

# **Social Influence in Public and Private Behaviors: A Large-Scale Randomized Experiment in Social Advertising**

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## **Abstract**

The motive and degree of social influence is likely to differ between public and private behaviors. I designed and analyzed a large-scale randomized field experiment involving more than 37 million users to quantify and compare social influence in consumers' public (i.e. liking) and private (i.e. clicking) responses to social ads. In the experiment, I randomized the number of social cues (i.e. peers endorsements of ads), and identified the effects of them on liking and clicking to the ads. Liking was associated with much more positive effects of social cues than clicking, while both of them were susceptible to a significant degree of social influence. Influence on liking is larger than on clicking is not because users are more likely to conform to higher-status or close friends in public but because socially expressive users are significantly more susceptible to friends' influence, when their behaviors are visible and can be diffused in social networks. Stronger motive to conform to a group than a person is identified in public behaviors but not in private behaviors. To the best of my knowledge, this is among the first studies that quantitatively compare social influence and identifies social ads' effectiveness in public and private responses to social ads.

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## 1. INTRODUCTION

Social influence is the main behavioral mechanism in the diffusion of new products and the spread of information and behaviors in society (Manski 1993, Aral et al. 2009, Tucker 2008, Aral et al. 2009, Sacerdote 2001). Behavioral characteristics can encourage or constrain social influence. However, limited is known about whether and how such influence differs in different behaviors. Public behaviors, which can be seen and identified by others, and private behaviors, not broadcasted to other people are one of the most widely used and natural ways of dividing individuals' behaviors in social networks. The motive and degree of social influence are likely to differ between these two types of behaviors. The goal of this research is to identify of what degree and under what process social influence varies between public (i.e., liking) and private (i.e., clicking) responses to social ads. Answering this question will have important implications for advertisers to understand how social influence works through different channels (i.e., public and private responses) and to optimize the value of social influence in social ads. This is among the first studies that compare degree and motive of social influence in different behaviors and measure social ads effectiveness.

People have different motives in changing their attitudes or behaviors because of the influence of others. Individuals have both concerns with being right and being liked. They care about intrinsic utility derived directly from a product as well as their social status relative to others displayed through the ownership of goods. Social influence thus can be classified as informational or normative (Deutsch and Gerard 1955). First, informational social influence refers to the influence to accept information obtained from another as evidence about reality, in which peers are the mediators of facts. Informational influence affects customers awareness and beliefs of products risks and benefits. Individuals are inclined to imitate those who are believed to be better informed and trust that their decisions are more likely to be "right". Second, normative social influence is the influence of individuals to conform to the expectations of another person or a group, in order to be accepted and liked. It stems from the human identity as a social being with needs for association with

others and recognition by the society. Individuals are especially motivated to conform to high-status people or groups to obtain or maintain a desired social status. Although normative social influence may happen in private due to the process of identification, in which "behavior is associated with a satisfying self-defining relationship" to the other, beneficial to individual's self-concept" (Kelley 1967, p.63). Public observability of product choices will increase normative social influence, because it allows individuals to display their own status through product decisions and signal it to other consumers, which enables them to match up with a high-status person or group rather than a low-status one. Only if the conformity behaviors can be identified by a person or a group, individuals are able to realize a reward or avoid a punishment mediated by that person or that group. As a result, normative social influence is likely to be greater in the influence process of public behaviors than private behaviors. Previous research argued that private responses are likely to under the control of informational social influence and to be relatively unaffected by normative social influence (Deutsch and Gerard 1955).

I designed and analyzed a very large-scale randomized field experiment on the social ads of a world leading mobile social network: WeChat, to identify and compare the degree and motive of social influence in public and private behaviors. Social influence in our experiment is measured as the degree to which social cues (i.e., likes), representing friends' endorsements of products, affect users' public (i.e., liking) and private (i.e., clicking) responses to social ads. The experiment was conducted on a random sample of more than 37 million users of WeChat Moments Ads, a type of social advertisement displayed in WeChat users' newsfeed, across 99 ads and over 21 days. The experiment involves user-ad level randomization of the number of social cues displayed on WeChat Moments Ads. By randomly assigning the number of social cues displayed on the ads in a real context, we are able to obtain unbiased estimates of social influence. Ad clicks are private behaviors, not broadcasted to other users in the social network, while ad likes are broadcasted through the social network and are displayed to users' friends. WeChat Moments ads is particularly suited for this study, in

which strong public responses are clearly distinct from private responses.

