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Analysis of Online Social Networks to Understand Information Sharing Behaviors Through Social Cognitive Theory

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Abstract

Analyzing the contents of online social networks is an effective process for monitoring and understanding peoples' behaviors. Since the nature of conversation and information propagation is similar to traditional conversation and learning, one of the popular socio-cognitive methods, social cognitive theory was applied to online social networks to. Two major news topics about colon cancer were chosen to monitor traffic of Twitter messages. The activity of "leaders" on the issue (i.e., news companies or people will prior Twitter activity on topics related to colon cancer) was monitored. In addition, the activity of "followers", people who never discussed the topics before, but replied to the discussions was also monitored. Topics that produce tangible benefits such as positive outcomes from appropriate preventive actions received dramatically more attention and online social media traffic. Such characteristics can be explained with social cognitive theory and thus present opportunities for effective health campaigns.

Keywords

micro-blogging; social network services; twitter; social cognitive theory

I. Introduction

Since the success of Twitter, micro-blogging is one of the most popular venues of online communication and social networking. Micro-blogging is a form of instant messaging where users report their current status of users and deliver breaking news in short text. The flourish of micro-blogging and online social network services (SNS) has attracted the researchers' interest who try to understand what makes the SNS so popular and how to use SNS as a platform to study human behaviors and dissemination of information [1][2].

The most popular SNS characteristic is the rapid response of conversation. For example, Kwak analyzed the temporal behavior of Twitter users discussing various news topics [3]. The study confirmed fast diffusion of information. The real-time nature of SNS makes it an effective means for spreading breaking news such as in natural disasters when real-time crisis mapping and communication are critical. Sakaki monitored and analyzed Twitter conversations to detect target events such as earthquakes [4]. Another popular application of

SNS analysis is to monitor human behaviors. SNS conversation participants are not only organizations or institutions, but also individuals who shared their life stories and opinions. Pak analyzed Twitter contents for sentiment analysis [5] while Bollen analyzed Tweets to sense sentiments of market participants for predicting the stock market [6].

In this study, we leveraged the real-time responsiveness and sentimental nature of social networking, to examine how current news on breast cancer detection and diagnosis may attract the attention of micro-bloggers and potentially influence cancer prevention behaviors such as their decisions to participate in cancer screening programs. Specifically, we applied a social learning and cognitive model to analyze SNS conversations among people either in the form of small talks or by exchanging information about current issues and breaking news, to understand how people influence each other. In Section II we review a social learning and cognitive model and propose adaptation of the model for analyzing conversations on online social networks. The model is confirmed with the conversations discussing Section III presents application of the model for analyzing Twitter content related to two different aspects of colon cancer. Study findings and discussions are presented in Section IV.

II. Methods

A. Social Cognitive Theory

Social Cognitive Theory (SCT) [7] is a learning theory stating that people learn by observing and imitating others and by positive reinforcement. SCT posits that behavioral change is affected not only by personal factors and internal dispositions but also by environmental influences. Therefore, behavioral change is a complex process influenced by internal and external factors.

According to the social cognitive theory, self-efficacy is the most important characteristic that changes human behavior. Self-efficacy is the extent or strength of one's belief in his own willingness and ability to complete tasks and reach goals. Individuals with high self-efficacy have high expectation that the outcomes or consequences of the tasks they perform must be effective, valuable and beneficial to them, and they believe that they can exhibit such behavior. Self-efficacy is not only influenced by the individual's capability, but also by other people around who may have positive or negative attitude towards a specific behavior. For example, a heavy smoker who is surrounded by heavy smokers may not expect to get positive influence from colleagues to quit smoking. Broader environmental influence such as from mass media and campaigns is another factor. According to SCT, people learn positive behaviors which they believe beneficial to them by observing the benefits of other people exhibiting the same behaviors or by paying attention to public campaigns, research and media discussing the benefits of these actions and behaviors.

Bandura applied social cognitive theory to study health promotion and disease prevention [8]. He emphasized that changes in peoples' beliefs in their collective efficacy to accomplish social change are a critical component in public health policy strategies for health promotion and disease prevention. In [9] Bandura emphasized the mass media influences on individual

behaviors. He applied SCT to understand sociocognitive behaviors by analyzing the diffusion and influence of new behaviors through the social networks they spread.

B. SCT application to online social networks

Conversations on SNS are very similar to traditional face-to-face conversations. One of the most advantageous factors on SNS is its independence to physical difficulties such as time and space. Such independence enables us to monitor real-time responses to current issues promptly with no geographical divide from participants of various educational, social and cultural backgrounds. The participants include diverse groups of people who have never heard about these issues before, people who are experts on these issues, as well as people who produce and disseminate news. People who are interested in a specific topic and they are very familiar with it, tend to be most up-to-date and circulate new information on the topic promptly in SNS. They are also very eager to share their personal beliefs. These people are “influencers” and if there exist many such influencers who understand and agree on a particular topic, news on the topic can be propagated easier and faster. Such rapid and massive dissemination of information and personal opinions makes SNS a fertile field for observing characteristics of social cognitive theory for many topics including health-related topics such as early detection and prevention of cancer.

However, there exist one major limitation with online social network analysis. Even if SNS users express their agreement on a specific issue such as the benefits of preventive cancer screening, such agreement may not translate into actions in real-life (i.e., long-term adherence to preventive health behavior). A thorough tracking study is necessary to confirm improvements in people's self-efficacy. Still, understanding SNS activity and whether certain messages are “retweeted” on Twitter, can be regarded as a pseudo self-efficacy indicator, in the sense that people recognize the importance of the message and want to promote positive actions. In this context, SNS analysis using SCT principles may help design effective health campaign strategies that expand the reach and strength of a message such as the importance of early cancer screening.

