did you see <u>industry-sponsored</u> tobacco or e-cigarette advertisements (e.g. billboards, posters, online banner ads)?		X		
	In the past 24 hours, how many times did you see <u>user-generated</u> tobacco or e-cigarette content (e.g. social media posts, discussion threads, photos, or videos)?				
Photograph or Description	Submitted photograph or screenshot of encounter, or description of message if unable to take picture			X	

Table 2

Participant Characteristics by Survey Participation

Characteristic	Baseline % or Mean (N or SD) N = 181	Event EMA % or Mean (N or SD) N = 92	Post-Study % or Mean (N or SD) N = 148
Age	20.94 (2.9)	21.21 (2.9)	21.09 (3.0)
Female	77.9% (141)	76.1% (70)	79.1% (117)
Hispanic	14.4% (26)	16.3% (15)	14.9% (22)
Race			
White	60.2% (109)	62.0% (57)	58.8% (87)
Black	5.0% (9)	5.4% (5)	4.7% (7)
Asian	27.1% (49)	25.0% (23)	28.4% (42)
Other/More than One	7.7% (14)	7.6% (7)	8.1% (12)
Student	85.6% (155)	81.5% (75)	83.8% (124)
Tobacco Use			
Non-User	64.1% (116)	69.6% (64)	66.9% (99)
Tobacco Only	20.4% (37)	15.2% (14)	18.2% (27)
E-Cigarettes Only	2.8% (5)	2.2% (2)	3.4% (5)
Dual	12.7% (23)	13.0% (12)	11.5% (17)

Note. Tobacco use defined as use on at least one day during the last 30 days, dual defined as the use of both e-cigarettes and another tobacco product during the last 30 days

Table 3

Correlation Between Baseline and Post-Study Recall vs. Messages Reported via EMA

	Baseline vs. Daily EMA	Post-Study vs. Daily EMA	Baseline vs. Event EMA	Post-Study vs. Event EMA
30-Day Recall				
Industry-Sponsored	0.389 ***	0.656 ***	0.241 **	0.603 ***
User-Generated	0.329 ***	0.766 ***	0.196 *	0.599 ***
Perceived Frequency				
Magazine	-	-	0.136	0.147
Billboard	-	-	-0.058	0.084
Point of Sale	-	-	0.172	0.332 **
Internet	-	-	-0.112	0.199

Note. Location of ad only assessed on Event EMA

*
p < .05,

**
p < .01,

p < .001