The experimental evidence demonstrates that public responses to ads were associated with significantly larger positive effects of social cues than the private responses, while both of them were susceptible to a significant degree of social influence. Displaying a social cue on an ad results in an increase of 28.9% in users' probability of liking an ad, which is significantly larger than 3.9% in that of clicking. Displaying organic social cues on an ad leads to an increase of 28.9% in users' likelihood of liking an ad, which is significantly larger than 3.9% in that of clicking. At least XX% social influence happens in users' first impressions of ads out of users' multiple (entire) impression of ads. The significantly positive marginal social influence (the effects of one social cue on ads responses, compared to no social cue) also well establishes that social ads are more effective than non-social ads (ads without any social cue) and social influence is at work in social ads.

To understand the motives in influence process for public and private responses, I first explored the relationship between group size (i.e., number of social cues) and social influence. The form of the relationship will differ depending on whether informational or normative social influence predominates. The empirical analysis suggests that the degree of influence on liking significantly increases as the number of social cues increases, while influence on clicking does not affected by group size. This indicates that normative social influence predominates in liking not in clicking. When the process is essentially informational social influence, the first and the most credible source provides the most information and each additional source may be redundant. Group size (number of social cues) is supposed to affect normative social influence more than informational social influence. On the other hand, group size can be an important factor that determines the level of social conformity an individual displays. Normative social influence is the main mechanism leading to social conformity, which is fundamentally a group behavior. Individuals are motivated to match attitudes, beliefs, and behaviors to group norms, which are enhanced by the number of group members who support the norms. Larger groups also have greater power to mediate

the rewards and punishment due to the social conformity.

I then examined how friends' product knowledge and social status relative to users moderate the degree of social influence, to identify and compare individuals' motives to seek information from informed friends or conform to high-status groups. This helps to understand whether and how informational and normative social influence works in public and private responses. I measured product knowledge by users' accumulated information in product-related areas that he or she read historically in WeChat, and social status by the city that a user comes from. Huge economic differences exist among cities in China. Therefore, city is an indicator for social status of an individual from China. Users exhibited significant motivation to both seek information from knowledgeable friends and display conformity to higher-status groups. XXXX. They show stronger intention to conform to higher-status groups in liking than in clicking, while they exhibit similar level of intention to seek information from knowledgeable friends. XXXX. This is consistent with my previous finding that normative social influence stronger in liking than in clicking.

Finally, I compared users' conformity behaviors to a single friend (one social cue) with those to a group of friends (more than one social cues). Users tend to conform to a friend with more product knowledge and from bigger cities, when there is only one friend endorsed the ad and exerted influence. These two tendencies are similar in liking and clicking. XXXX. In consequences, users' motives to conform to high-status groups are stronger in liking, only when a group (more than one) of friends make influence, while users' tendency to seek information from knowledgeable friends is similar in liking and clicking. Normative social influence is more dominant in liking when more than one friends exerted influence, while informational and normative social influence exist in both liking and clicking no matter how many social cues were presented.

Until now, I show that the degree and the motive of social influence are different between public (i.e., liking) and private (i.e., clicking) responses to social ads. One might naturally asks how these differences implicate for the ads effectiveness. Displaying social cues led to an

increase in click rate, directly contributing to product impressions. Social cues benefited more to accumulating social cues (i.e., likes), which generate social influence in return. However, it is unclear whether and how liking itself correlates with ads effectiveness. One may argue that liking may lead to clicking, due to self-justifications of behaviors. But I observe that more than 90% of liking was not associated with clicking, indicating that at least in 90% cases liking does not lead to clicking. Liking itself may indicate more attentions paid to the ads. But liking does not positively correlate with users' dwell time on the ads. Finally, I surprisingly found that in absence of influence, friends' likes did not predict clicking but largely predict liking. Since friends' behaviors tend to cluster together, liking and clicking are distinct behaviors accordingly.

