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Graphic health warnings as activators of social networks: A field experiment among individuals of low socioeconomic position

Shoba Ramanadhan[a,b,*], **Rebekah H. Nagler**[c], **Rachel McCloud**[a], **Racquel Kohler**[a,b], and **Kasisomayajula Viswanath**[a,b]

[a]Center for Community-based Research, Dana-Farber Cancer Institute, 450 Brookline Ave, LW601, Boston, MA 02215, United States

[b]Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, 677 Huntington Ave, Boston, MA 02115, United States

[c]School of Journalism and Mass Communication, University of Minnesota, 206 Church St SE, Minneapolis, MN 55455, United States

Abstract

Rationale—Graphic health warnings (GHWs) on cigarette packages present an important tobacco control opportunity, particularly for vulnerable populations suffering a disproportionate tobacco burden. One mechanism by which GHWs may influence smoking outcomes is by prompting interpersonal discussions within health discussion networks (the set of personal contacts with whom an individual discusses health issues).

Objective—The study examined the association between GHW-prompted conversations within health discussion networks and key tobacco-related outcomes, with attention to valence and content of the discussions.

Method—Between August 2013 and April 2014, we recruited 1200 individuals from three communities in Massachusetts, emphasizing recruitment of individuals of low socioeconomic position (SEP) and members of other selected vulnerable groups. Respondents were exposed to the nine GHWs proposed by the FDA in 2011, asked a series of questions, and assessed at follow-up a few weeks later.

Results—A total of 806 individuals were included in this analysis. About 51% of respondents reported having a health discussion network, with significantly lower reports among African-Americans and Hispanics compared to Whites. Around 70% of respondents (smokers and nonsmokers) with health discussion networks reported having one or more conversations about the GHWs with network members, the bulk of which were negative and focused on warning others about smoking. For smokers, we found a small but positive association between the percentage of network conversations that were negative and reports of quit attempts.

Conclusion—The results point to a potential mechanism by which GHWs may impact tobacco-related outcomes, prompting further inquiry into the role of health discussion networks (and discussion networks, more broadly) in tobacco control among low SEP individuals.

*Corresponding author. 450 Brookline Ave, LW 601, Boston, MA 02215, United States.

Keywords

Social networks; Low socioeconomic position; Tobacco; Egocentric; Graphic health warnings

1. Introduction

Adult cigarette smoking rates in the United States have declined in recent decades, from about 43% in 1965 to about 18% in 2014, but the gains have been unequally distributed. In 2014, the smoking prevalence among individuals (aged 25 or older) with less than a high school education was 43% versus 5% among those with a graduate degree, and the smoking prevalence among adults living below the poverty threshold was 26%, compared to 15% among those at or above the poverty threshold (Jamal et al., 2015; US Department of Health and Human Services, 2014). Smoking may be more difficult to address among groups of low socioeconomic position (SEP) due to a number of interacting drivers, including targeted marketing by the tobacco industry, lower access/adherence to cessation treatments, social norms, greater life stress/competing demands, and higher proportions of smokers in their social networks (Christakis and Fowler, 2008; Hiscock et al., 2012; Hitchman et al., 2014). Given the complexity of these challenges, multi-prong solutions are required to reduce tobacco use among low SEP populations. In addition to leveraging evidence-based programs for tobacco cessation at the individual level, attention is increasingly being paid to population-level interventions and policy solutions (National Institutes of Health Office of the Director, 2006).

1.1. Graphic health warnings

A prime example of a population-level solution is the recommendation from the World Health Organization's Framework Convention on Tobacco Control (FCTC) to place prominent graphic health warnings (GHWs) on cigarette packs. These labels cover 30–50% of cigarette package covers and relay information regarding the consequences of tobacco use, often including images (World Health Organization, 2003). GHWs leverage the opportunity to communicate the risks of smoking with smokers at the time of the behavior—up to 7000 times per year for those who smoke a pack per day—and can also relay information to nonsmokers who are exposed to the packs when the product is being used or is on display (Hammond, 2011). A recent systematic review of longitudinal observational studies found that strengthened warnings (implemented nationally) were associated with increases in knowledge and calls to quitlines, as well as decreases in smoking behavior (Noar et al., 2016a). A meta-analysis of experimental data found that, compared to text-only warnings, pictorial warnings were perceived as more effective and were better able to attract and hold attention, generate reactions (cognitive and emotional), induce negative attitudes about smoking and cigarette packs, and increase intentions to quit and to not initiate smoking (Noar et al., 2016b). As summarized by Cappella (2016), when considering the body of work on GHWs, a "picture of the causal effectiveness of warning labels emerges that is difficult to ignore" (p.132). Recent experimental studies have suggested that GHWs may present an important opportunity to address disparities, as they were similarly effective across diverse racial/ethnic and socioeconomic populations (Cantrell et al., 2013; Gibson et al., 2015).

1.2. Interpersonal discussions

One way in which GHWs may support tobacco control is by prompting interpersonal discussions among those exposed to the warnings. Interpersonal discussions provide individuals with opportunities to share, engage with, and process information and access social support (Hall et al., 2015; McAfee et al., 2013; Southwell and Yzer, 2007). Interpersonal discussions have been shown to increase the impact of tobacco control campaign messages on behavioral intentions and behavior, beyond the direct effects of campaigns (Dunlop et al., 2008; Durkin and Wakefield, 2006; van den Putte et al., 2011). Recent studies show that GHWs prompted conversations about quitting and the health risks of smoking among smokers in the US (Hall et al., 2015) and that such conversations predicted quit attempts in Canada, Australia, and Mexico (Thrasher et al., 2016).

