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A Vision for Eye-tracking Research in Tobacco Regulatory Science

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Abstract

The purpose of this compendium of recent research in this themed issue is to heighten awareness of eye-tracking methodology and its application in tobacco regulatory science to advance knowledge of consumer understanding of the diversity of advertising, marketing, and other communications about tobacco products. Eye-tracking provides an objective and direct measure of attention that cannot be obtained through self-reported measures. The 7 papers selected for this special issue contribute to scientific knowledge and this editorial provides a synthesis to help guide readers and offer insights for future eye-tracking research. These elegantly designed studies apply eye-tracking methods to 3 major topics related to tobacco products: health warnings, advertising, and constituent information. The application of eye tracking methodology to tobacco regulatory science research has the potential to increase understanding of the impact of tobacco communication and marketing on consumers.

Keywords

eye-tracking; communication; health warnings; harmful and potentially harmful constituents; advertisements; marketing

As part of its effort to protect Americans from tobacco-related death and disease through regulation of the manufacturing, distribution, and marketing of tobacco products, the Food and Drug Administration (FDA) Center for Tobacco Products (CTP) supports science and

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None noted.

research to better understand tobacco product use and associated risks. A cornerstone of the CTP research program is an interagency partnership with the National Institutes of Health (NIH) to foster the development of the emerging field of tobacco regulatory science (TRS). TRS research is funded by CTP and administered through the Tobacco Regulatory Science Program (TRSP) within the Office of Disease Prevention (ODP) at the NIH along-side partnering NIH institutes and includes the Tobacco Centers of Regulatory Science (TCORS), individual research grants (eg, R01, R21), and interagency agreements.

Communication about the risks of using tobacco products and tobacco product marketing are 2 CTP priority areas in which many tobacco regulatory scientists and CTP funded grantees have focused their research efforts. Several studies have employed eye-tracking methodology to assess consumer attention to tobacco-related communication and marketing. Eye-tracking provides an objective and direct measure of attention that cannot be obtained through self-reported measures (eg, recall), which may be biased.^{1,2} Attention to stimuli is essential for information processing and recall. Often, assessment of attention is combined with other methods, such as self-reports from surveys, to understand how attention to specific visual stimuli correlates with variables such as attitudes, beliefs, cognitions, and behaviors.

Eye-tracking methods are traditionally conducted in a stationary environment (eg, sitting and looking at a computer monitor). Often, researchers identify areas of interest (AOIs) for their study *a priori* and assess different measures for each of the AOIs. The most commonly used eye-tracking measurement is *dwell time*, which refers to the total time (typically in milliseconds) spent fixating on a particular visual stimulus. Other eye-tracking measures include fixations (eg, time to first fixation or total number of fixations) which are described as when the eyes stop scanning and hold the central vision in place to take in detailed information about stimuli, and saccades which are the eye movement used to move central vision rapidly from one point of interest to another.

Understanding visual attention to tobacco-related communications and marketing may inform the CTP in developing activities and regulatory policies. In a systematic review, Meernik et al³ identified 18 eye-tracking studies reporting outcomes related to tobacco regulation and communication (health warnings, tobacco advertising, tobacco product packaging, tobacco marketing at the point of sale, and general tobacco communication). These eye-tracking studies consistently showed that health warnings often were ignored. However, the authors concluded that novel warnings, graphic warnings, and plain packaging can increase attention towards warnings. Across studies, greater visual attention to warnings on advertisements and product packages were associated with greater cognitive processing through measurement of participants' correct recall of the warning messages. Similarly, Maynard et al⁴ argued that techniques such as eye-tracking and other methods more commonly employed in neuroscience research (eg, electroencephalography and functional magnetic resonance imaging) provide a deeper understanding of underlying cognitive mechanisms to assess the impact of tobacco policy on consumers compared to more traditional methods (eg, surveys, experiments).

SPECIAL ISSUE ON EYE-TRACKING

The purpose of this compendium of recent research in this themed issue is to heighten awareness of eye-tracking methodology and its application in TRS to advance knowledge of consumer understanding of the diversity of advertising, marketing, and other communications about tobacco products. A call-for-papers for the current special issue of *Tobacco Regulatory Science* was developed in conjunction with the TCORS Eye-Tracking Working Group with support from the Center for Evaluation and Coordination of Training and Research (CECTR), which serves as an infrastructure for providing scientific leadership and technical research expertise for TRS. The call was widely disseminated.