In the following sections of this paper, I first describe the experimental design and procedures. Then I report the descriptive statistics, which reveal support for the larger effects of social cues on users' public responses to ads than their private responses to ads. XXXXX

## 2. RESEARCH SETTING: WECHAT MOMENTS ADS

WeChat is one of the largest messaging apps, with over 889 million active users spending averagely 66 minutes a day on the app. WeChat Moments, like Facebook's news feed, supports posting images and texts, as well as sharing music, articles and short videos. WeChat Moments ads are very similar to Facebook ads appearing on the timeline of Moments and were launched in the spring of 2015. The experiment started in Dec of 2015, in a very early stage of WeChat Moments ads. Users could click, comment and "like" the ads in the Moments (See Figure 1).

Several features of WeChat Moments ads make it different from Facebook ads and particularly suited for studying social influence in public and private responses to ads. First, public behavior in WeChat Moments, such as liking, is a social signaling device, making it distinct from private behaviors, such as clicking. WeChat Moments deliver 100% of

users' contents, including posts, likes and comments to their first-degree friends. Only the first-degree friends from the users' contacts are able to view their Moments' posts, likes and comments. If a user liked an ad, they will be sure that their "like" will be displayed to and only to their first-degree friends in Moments. This is different from Facebook, in which newsfeed contents are visible to both friends and strangers. Only around 9% of feeds for a user will be displayed. Users therefore are very uncertain about whether their public responses to ads will be shown to their friends and who will see their likes and comments. These ambiguities will largely hamper users' motive to socially signal their preferences and opinions through responding to ads publicly.

Second, the design of WeChat Moments' ads allow researchers to identify the marginal social influence - comparing ads with and without social cues. Facebook's social ads are socially targeted and broadcasted to a user only if he or she has a friend liked this ad organically. It is thus almost impossible for the experiments on Facebook social ads to compare ads with social cues and without any social cue, measure marginal social influence and social ads effectiveness. In the Facebook experiments of Bakshy et al. (2012), they only compared ads with one social cue and with more than one social cues, and compared ads with social cues of friends and with global social cues (the number of Facebook users liked this ads). Their design of experiments does not allow them to quantify marginal effects of social cues (compare with and without social cues). Tucker (2012) studied the social ads effectiveness through comparing socially targeted ads with different kinds of social influence and demographically targeted ads. This study does not answer whether the effectiveness of social ads were caused by social targeting or social influence.

### 3. EXPERIMENTAL DESIGN

Identifying social influence is difficult, because influence is often endogenous (Manski 1993, Shalizi and Thomas 2011). Comparing this influence on different behaviors is even more difficult, because the behaviors have to happen in the same context in order to make



them comparable. Previous researchers endeavored to identify social influence empirically, using instrumental variables (Bramoull et al. 2009, Tucker 2008), dynamic matched-sample estimation (Aral et al. 2009) and structural models (Ghose and Han 2010). However, the gold standard for causal inference, as well as social influence identification, is randomized field experiments.

This study utilized a randomized field experiment to identify social influence in different behaviors. The experiment was conducted on WeChat Moments Ads. WeChat Moments, like Facebook’s news feed supports posting images and texts, as well as sharing music and short videos. WeChat officially delivers ads to the Moments of targeted users. Users could express their attitudes towards the ads and show their preferences and opinions by liking and commenting them. They can learn the content of ads by clicking the links to the advertisers’ profile page, landing page, and product photos. See Figure 1 for an example of WeChat Moments Ads. Unlike Facebook, only first-degree friends’ likes or comments are visible to WeChat users. As a result, the social influence in our experiment has a consistent meaning that the effects of a social cue (i.e., like) that represents *first-degree friends*’ endorsements of an ad on users’ response to the ad (i.e. clicking).