The valence of interpersonal discussions prompted by health promotion campaigns is also hypothesized to have an impact on behavior. For example, in the context of HPV vaccination, conversations that were favorable (i.e., supported the vaccine) were linked to health-promotive norms and attitudes as well as intentions to receive the HPV vaccine (Dunlop et al., 2010). In the context of condom use in South India, positive campaign-prompted conversations were shown to predict greater health-promotive attitudes, higher self-efficacy for condom use, and subjective and descriptive norms supporting condom use (Frank et al., 2012). A study of binge drinking in the Netherlands found that negative conversational valence about alcohol was linked to greater intention to refrain from binge drinking (Hendriks et al., 2012). It is important to note that interpersonal communication can also have a dampening effect on campaigns and serve as a competing channel of information (Southwell and Yzer, 2007).

1.3. Health discussion networks

Interpersonal discussions do not occur in a vacuum and studying them requires investigation into the broader social context in which they occur, including the social networks that support health-related conversations (Ackerson and Viswanath, 2009). Social networks affect health through a number of key mechanisms, including provision of social support, social influence, social engagement, exposure through direct connections, and access to resources (Berkman et al., 2000; House et al., 1988). The quality, quantity, and types of ties an individual possesses, as well as the position s/he plays in social networks, are all important drivers of behavior change and health outcomes (Perkins et al., 2015; Valente, 2012). As Borgatti et al. (2009), “One of the most potent ideas in the social sciences is the notion that individuals are embedded in thick webs of social relationships and interactions” (p. 892). The challenge, then, is to understand how these webs influence/are influenced by health behaviors.

Individuals have a range of social networks, which can be differentially accessed for specific functions—for example, searching for a job versus finding medical information (Wellman and Wortley, 1989). *Health discussion networks*, or the set of interpersonal connections with whom individuals discuss health matters, are expected to play an important role regarding the access to resources and supports needed to maintain abstinence among non-smokers and support cessation among smokers. These networks have been shown to impact attitudes;

access to services, emotional support, advice, information, and the understanding individuals develop about health issues (Abbott et al., 2012; Perry and Pescosolido, 2010; Pescosolido, 1991, 1992). Interpersonal communication networks can accelerate the spread of new information (Rogers, 2003) and lead to greater exposure to health information (Viswanath et al., 2006). Given that networks spread diverse content, the effects of health discussion networks can be health promoting (e.g., facilitating access to cessation services) or risk promoting (e.g., spreading pro-tobacco norms).

Health discussion networks are expected to be sources of social capital, the resources embedded within social relationships that can be mobilized to meet an individual's goals (Lin, 2001). By studying the structure of health discussion networks and the resources that flow within them, we can better understand how these networks influence and give meaning to context (Pescosolido, 2006) and can then more effectively shape interventions and communication campaigns. A network approach, as opposed to assessing GHW-prompted conversations among individuals, allows us to measure aspects of the context in which health behaviors are occurring, rather than focusing solely on individual-level attributes. The use of egocentric analysis (focused on individuals' networks) provides insight into each respondent's personal network environment in a manner that could not be assessed using traditional methods (Valente, 2010).

Although the body of work on the effectiveness of GHWs generated in other countries is large and compelling, the moderating influences of social structural factors such as SEP that drive tobacco-related disparities in the US are much less clear. The focus on low SEP groups is vital, given the impact of *communication inequalities*, or differences among social groups in the generation, manipulation, and distribution of information at the group level and differences in access to and ability to take advantage of information at the individual level. Inequalities in communication may mediate the relationship between social determinants and health outcomes, thus serving as one potential explanation for health disparities (Viswanath, 2006).

To our knowledge, no previous study has assessed GHW-prompted discussions in the context of personal social networks. The literature is also limited in assessments of the impact of the valence and content of GHW-related conversations on tobacco control outcomes. Given these gaps, the objectives of this study were to assess the impact of GHW-related interpersonal discussions on tobacco cessation behaviors among persons of low SEP.

2. Method

2.1. Study overview

Data for this study were collected as a part of Project CLEAR, a field experiment conducted from August 2013–April 2014 to examine the impact of GHWs on tobacco control outcomes in three Massachusetts communities. Although the pictorial content of these warnings was struck down due to lawsuits filed by tobacco companies, GHWs were ultimately found to be constitutional and the FDA is developing new warnings (Bach, 2016). Although the labels presented in this experiment may not appear on cigarette packs, lessons learned can be

applied to the design of future GHWs and impact evaluations. The study design utilized egocentric network analysis methods, focusing on personal social networks.

2.2. Study respondents

We recruited 1200 individuals (619 smokers and 581 non-smokers) from Boston, Lawrence, and Worcester, Massachusetts. We used targeted recruitment to ensure participation by individuals of low SEP. In a recent study conducted by our team, purposive recruitment enabled us to generate a sample with greater representation of individuals living below the federal poverty line, those with low education levels, and those who are unemployed, compared to the Pew Internet Tracking survey, the National Cancer Institute's HINTS survey, and the 2010 Census Viswanath et al. (2013). Our purposeful recruitment strategy included outreach by a local community health educator and community partners, conducting the experiment in accessible community locations (such as community colleges and senior centers), advertising in local English- and Spanish-language media, providing audio-assisted survey software (in which a respondent could hear a recording of any or all questions), and offering staff support for respondents taking the survey. We recruited adults aged 18–70 years who could communicate in English or Spanish. Our primary goal was to recruit low SEP individuals, but given an interest in other vulnerable populations, we also recruited individuals who identified as members of one or more of the following population groups: African-American; Hispanic; lesbian, gay, bisexual, transgender, or not sure of sexual orientation; and blue-collar workers.

2.3. Survey procedures

The baseline survey was administered in English or Spanish on a tablet or desktop computer. Respondents were randomized to view one of the nine GHWs proposed by the FDA in 2011 in response to the Family Smoking Prevention and Tobacco Control Act of 2009 ("Family Smoking Prevention and Tobacco Control Act," 2009). Each label included an image, a text warning about the consequences of smoking, and the quitline number. Respondents were then asked 19 questions to capture their reactions to the label content. They then viewed the eight remaining labels and answered 17 questions about the labels as a set. Respondents also answered demographic questions and were randomized to receive other sets of questions not analyzed here. The baseline survey took 20–60 min to complete, depending on respondents' reading ability and familiarity with tablet/desktop computers.