The 7 papers selected for this special issue contribute to scientific knowledge, and this editorial provides a synthesis to help guide readers and offer insights for future eye-tracking research. These elegantly designed studies apply eye-tracking methods to 3 major topics related to tobacco products: health warnings, advertising, and constituent information. The first section contains studies that utilize eye-tracking to examine pictorial tobacco product health warnings. Eye-tracking can reveal attributes of the warnings that are associated with increased attention. The second section focuses on marketing and advertising. Eye-tracking flourished in the 1970s and 1980s in research and business applications. Tobacco industry documents show that during the 1990s industry utilized eye-tracking of marketing and advertising campaigns.^{5,6} The third section includes studies that examine communication about harmful and potentially harmful constituents (HPHCs). The Family Smoking Prevention and Tobacco Control Act⁷ directs the FDA to publish the levels of HPHCs, or chemicals or chemical compounds in tobacco products or smoke that cause or could cause harm to users or non-users, as reported by tobacco manufacturers and importers. This information must be placed on public display and not be misleading to a lay person. Below, we provide a brief overview of the papers in each section.

Three studies address FDA regulatory research priorities related to health warnings. Mercincavage et al⁸ recruited current daily, non-treatment-seeking adult smokers and exposed them to the FDA's 9 originally proposed pictorial cigarette health warnings. Their results showed that smokers looked more quickly at the image than text, with more graphic images gaining faster attention. The study results suggest that smokers generally demonstrated greater attention to the image for (1) both image and text on pictorial cigarette health warnings that showed congruent (text and graphic matched) than incongruent information, (2) warnings that displayed text across the label, and (3) warnings that were rated as most effective in helping them quit. Byrne et al⁹ recruited adult smokers and youth who were susceptible to smoke in the future to view images of cigarette packages for the 3 most popular brands (Marlboro, Camel, and Newport) with 9 pictorial cigarette warning labels to examine the effects of attention on negative emotions, risk beliefs, intentions, and susceptibility to smoking in the future. Results indicated that participants spent more time on the pictorial cigarette warning labels than the branded content of the pack and that attention to the warning labels was associated with negative affect. Furthermore, among youth (but not adults) there were clear associations between greater attention to the pictorial cigarette warning and less susceptibility to smoke in the future, but greater attention to the brand imagery was associated with greater susceptibility. Quisenberry et al¹⁰ recruited rural adult

smokers to examine the association of health literacy with attention to 9 pictorial cigarette health warnings on a tobacco advertisement. In this randomized experiment, smokers were assigned to view a pictorial health warning encompassing 20% or 33% of a cigarette advertisement. Whereas no differences emerged between these conditions, rural smokers with lower, but adequate, health literacy viewed pictorial portions of health warnings longer than those with greater health literacy. This demonstrates that health literacy is an important consideration in health communications, including future cigarette health warnings.

Using eye-tracking to examine tobacco product advertisements can clarify which features capture attention and have associations with behavioral outcomes. Two studies in this special issue examine the effects of tobacco industry marketing. Nonnemaker et al¹¹ examined adult little cigar and cigarillos (LCCs) ever users' attention to LCC packs in a 2×2 study design that varied the background color of text-based health warnings (yellow vs white) and price promotion (present vs absent). Results showed that the presence of price promotions detracted from health warning attention and that, although the health warning with a yellow background did not increase attention, it was associated with greater recall and risk perceptions. Londerée et al¹² examined attention to and interest in advertisements for flavored e-cigarettes among adolescents. The investigators used images of storefront scenes with real-world advertisements for either flavored (eg, sweet, candy, snack) or unflavored (tobacco) e-cigarettes. Eye-tracking results revealed greater attention to flavored (vs unflavored) e-cigarette advertisements and this attention, in turn, was significantly associated with greater willingness to try flavored (vs unflavored) e-cigarettes.