During the experiment, as users received a new ad, they were randomly assigned into three groups: without any social cue (control group), with maximum one like and with organic likes displayed on the ads (treatment groups), or outside the experiment (See figure 2). There are two types of potential social cues on the ads: friends’ likes and comments. Since comments do not show clear positive or negative preferences and vary by their contents, we focused on the likes as the only social cues, which uniformly represent friends’ endorsements of an ad, and hid all the friends’ comments from the ads shown to the users during the experiment. Every ad stayed in users’ newsfeed for maximum 48 hours. After 48 hours, the old ad would disappear, and a new ad was received. In this way, users saw only one ad at one time in WeChat Moments during the experiment. Randomization would happen again whenever users received a new ad. Users could be in a different treatment group or outside

the experiment for different ads. The randomization was at user-ad level.

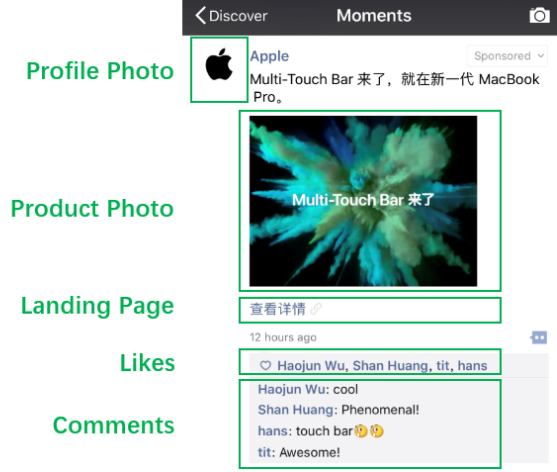


Figure 1: Example of WeChat Moments Ads



Figure 2: Experimental Treatments

Note. Figure illustrates the control condition (i.e., without any social cue, and two possible treatment conditions (i.e., with a maximum of one and with organic likes)

Our experimental design carefully avoided many known sources of bias in influence identification and networked experiments. First, it eliminated bias created by homophily through randomly assigning the social cues such that observed and unobserved attributes of users are equally distributed across different groups. Second, the randomization controls for external confounding factors, because users are equally likely to be exposed to external stimuli that affect adoptions across different treatment groups. Third, all the ads involved in the experiment were new and distinctive, so there were no external sources for users to get access to the ads before or outside the experiment. Fourth, “likes” from different

users are shown in identical forms in Moments and are only different in friends' names or profile pictures, eliminating the heterogeneity of unmeasurable characteristics of social cues. See Figure 1 for an example of WeChat Moments ad. Fifth, this method guarantees the stable unit treatment value assumption (SUTVA)(?). Users would not receive different treatments from different ads at the same time, because of one-ad limit within 48 hours. Sixth, since randomization (re)occurred for every 48 hours, it was very unlikely that users noticed they were being treated during the experiment. The treatment effects, therefore, were not confounded by unmeasurable psychological factors of users, who suspected or realized they were in an experiment.

#### 4. DATA

Social influence is measured by the number of social cues (i.e., likes) displayed on the ads. Dependent Variables are users' public (i.e., whether like) and private responses (i.e., whether click) to an ad. According to the design of WeChat Moments ads,

response time, and users' and their affiliated friends' profile (i.e., age, gender and city) and behavioral characteristics on WeChat (i.e., number of login days to WeChat Moments and number of WeChat friends) were recorded. *Affiliated friends* are the ones who had liked an ad before the users saw the ad at the first time. We consider users' responses during their first and multiple impressions of a new ad. This study therefore only focuses on the social influence on the first adoptions of new ads and excluded the repeated adoptions. We counted any click on a given ad as long as they click on the profile page, link to the landing page or product photos. Ads information, including product and brand names and the product category that a product belong to, was also collected. We adopted the categorization method used in WeChat ads department, which is the standard method in ads industry.