We conducted a follow-up survey to assess the short-term impacts of exposure to the GHWs during the experiment. Follow-up was conducted by phone or through a web-based survey roughly two weeks after the baseline survey. The follow-up survey took 5–20 min to complete based on mode and number of network members nominated. The timing varied due to delayed initiation of the follow-up survey and difficulties contacting respondents, often because of changing phone numbers and cell phone service disruptions. Such challenges are common when recruiting and retaining low SEP populations (Nagler et al., 2013), but given that low SEP groups are understudied, the study team prioritized completion over data collection within a small window of time. Follow-up time ranged from 9 to 184 days (the median was 49 days). The Harvard T.H. Chan School of Public Health Institutional Review Board approved this study.

2.4. Measures

The survey instrument was developed based on existing items from the literature and findings from formative research for this project, including focus group discussions with individuals from vulnerable populations of interest (Bigman et al., 2016). We conducted cognitive testing of the survey using established procedures (Collins, 2003; Tourangeau et al., 2000) among a group of individuals similar to our target population. We also conducted usability testing to ensure that survey administration via tablet would be effective, including use of a feature that reads the question out loud while the respondent uses headphones. We made adjustments before the implementation of the baseline survey, including clarifying wording and improving survey display on computer screens, as a result of these tests.

2.4.1. General measures—We collected data on race/ethnicity, age, income, education, gender, and employment status. We also assessed smoking status based on two questions: 1) respondent identification (regular, occasional, former smoker; tried smoking; or nonsmoker) and 2) how many of the last 30 days they had smoked even one puff of a cigarette. Individuals who identified as regular or occasional smokers and/or who had smoked even one puff of a cigarette in the past 30 days were classified as smokers for this analysis (Berg et al., 2011). For smokers, we also assessed intention to quit at baseline—specifically, the likelihood in the next 30 days of trying to quit smoking, with responses on a 5-point scale from 1 (not at all likely) to 5 (extremely likely). Those who identified as very or extremely likely (4 or 5 on the scale) were categorized as having high intention to quit.

2.4.2. Network definition and measures—We used established methods for egocentric (or personal) network analysis to identify these networks of interest (Borgatti et al., 2013; Marsden, 2005). Respondents were asked to identify people they discussed important health issues with over the last six months, an adaptation of a widely-used name generator from the General Social Survey (Burt, 1984). As is typical, responses were limited to five individuals to reduce respondent burden. Respondents who identified at least one person (by first name or initials) were asked a series of questions about the network member(s). First, the respondent was asked to identify how s/he is connected to the network member. We used an established measure and response options included spouse or significant other, parent, child, sibling, other family member, coworker, group member, neighbor, friend, health care provider, or other (open-ended) (Burt, 1984). Here, “group member” refers to individuals who belong an organization (e.g., a voluntary club) to which the respondent also belongs. Multiple response options were permitted. Additional questions about the network member(s) included age, gender, number of years known to the respondent, frequency with which they talk, smoking status, and history of encouraging the respondent to quit smoking.

Asking the above questions supports characterization of respondents’ health discussion networks. Individual network size, or the number of connections reported, is a measure of interest as there is a positive relationship between the number of connections a respondent reports and the diversity of resources s/he may be able to access (Borgatti et al., 1998). Network density, or the proportion of possible connections that were actually realized, is of interest as densely connected networks typically have a great deal of influence on an individual’s behavior but may not offer access to new information or resources, whereas

sparsely connected networks may allow for the introduction of new information, but may provide less tangible support (Lakon et al., 2008). We also assessed personal network exposure, or the extent to which a respondent's alters (or nominated contacts) reported a behavior of interest—here, smoking.

Respondents who reported GHW-related conversations with network members were asked why they had these conversations. Response options developed through formative research (Bigman et al., 2016) included to ask questions about information on the labels, discuss quit options, ask for support in quitting, warn them about the risks of smoking, motivate the network member to quit, and make fun of the label. We also included an open-ended response option of "other (please specify)." Similar responses were found through open-ended questions in another study (Hall et al., 2015).

In a separate question, respondents who reported having health discussion networks were asked to report any additional GHW-related conversations outside these networks. For those who did not report a health discussion network, we asked about any GHW-related conversations. In this way, we were able to capture all GHW-related conversations prompted by exposure during the baseline session. We kept these responses separate for this analysis to support inquiry into the impact of health discussion networks.

2.4.3. Measures for smokers-only assessments—Among smokers, we were interested in assessing the impact of GHW-related discussions on quit attempts, an important tobacco control outcome. The main independent variable of interest was the percent of GHW-related discussions within the health discussion network that were negative about smoking. For each respondent who reported having a health discussion network, the respondent was reminded about the GHWs that were shown during the study and was asked if s/he talked about the GHWs or the information on them with the health discussion network member in question. For those who said yes, they were asked how they talked about smoking in that conversation, using a 5-point scale ranging from 1 (very negatively) to 5 (very positively). The data were collapsed into three categories: negative, neutral, and positive, and transformed into summary measures: the percent of all GHW-related conversations held with health discussion network members that were negative, neutral, or positive. In other words, if a respondent spoke to three health discussion network members about the labels and two of the conversations were negative about smoking, the respondent would be assigned a value of 0.66 (or 2/3) for the negative valence variable. The use of a composition measure reflects the theoretical importance of the overall impact of local networks on behavior change (Christakis and Fowler, 2008). The main outcome measure assessed quit attempts. At follow-up, respondents were asked if, since completing the main survey, they attempted to quit smoking cigarettes (yes/no). They were also asked if they had attempted to reduce the amount of cigarettes they smoked (yes/no). We calculated another "network composition" variable for respondents who reported having a health discussion network, the percent of the health discussion network that smokes.