Two studies in this special issue address messaging around HPHCs. Jarman et al¹³ recruited current smokers to examine the effect of cigarette constituent messages focused on the health effects of arsenic, formaldehyde, and uranium, as well as a message of the general harms of smoking in a 2×2 design: providing quit information (or not) and FDA source information (or not). Results indicated that participants were attentive to the quit information, which included both the health benefits of quitting and information about a quitline number, on average spending 10 seconds on this textual information. Furthermore, 30% of participants exposed to this information recalled the quitline number. FDA source information did not grab participant's attention nor was it recalled. Klein et al¹⁴ examined brief, single-page website formats developed to increase adult, daily smokers' recognition of HPHCs in cigarettes. Smokers who viewed an untailed, non-interactive website spent less dwell time on the HPHC text and entire website compared to adults who viewed a brand-tailed and interactive website. Despite this, adult smokers who viewed the untailed, non-interactive website had greater improvement in HPHC recognition compared to those who viewed the brand-tailed and interactive website. The eye-tracking data confirmed that, whereas a basic format and narrative HPHC web-based content may attract less visual attention, this simple format may enhance recognition of the chemicals in cigarettes.

IMPLICATIONS FOR TOBACCO REGULATION

There are numerous ways in which TRS can be informed by studies utilizing eye-tracking. Eye-tracking could be used prior to launching large tobacco control media campaigns to examine how tobacco users and non-users attend to information. As the FDA has expanded

its authority to all tobacco products, an assessment of warnings and advertisements of non-cigarette tobacco products may be valuable. The systematic use of eye-tracking, alongside other data collection techniques, could help to inform regulatory activities around tobacco communications.

Consumer research has connected visual attention to consumer involvement, demonstrating that pre-attention (the first 0.5 to 5 seconds) is used to establish familiarity and significance of stimuli, as attention remains focused on such stimuli, consumers remain focused, establish comprehension, and have the opportunity to deeply process the stimuli.¹⁵ In other instances, eye-tracking can reveal insights about attention that may be important in designing more effective public health campaigns to reduce tobacco use. Visual attention (1) is a relevant link in the chain between tobacco communications and reactions to the information (2) informs attitudes and beliefs, and ultimately, (3) influences tobacco use behaviors.¹⁶ Leveraging eye-tracking research to better inform tobacco communication campaigns and other regulatory activities may be a useful tool to improve the quality of health information used to inform consumer decision-making.

Questions around the standardization of measurement terms and eye-tracking designs remain for the field. For example, all the studies in this special issue used dwell time as a key assessment, but only some used time to first fixation or total fixations. Whereas the 7 studies in this collection all use static media/exposure (eg, print advertisements, pictorial tobacco health warnings, websites), enhancements in eye-tracking technology can examine attention in mobile (eg, dynamic or interactive), real-world settings, such as point-of-sale in stores and on social media. Of note, stimuli exposure time varied between studies, from 10 seconds to allowing participants to determine the length of time on the stimulus. Eye-tracking in tobacco control research has typically combined eye-tracking with self-report survey items. Studies that incorporate fMRI, cognitive interviewing, and other methods could reveal important insights into the connections between eye-tracking measures and TRS outcomes. The studies in this special issue assessed exposure at one time point and assessed mostly proximal outcomes (eg, attitudes, intentions). Future studies may examine how repeated exposure to stimuli, as assessed through eye-tracking within and/or outside of laboratory settings, may influence attention and related outcomes. Although visual attention in a controlled laboratory setting can provide important information, this may not correspond to real world exposure. Study design tradeoffs, such as well-controlled experiments and ecological validity, also must be weighed carefully. Newer eye-tracking technologies may help studies maximize both. Experimental studies will help us better understand the possible causal nature of exposure to tobacco-related messaging with outcomes. Recruitment of appropriate study samples (eg, youth, adults, at-risk populations, tobacco users, non-users, etc) may help inform different aspects of regulatory activity. The rationale for such design decisions is important to note and future studies should consider them carefully.

The application of eye tracking methodology to TRS research has the potential to increase our understanding of the impact of tobacco communication and marketing on consumers. The frequency of communications to consumers about tobacco products is likely to persist or quicken. Research efforts will continue to be challenged to maintain rigor while being responsive to current tobacco communications in retail environments, on social media, and

in traditional media. The precision and objectivity of eye-tracking methodology described in this special issue illustrates how this technique can enhance research efforts to address the priority areas of communication about the risks of using tobacco products and tobacco product marketing.

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