## 5. DESCRIPTIVE STATISTICS

The experiment was conducted over a 21-day period starting on Dec 22th of 2015, during which 57,510,157 user-ad pairs, 37,951,299 distinct users, and 99 ads participated in the experiment. 19,198,084 user-ad pairs were randomly assigned to the control group with no social cue. 19,174,955 user-ad pairs were randomly assigned to the treatment group with a maximum of one like. 19,137,118 user-ad pairs were randomly assigned to the treatment group with organic likes. We dropped 17 ads with invalid data and finally got 82 ads and 71 distinct products, which are categorized into 25 categories. Every product category has 2.8 products. Among the 71 products, there are 57 experience goods and 14 search goods, while there are 24 status goods and 47 non-status goods. The correlation between the two dummy variables indicating whether a product is experience good or search good and whether it is status good or non-status good, is 0.138.

Assignment to treatment groups was clearly random, with no economically significant distributional and mean difference between users of different groups(?), in terms of their age, gender, network degree (i.e., number of WeChat friends) and level of WeChat Moments activity (i.e., log-in days) in November of 2015, the month right before the experiment (t-test, mean difference/mean < 0.5%,  $p > 0.1$ <sup>1</sup>) (See Table ?? and Figure ?? in appendix for more details). This evidence taken together confirm the integrity of the randomization procedure. The manipulation was correct and successful. Zero like was displayed to the users in the control group, and a maximum of one like and organic likes were displayed to the users in the two treatment groups (See Table ?? in the appendix).

We focus on the marginal social influence, which refers to the effect of one social cue on users' adoptions of product ads (i.e., clicking) in the main analysis and will analyze effects of more than one social cues for robustness checks. We can manipulate only the maximum number of social cues rather than the exact number of them. The maximum number of

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<sup>1</sup>Hypothesis testing:  $\mu_0 = \mu_1$  would always be rejected in a very large dataset. We therefore test the hypothesis :  $\mu_1 - \mu_0 < 0.5\% * \mu_0$  instead (?).

displayed social cues is therefore limited by the number of affiliated friends. To get the treatments of an exact number of social cues and measure the marginal social influence, we filtered the data on the condition that there were more than one affiliated friends. We finally got a sample of 5,571,116 user-ad pairs and 4,884,070 distinct users in total for our analysis coming from three groups: control group without any social cue, treatment groups with one displayed like and with more than one displayed likes on the ads in users' first impressions of the ads (See Table ?? for more details on sample characteristics). There is no economically significant distributional and mean difference between users of these three different groups, in terms of their age, gender, network degree (i.e., number of WeChat friends), and level of WeChat Moments activity (i.e., log-in days in November of 2015) (See Table 1 and Figure 3).

Table 1: Mean Comparison between Groups

	t-statistic ( $  \#0 - \#1   < \#0 * X\%$ )	t-statistic ( $  \#0 - \#N   < \#0 * X\%$ )	t-statistic ( $  \#1 - \#N   < \#1 * X\%$ )
	t-statistic (X%)	t-statistic (X%)	t-statistic (X%)
Age	-0.371 (0.10%)	-13.882 (0.50%)	0.835 (0.10%)
Gender, 1=Male	1.410 (0.10%)	-0.629 (0.10%)	1.637 (0.10%)
City, 1=Class <sub>1</sub>	0.618 (0.10%)	1.556 (0.10%)	0.269 (0.10%)
City, 1=Class <sub>2</sub>	0.092 (0.10%)	0.371 (0.10%)	-0.843 (0.10%)
City, 1=Class <sub>3</sub>	-0.292 (0.10%)	0.739 (0.10%)	0.718 (0.10%)
Degree	-1.269 (0.50%)	-0.778 (1.80%)	-1.179 (1.50%)
Login Days	-27.647 (0.10%)	-27.567 (0.10%)	-27.820 (0.10%)