2.5. Data analysis

For respondents who reported having health discussion networks, we analyzed network data using Enet, dedicated network software for egocentric analyses (Borgatti, 2006). The percent of all GHW-related conversations that were negative was calculated using the "network composition" routine. Other network attributes, such as degree and density, were calculated using Enet routines. We appended the network data to the main survey dataset and analyzed the data using SAS v9.4 (SAS Institute, 2012). We ran descriptive statistics for all variables of interest and utilized chi-square tests for group comparisons. We utilized logistic regression to model the association between the valence of GHW-related conversations and quit attempts. We conducted a sensitivity analysis that utilized multiple imputation (Sterne et al., 2009) with 20 imputation datasets to evaluate the robustness of the results obtained from complete case analysis. Age, education level, and employment status were associated with whether respondents took the follow-up survey. The results from the multiple imputation analysis accounting for the missing data pattern were consistent with the results in complete case analysis. We also conducted a sensitivity analysis to determine the effect of variation in follow-up periods and found that the results remained unchanged.

3. Results

A total of 816 of the 1200 experiment respondents took the follow-up survey, for a 68% follow-up rate. Those who completed follow-up were younger, better educated, and more likely to work for pay than those who did not complete the follow-up survey. There were no differences by race/ethnicity, gender, or income. Ten individuals were excluded from this analysis because they did not complete the questions on health discussion networks; the total sample for this analysis was 806. Overall, respondents had low levels of income and low levels of education, with substantial racial/ethnic diversity, as seen in Table 1. We found statistically significant differences between smokers and nonsmokers for education, age, gender, and employment (χ^2 tests, $p < 0.05$).

3.1. Health discussion networks: nonsmokers and smokers

A little more than half (51%) of the respondents reported that they discussed health matters with contacts in the last six months and therefore were considered to have health discussion networks. A greater proportion of nonsmokers (54%) versus smokers (47%) reported having a health discussion network ($\chi^2 = 3.8795$, $p < 0.05$). The average degree (or number of connections in the health discussion networks) was 2.56 ($SD = 1.59$). The average network density (or the proportion of potential connections among network members) was 0.35 (SD = 0.17). There were no significant differences between smokers and nonsmokers in number of health discussion network members or network density.

Among nonsmokers, we found significant differences in reports of having a health discussion network by race/ethnicity, with 68% of White non-Hispanics reporting having a health discussion network, compared to 50% of Black non-Hispanics and 46% of Hispanics ($\chi^2 = 13.71$, $p = 0.001$). We also found differences by gender, with 60% of females reporting having a health discussion network, compared to 46% of males ($\chi^2 = 8.27$, $p = 0.004$). The other gender categories were too rare to include in a sub-analysis. There were

also significant differences by education level, with larger networks reported by those with more education.

Among smokers, we found significant differences in reports of having a health discussion network by race/ethnicity, with 58% of White non-Hispanics reporting having a health discussion network, compared to 31% of Black non-Hispanics and 50% of Hispanics (χ^2 = 17.91, p = 0.0001). There were no significant differences by age, gender, or education among smokers.

3.2. Nonsmokers' health discussion networks

A diverse set of contacts were included in nonsmokers' health discussion networks. The 220 nonsmokers identified 547 relationships with network members, with family members of various types accounting for most of the network membership (Table 2).

On average, only about one-fifth of nonsmokers' network members were regular smokers (mean = 0.19, SD = 0.33). Over two-thirds of nonsmokers' network members disapprove of smoking (mean = 0.71, SD = 0.37). About 70% of nonsmokers with health discussion networks (n = 156) reported that they had one or more conversations with network members about the GHWs during the follow-up period. GHW discussions were held with network members in a pattern that reflected network composition. Conversations were most common with friends (31%), followed by spouse/significant other (14%), siblings (14%), and parents (11%).

We also assessed the valence of conversations about the labels. The 156 nonsmokers reported 272 conversations with network members and gave 400 reasons for having those conversations. The bulk of the conversations were negative about smoking (78%) and smaller proportions were positive about smoking (11%) or neutral (10%). The most frequently reported purpose of the conversations (30%) was to warn others about the risks of smoking (Table 3).

3.3. Smokers' health discussion networks

A diverse range of contacts were included in smokers' health discussion networks, once more with family members of various types accounting for most of the network, as seen in Table 4. The 189 respondents identified 474 relationship types with their network members.

Roughly one-third of smokers' network members were regular smokers (mean = 0.32, SD = 0.36), about two-thirds were individuals who disapprove of smoking (mean = 0.62, SD = 0.39), and about two-thirds were individuals who have encouraged the respondent to quit smoking (mean = 0.65, SD = 0.41). Almost three-quarters (72%, n = 136) of smokers with health discussion networks reported having had one or more conversations with network members about the warning labels. GHW discussions were held with health discussion network members in a pattern that reflected network composition, with friends as the most common members reported (28%), followed by spouse/significant other (15%), siblings (11%), parents (11%), and other family (11%).

Once more, we assessed the valence of conversations about the labels. The 136 smokers reported 241 conversations with network members and gave 452 reasons for having those conversations. The bulk of the conversations were negative about smoking (58%), with fewer positive about smoking (32%) and neutral (21%). When asked about the purpose of the conversation, many were reported to be discussion of quit options or warning others about the risks of smoking (Table 5).

3.4. Smokers: the impact of negative conversations on quit attempts

We assessed the association between the valence of GHW-related conversations and our outcome of interest: quit attempts (Table 6). Respondents with higher proportions of negative conversations had higher odds of having made a quit attempt ($OR = 1.010$, 95% $CI = 1.001, 1.018$; $p = 0.02$), adjusting for important covariates (proportion of positive conversations, proportion of neutral conversations, the percent of the network that smokes, and a high baseline intention to quit). A high baseline intention to quit was also significantly associated with reported quit attempts. The Hosmer and Lemeshow goodness of fit test indicated adequate model fit ($p = 0.44$).