III. Results

Study was performed by observing communications on SNS. In this paper we continuously captured conversations including a specific keyword from Twitter, where data consists of timestamp, author and content. We also observed and captured news articles including the same keyword from national news providers' health sections via RSS feeds.

On March 17, 2014, the American Cancer Society released articles [10] reporting on colorectal cancer screening. The articles reported that in the past decades the colon cancer incidence rate dropped 30% among adults older than 50 yrs old in the United States. The dramatic decline was attributed to the widespread use of colonoscopy, the standard screening study for colon cancer. The articles emphasized the importance of colon cancer screening for early cancer detection and thus better patient outcomes. These important health news repeatedly appeared on national and local news channels. The same news soon emerged on Twitter conversations of news providers and people who had shown interest on the same topic as evidenced by their earlier content on Twitter. These groups or individuals

are considered influencers (or leaders). Interestingly, other people who no prior tweeting activities on the specific topic also paid attention by “retweeting” the news.

To quantify the flow of information more precisely, we divided the participants into “leaders” and “followers”. The leaders brought news and latest information and circulated in the Twitter community, while the followers digested these topics by reading and showing their agreement or disagreement. Leaders were defined based upon either their history of expressing interests of the topic constantly, or the twitter accounts belonged to news companies with typically many followers. Leaders were determined by their frequency of prior mentions about the keyword, or number of occurrence of quotation, i.e., “retweet”, of the topic by others. In this study, there were 244 leaders and 1851 followers in the timeline.

Observation was initiated at March 17, 2014, 13:00 EST, when the news were released by the major national news media. There were 718 tweets containing the keyword “colon cancer” and “screening” on March 17, and 643 tweets on March 18. The leaders made 355 tweets while the followers made 1006 tweets. Figure 1(a) illustrates the occurrence on hourly basis.

The phenomenon of social cognition is observable by measuring the first event of introducing the topic, which is shown in Figure 1(b). On March 17, the peak of the first tweet from leaders was one hour prior to the peak of the tweets from followers. This observation implies that leaders brought attention to the issue on early colon cancer screening and then the followers start receiving and digesting the message by retweeting it.

Another major news article was published by the New England Journal of Medicine two days later, on March 19, about the study of a non-invasive, multitarget DNA stool test kit for colon cancer detection. The study reported 92% detection accuracy [11]. This was a pilot study of a new test product not yet approved by the United States Food and Drug Administration. The new traffic observed on the Twitter community from March 18, 10 PM EST had the keywords “DNA” and “stool test” along with “colon cancer”. Their number of tweets and the first tweets of leaders and followers are illustrated in Figure 2(a) and Figure 2(b). There were 547 tweets on March 19, and 299 tweets on March 20. 73 tweets belong to leaders, and 773 tweets to followers.

As it is observed in Figure 2(b), the principle of the leader-follower relationship according to the time lapse also holds on the second topic. There exists a peak of leaders’ first tweets on March 19, 1 PM EST, whereas the followers’ peak was observed two hours later at 3 PM EST. However, in contrast to Topic 1, the numbers of tweets for Topic 2 are considerably lower than those of the first topic. This is expected given that Topic 1 made national media coverage while Topic 2 was published in a medical journal and received less attention by the news media.

IV. Discussion

From the observation of the propagation of the two colon cancer news on Twitter SNS, there exists a distinct and consistent difference in terms of the time a topic conversation starts between the leader group and the follower group. Leaders are eager to start circulating news

on SNS early. This implies that when more leaders reside in SNS, the higher the chance to distribute the message, particularly with respect to promoting a positive health behavior. Wider spread of such message increases the chances of impacting positively the self-efficacy of followers, encouraging them to take positive action for regular screening and prevention of colon cancer.

However, this is valid only if people believe that the news is informative and beneficial to them directly. The two colon cancer news described in Section 3 have clear differences. The first topic was released with confirmation of statistics of the multi-year history, demonstrated clear evidence of benefits, and patient guidance. No doubt, the news on the experimental colon cancer screening test although promising, it is preliminary, unavailable, and therefore fails to connect directly to ordinary people in terms of its importance to them and taking any specific action. This is reflected in the dramatic difference on the number of mentions on SNS.

Cancer prevention and early detection campaigns on SNS could be designed as an application of this observational study. Designing SNS campaigns with clear messages on specific preventive actions is easy to implement and possibly beneficial in terms of spreading the message fast and retaining interest in the long run. In addition, forming a group of leaders who appreciate the importance of the message and are eager to disseminate information consistently engaging followers in discussions may provide consistent benefits by improving peoples' self-efficacy through persistent positive external influences. Although the effectiveness of incorporating online social media to influence health behaviors is still under investigation, regular monitoring of SNS activity may serve as an informative surrogate measure of whether a specific health campaign attracts and retains attention on target topics.

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(a)

(b)

Fig. 1. Number of tweets and retweets per hour mentioning of the news about articles on American Cancer Society, (a) total number of tweets and (b) number of first tweets of participants.

(a)

(b)

Fig. 2. Number of tweets and retweets per hour mentioning of the news about articles on New England Journal of Medicine, (a) total number of tweets and (b) number of first tweets of participants.