3.5. Conversations with other contacts

There were 137 individuals who did not identify a health discussion network, but still reported speaking about the GHWs to contacts after the initial exposure to the GHWs. Nonsmokers ($n = 68$) typically reported talking about the GHWs with one or two people (mean = 1.61, $SD = 1.15$). The bulk of the 110 conversations reported were negative (78%); small proportions were neutral (13%) or positive (8%). The purposes of the conversations centered on warning others about the risks of smoking (40%), motivating others to quit smoking (25%), and asking questions about the information (24%). Smokers who did not report a health discussion network, but spoke with contacts about the labels ($n = 69$) typically reported having talked about the GHWs with one or two people (mean = 1.78, $SD = 1.40$). The bulk of the 119 conversations reported were negative (78%); small proportions were neutral (15%) or positive (7%). Conversations centered on discussing quit options (25%), asking questions (22%), warning others about the risks of smoking (15%), asking for support in quitting (14%), and motivating others to quit (11%).

4. Discussion

Broadly, this study's results point to the potential for GHWs to support tobacco control among low SEP individuals by prompting discussions within health discussion networks. Brief exposure to the GHWs prompted interpersonal discussions among smokers and nonsmokers, and most of these discussions were negative about smoking. Among smokers, the rate of negative network conversations was linked to key cessation outcomes. Finally, about half of the respondents did not report having health discussion networks, which may reflect lack of access to an important resource.

Exposure to the labels prompted respondents to discuss the labels with contacts. Over half of all respondents (53%) discussed the GHWs with one or more contacts, whether in their health discussion networks or not. This finding is noteworthy, considering that respondents

were only exposed to the labels during the baseline survey and were not explicitly encouraged to discuss the content with others. The finding that exposure led to interpersonal communication is consistent with a large study, in which about half of respondents discussed the GHWs after they were implemented (Thrasher et al., 2016). The magnitude of the response was smaller (as expected) than recent small studies with much more intense exposure, in which almost all smokers reported discussing the content of the warnings with others (Hall et al., 2015).

Effective implementation of GHW policy could translate into high consistent exposure at both the point-of-sale and during daily product use, yielding an estimated 7000 views per year for those who smoke a pack per day (Hammond, 2011). Syntheses of the GHW literature (Hammond, 2011; Noar et al., 2016a, 2016b), coupled with recent experimental evidence (Brewer et al., 2016; Gibson et al., 2015; McQueen et al., 2015), show that such exposure can produce important effects on smoking-related cognitive, affective, and behavioral outcomes. Moreover, our study, together with previous research (Hall et al., 2015; Thrasher et al., 2016), suggests that conversations stimulated by GHW exposure could serve to reinforce and amplify these effects. The fact that GHW effects could be far-reaching and sustainable, due to the low cost of implementing GHW policy (compared with expensive mass media campaigns), offers additional support for this tobacco control strategy (Brewer et al., 2016).

The results also point to the potential for GHWs to activate existing networks—here, health discussion networks—and leverage their resources. Health discussion networks were dominated by family members and friends. This is consistent both with the literature on the composition of health discussion networks (Perry and Pescosolido, 2010), as well as pilot studies that found that smokers tended to talk about the GHWs with friends and spouses/ significant others (Hall et al., 2015). In this study, exposure to the GHWs prompted conversations among 70% of individuals with a health discussion network, the bulk of which were negative and emphasized content that supports tobacco control. This highlights potential ways in which interpersonal discussions may lead to behavior change, an area of the literature highlighted as needing more attention (Dunlop, 2011; Southwell and Yzer, 2009). These results are encouraging, as interpersonal discussions in line with tobacco control goals can increase the reach of anti-tobacco messages and prompt individuals to engage more deeply with the content (Eveland, 2004; Southwell and Yzer, 2007).

Not only did exposure spark GHW-related conversations, but we also found that higher rates of negative conversations in the network were associated with higher odds of making a quit attempt. The size of the association between negative conversations and quit attempts was modest, particularly when compared to the contribution of baseline intention to quit, but this may be due to the nature of the exposure (on a tablet, for a short duration). Outcomes may be different with cumulative exposure to the packs themselves, point-of-sale labeling, and supporting campaigns. The findings are consistent with the literature describing the important role social networks play in supporting cessation and continued abstinence (Christakis and Fowler, 2008; Dunlop et al., 2014; Hornik, 2006; Jeong et al., 2015).

Although the results suggest that GHWs may prompt important conversations in health discussion networks, it is worth noting that half of the study respondents did not identify such network members. This does not mean that these individuals do not discuss health with interpersonal contacts, and indeed, our data show many conversations outside health discussion networks; it simply means that these respondents did not identify this theoretically useful resource. Given that interpersonal communication networks are an important source of social capital (Ackerson and Viswanath, 2009), this gap warrants further study. Again, taking a *communication inequalities* perspective, it is critical to assess differences in access to or distribution of information at the network level to understand potential differences in access to and ability to take advantage of information at the individual level. Opportunities to develop and bolster health discussion networks among low SEP populations may have important implications for tobacco control and other health issues. After all, network resources can only be useful if appropriate ties are developed and activated as needed (Lin, 2001).

4.1. Limitations and strengths

As with any study, findings must be interpreted in the context of its limitations. Given the nature of the experiment, respondents were exposed to GHWs in an intense manner, but only for a short time—not through routine exposure—so the effect produced may be different than the effect of the GHWs in real-world settings. Second, follow-up time was longer than expected for many respondents given the challenges we had in tracking and retaining this group of low SEP respondents, as described elsewhere (Nagler et al., 2013). Sensitivity analyses suggest that length of follow-up did not impact study findings. Third, we cannot determine the temporal order of the GHW-related conversations vis-à-vis quit attempts, and it is possible that a smoker may have made an attempt before having a GHW-related conversation during the follow-up period. Purposive sampling also limits the generalizability of study findings, but this was a considered calculation given our goal of studying GHWs in a low SEP population that is not easily reached through traditional methods supporting random sampling. Finally, we found significant sociodemographic differences between individuals who did (68%) and did not (32%) complete the follow-up survey. However, we conducted sensitivity analyses that suggest that the missing data/selective attrition did not bias the results.

Despite these limitations, the study has a number of important strengths. First and foremost, we conducted the study among a predominantly low SEP sample, one that is underrepresented in research. Our ability to recruit from this population, which faces a large tobacco burden, was a function of strong relationships with community organizations in our partner communities and by having a local community health educator leading recruitment. Second, we are unaware of other studies assessing GHW-related communication within personal networks and this contribution highlights a potentially important resource that can be leveraged for vulnerable populations. The network lens allowed us to characterize and assess the impact of GHW discussions in the context of a social network, rather than being restricted to considering relationships and conversations separate from their social context. Finally, the study adds to the literature describing the purpose and valence of GHW-related discussions. These contributions can provide important insight into intervention and

campaign development, which can have a strong complementary effect with GHWs (Brennan et al., 2011).

Broadly, these results suggest that GHWs may prompt negatively valenced conversations in health discussion networks held by smokers and nonsmokers of low SEP, with important implications for tobacco control. Future research into the mechanisms by which networks influence the impact of GHW content will be important for designing campaigns to support GHWs, with an eye toward preventing the creation or exacerbation of communication and/or health inequalities. As summarized by Valente and Fosados (2006), "who delivers the message, and in what interpersonal context, may be just as if not more important than the message itself" (p. S30).

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References

Abbott KM, Bettger JP, Hanlon A, Hirschman KB. Factors associated with health discussion network size and composition among elderly recipients of long-term services and supports. Health Commun. 2012; 27:784–793. [PubMed: 22292979]

Ackerson LK, Viswanath K. The social context of interpersonal communication and health. J Health Commun. 2009; 14:5–17. [PubMed: 19449264]

Bach, LE. Tobacco Health Warnings: Evidence of Effectiveness. 2016.

Berg CJ, Nehl E, Sterling K, Buchanan T, Narula S, Sutfin E, et al. The development and validation of a scale assessing individual schemas used in classifying a smoker: implications for research and practice. Nicotine Tob Res. 2011; 13:1257–1265. [PubMed: 21994337]

Berkman LF, Glass T, Brissette I, Seeman TE. From social integration to health: durkheim in the new millennium. Soc Sci Med. 2000; 51:843–857. [PubMed: 10972429]

Bigman CA, Nagler RH, Viswanath K. Representation, exemplification, and risk: resonance of tobacco graphic health warnings across diverse populations. Health Commun. 2016; 31:974–987. [PubMed: 26757354]

Borgatti, SP. Enet: EGO Software Package of Ego-network Analysis. Harvard MA; 2006.

Borgatti, SP., Everett, MG., Johnson, JC. Analyzing Social Networks. SAGE Publications Limited; 2013.

Borgatti SP, Jones C, Everett MG. Network measures of social capital. Connections. 1998; 21:27–36.

Borgatti SP, Mehra A, Brass DJ, Labianca G. Network analysis in the social sciences. Science. 2009; 323:892–895. [PubMed: 19213908]

Brennan E, Durkin SJ, Cotter T, Harper T, Wakefield MA. Mass media campaigns designed to support new pictorial health warnings on cigarette packets: evidence of a complementary relationship. Tob Control. 2011; 20:412–418. [PubMed: 21474501]

Brewer NT, Hall MG, Noar SM, Parada H, Stein-Seroussi A, Bach LE, et al. Effect of pictorial cigarette pack warnings on changes in smoking behavior: a randomized clinical trial. JAMA Intern Med. 2016; 176(7):905–912. [PubMed: 27273839]

Burt RS. Network items and the general social survey. Soc Netw. 1984; 6:293–339.

Cantrell J, Vallone DM, Thrasher JF, Nagler RH, Feirman SP, Muenz LR, et al. Impact of tobacco-related health warning labels across socioeconomic, race and ethnic groups: results from a randomized web-based experiment. PLoS One. 2013; 8:e52206. [PubMed: 23341895]

Cappella JN. Advancing the evidentiary base for tobacco warning labels: a commentary. Soc Sci Med. 2016; 164:130. 1982. [PubMed: 27492576]

Christakis NA, Fowler JH. The collective dynamics of smoking in a large social network. N Engl J Med. 2008; 358:2248–2258.

Collins D. Pretesting survey instruments: an overview of cognitive methods. Qual Life Res. 2003; 12:229–238. [PubMed: 12769135]

Dunlop SM. Talking "truth": predictors and consequences of conversations about a youth antismoking campaign for smokers and nonsmokers. J Health Commun. 2011; 16:708–725. [PubMed: 21476165]

Dunlop SM, Cotter T, Perez D. When your smoking is not just about you: antismoking advertising, interpersonal pressure, and quitting outcomes. J health Commun. 2014; 19:41–56. [PubMed: 23967804]

Dunlop SM, Kashima Y, Wakefield M. Predictors and consequences of conversations about health promoting media messages. Commun Monogr. 2010; 77:518–539.

Dunlop SM, Wakefield M, Kashima Y. The contribution of antismoking advertising to quitting: intra- and interpersonal processes. J Health Commun. 2008; 13:250–266. [PubMed: 18569357]

Durkin S, Wakefield M. Maximizing the impact of emotive antitobacco advertising: effects of interpersonal discussion and program placement. Soc Mark Q. 2006; 12:3–14.

Eveland WP. The effect of political discussion in producing informed citizens: the roles of information, motivation, and elaboration. Polit Commun. 2004; 21:177–193.

Family Smoking Prevention and Tobacco Control Act. United States of America; 2009.

Frank LB, Chatterjee JS, Chaudhuri ST, Lapsansky C, Bhanot A, Murphy ST. Conversation and compliance: role of interpersonal discussion and social norms in public communication campaigns. J Health Commun. 2012; 17:1050–1067. [PubMed: 22808934]

Gibson L, Brennan E, Momjian A, Shapiro-Luft D, Seitz H, Cappella JN. Assessing the consequences of implementing graphic warning labels on cigarette packs for tobacco-related health disparities. Nicotine Tob Res. 2015; 17:898–907. [PubMed: 26180214]

Hall MG, Peebles K, Bach LE, Noar SM, Ribisl KM, Brewer NT. Social interactions sparked by pictorial warnings on cigarette packs. Int J Environ Res public health. 2015; 12:13195–13208. [PubMed: 26506363]

Hammond D. Health warning messages on tobacco products: a review. Tob Control. 2011; 20:327–337. tc. 2010.037630. [PubMed: 21606180]

Hendriks H, de Bruijn GJ, van den Putte B. Talking about alcohol consumption: health campaigns, conversational valence, and binge drinking intentions. Br J Health Psychol. 2012; 17:843–853. [PubMed: 22646524]

Hiscock R, Bauld L, Amos A, Fidler JA, Munafo M. Socioeconomic status and smoking: a review. Ann N Y Acad Sci. 2012; 1248:107–123. [PubMed: 22092035]

Hitchman SC, Fong GT, Zanna MP, Thrasher JF, Chung-Hall J, Siahpush M. Socioeconomic status and smokers' number of smoking friends: findings from the international tobacco control (ITC) four country survey. Drug Alcohol Dependence. 2014; 143:158–166. [PubMed: 25156228]

Hornik R. Personal influence and the effects of the national youth anti-drug media campaign. Ann Am Acad Political Soc Sci. 2006; 608:282–300.

House JS, Landis KR, Umberson D. Social relationships and health. Science. 1988; 241:540–545. [PubMed: 3399889]

Jamal A, Homa DM, Babb SD, Caraballo RS, Singh T, Hu SS, et al. Current cigarette smoking among adults —United States, 2005–2014. Morb Mortal Wkly Rep (MMWR). 2015; 64:1233–1240. [PubMed: 26562061]

Jeong M, Tan AS, Brennan E, Gibson L, Hornik RC. Talking about quitting: interpersonal communication as a mediator of campaign effects on smokers' quit behaviors. J health Commun. 2015; 20:1196–1205. [PubMed: 26147367]

Lakon, CM., Godette, GC., Hipp, JR. Network-based approaches for measuring social capital. In: Kawachi, I.Subramanian, SV., Kim, D., editors. Social Capital and Health. 2008. p. 63-81.

Lin, N. Social Capital: a Theory of Social Structure and Action. Cambridge University Press; New York: 2001.

Marsden, PV. Recent developments in network measurement. In: Carrington, PJ.Scott, J., Wasserman, S., editors. Models and Methods in Social Network Analysis. Cambridge University Press; New York, NY: 2005. p. 8-30.

McAfee T, Davis KC, Alexander RL, Pechacek TF, Bunnell R. Effect of the first federally funded US antismoking national media campaign. Lancet. 2013; 382:2003–2011. [PubMed: 24029166]

McQueen A, Kreuter MW, Boyum S, Thompson VS, Caburnay CA, Waters EA, et al. Reactions to FDA-proposed graphic warning labels affixed to US smokers' cigarette packs. Nicotine Tob Res. 2015; 17:784–795. [PubMed: 25589676]

Nagler RH, Ramanadhan S, Minsky SJ, Viswanath K. Recruitment and retention for community-based eHealth interventions with populations of low socioeconomic position: strategies and challenges. J Commun. 2013; 63:201–220. [PubMed: 23439871]

National Institutes of Health Office of the Director. NIH state-of-the-science conference statement on tobacco Use: prevention, cessation, and control. NIH Consens State Sci Statements. 2006; 23:1–26.

Noar SM, Francis DB, Bridges C, Sontag JM, Ribisl KM, Brewer NT. The impact of strengthening cigarette pack warnings: systematic review of longitudinal observational studies. Soc Sci Med. 2016a; 164:118–129. [PubMed: 27423739]

Noar SM, Hall MG, Francis DB, Ribisl KM, Pepper JK, Brewer NT. Pictorial cigarette pack warnings: a meta-analysis of experimental studies. Tob Control. 2016b; 25:341–354. [PubMed: 25948713]

Perkins JM, Subramanian S, Christakis NA. Social networks and health: a systematic review of sociocentric network studies in low-and middle-income countries. Soc Sci Med. 2015; 125:60–78. [PubMed: 25442969]

Perry BL, Pescosolido BA. Functional specificity in discussion networks: the influence of general and problem-specific networks on health outcomes. Soc Netw. 2010; 32:345–357.

Pescosolido BA. Illness careers and network ties: a conceptual model of utilization and compliance. Adv Med Sociol. 1991; 2:164–181.

Pescosolido BA. Beyond rational choice: the social dynamics of how people seek help. Am J Sociol. 1992:1096–1138.

Pescosolido BA. Of pride and prejudice: the role of sociology and social networks in integrating the health sciences. J Health Soc Behav. 2006; 47:189–208. [PubMed: 17066772]

Rogers, E. Diffusion of Innovations. The Free Press; New York: 2003.

SAS Institute. SAS; Cary, NC: 2012.

Southwell BG, Yzer MC. The roles of interpersonal communication in mass media campaigns. Commun Yearb. 2007; 31:420.

Southwell BG, Yzer MC. When (and why) interpersonal talk matters for campaigns. Commun Theory. 2009; 19:1–8.

Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. BMJ. 2009; 338:b2393. [PubMed: 19564179]

Thrasher JF, Abad-Vivero EN, Huang L, O'Connor RJ, Hammond D, Bansal-Travers M, et al. Interpersonal communication about pictorial health warnings on cigarette packages: policy-related influences and relationships with smoking cessation attempts. Soc Sci Med. 2016; 164:141–149. [PubMed: 26092600]

Tourangeau, R., Rips, LJ., Rasinski, K. The Psychology of Survey Response. Cambridge University Press; Cambridge, UK: 2000.

US Department of Health and Human Services. A report of the Surgeon General. Office of the Surgeon General; Rockville, MD: 2014. The Health Consequences of Smoking—50 Years of Progress.

Valente, TW. Social Networks and Health: Models, Methods, and Applications. Oxford University Press; New York: 2010.

Valente TW. Network interventions. Science. 2012; 337:49–53. [PubMed: 22767921]

Valente TW, Fosados R. Diffusion of innovations and network segmentation: the part played by people in promoting health. Sex Transm Dis. 2006; 33:S23–S31. [PubMed: 16794552]

van den Putte B, Yzer M, Southwell BG, de Bruijn GJ, Willemsen MC. Interpersonal communication as an indirect pathway for the effect of anti-smoking media content on smoking cessation. J Health Commun. 2011; 16:470–485. [PubMed: 21337250]

Viswanath, K. Public communication and its role in reducing and eliminating health disparities. In: Thomson, GE.Mitchell, F., WIlliams, MB., editors. Examining the Health Disparities Research Plan of the National Institutes of Health: Unfinished Business. Institute of Medicine; Washington, DC: 2006. p. 215-253.

Viswanath K, McCloud R, Minsky SJ, Puleo E, Kontos EZ, Bigman-Galimore CA, et al. Internet use, browsing and the urban poor: implications for cancer control. J Natl Cancer Inst. 2013; 47:199–205.

Viswanath K, Randolph Steele W, Finnegan JR Jr. Social capital and health: civic engagement, community size, and recall of health messages. Am J Public Health. 2006; 96:1456–1461. [PubMed: 16809608]

Wellman B, Wortley S. Brothers' keepers: situating kinship relations in broader networks of social support. Sociol Perspect. 1989; 32:273–306.

World Health Organization. Framework convention on tobacco control. World Health Organization; Geneva, Switzerland: 2003.

Table 1

Demographic characteristics of the sample (n = 806).

Category	Overall sample, percent (%)	Nonsmokers, percent (%) (n = 406)	Smokers, percent (%) (n = 400)
Education *			
Some high school or less	14	10	19
GED or high school	37	29	44
Some college	31	41	31
College or higher	18	19	6
Income			
Less than $10,000	19	16	23
$10,000–$19,999	15	17	14
$20,000–$29,999	10	10	10
$30,000–$39,999	9	10	9
$40,000– $49,999	6	6	5
$50,000 or above	16	18	14
Don't know	24	24	25
Age *			
18–24	47	52	42
25–49	37	33	41
50+	16	15	18
Race/Ethnicity			
White, non-Hispanic	31	29	33
African-American, non-Hispanic	31	34	28
Hispanic	38	38	40
Gender *			
Male	48	43	53
Female	51	56	45
Transgender	1	1	1
Other	1	0	1
Sexual orientation			
Heterosexual	87	89	84
Gay or lesbian	6	6	6
Bisexual	5	4	7
Not sure	2	1	3
Employment *			
Not working for pay	36	31	41
Smoking status			
Smoker	50		
Nonsmoker	50		
Cessation intention and behaviors intention to quit in next 30 days (baseline)			
High	58		

Category	Overall sample, percent (%)	Nonsmokers, percent (%) (*n* = 406)	Smokers, percent (%) (*n* = 400)
Behaviors at follow-up			
Attempted to quit	51		
Attempted to reduce cigarettes smoked	68		
Talked to a medical professional for help quitting	26		

* Significant difference between nonsmokers and smokers, $p < 0.05$.

Table 2

Composition of nonsmokers' health discussion networks (n = 547 relationship types).

Relationship type	Percent (%)
Friend	30
Sibling	14
Parent	13
Spouse or significant other	10
Other family	8
Coworker	7
Provider	7
Other	4
Neighbor	3
Child	2
Group member	1

Note. Multiple selections were permitted.

Table 3

Purpose of nonsmokers' conversations with health discussion network members, in decreasing order (n = 400 purposes reported).

Purpose	Percent (%)
To warn [the conversation partner] about the risks of smoking	30
To ask questions about the information on the labels	23
To motivate [the conversation partner] to quit	19
Other	18
To make fun of it/to joke about it	8

Note. Multiple selections were permitted.

Table 4

Composition of smokers' health discussion networks (n = 474 relationship types).

Relationship type	Percent (%)
Friend	26
Parent	13
Sibling	12
Other family	12
Spouse or significant other	10
Coworker	7
Other	6
Provider	6
Neighbor	3
Child	3
Group member	0

Note. Multiple selections were permitted.

Table 5

Purpose of smokers' conversations with health discussion network members, in decreasing order (n = 452 purposes reported).

Purpose	Percent (%)
To discuss quit options	24
To warn [the conversation partner] about the risks of smoking	21
To motivate [the conversation partner] to quit	15
To ask for support in quitting	15
To ask questions about the information on the labels	13
Other	8
To make fun of it/to joke about it	3

Note. Multiple selections were permitted.

Table 6

Likelihood of quit attempts based on valence of GHW-related conversations with health discussion network, controlling for important covariates ($n = 177$).

Parameter	Point estimate	95% Confidence interval		*p*-value
		Lower	Upper	
Negative conversations (Percentage)	1.010	1.001	1.018	**0.0248**
Neutral conversations (Percentage)	0.998	0.998	1.009	0.7543
Positive conversations (Percentage)	1.008	0.998	1.019	0.1178
Percent of network that smokes	1.005	0.997	1.014	0.2326
High baseline intention to quit	3.708	1.858	7.399	**0.0002**

Bold text denotes p-value less than 0.05.