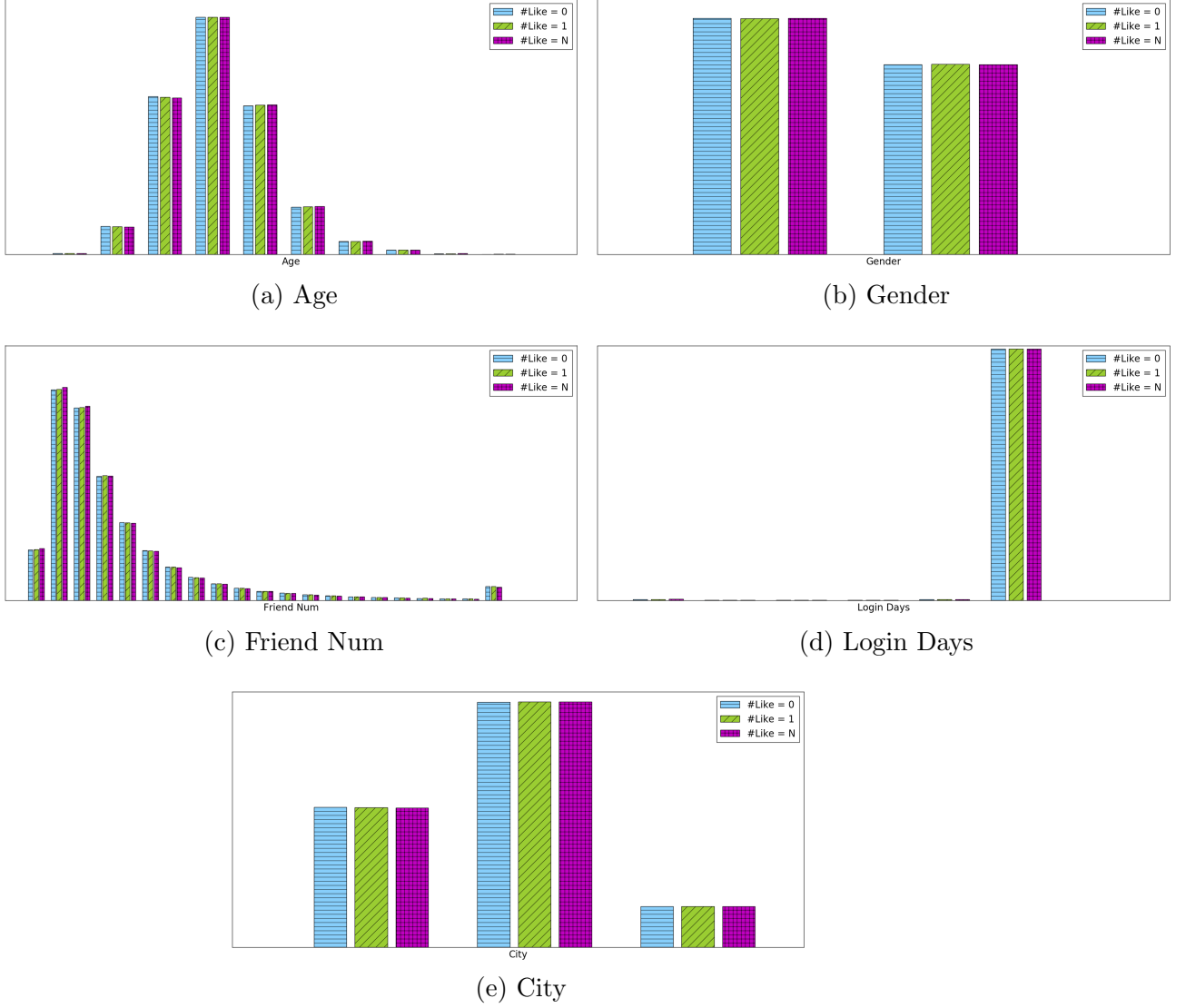


Figure 3: Distribution Comparison between Groups

## 6. COMPARING SOCIAL INFLUENCE BETWEEN LIKING VS. CLICKING

### 6.1. Model Specification

We estimate a logistic regression model <sup>2</sup> in Equation 6.1. Our analysis is at user-ad level.

Each observation represents an user-ad pair. The model simultaneously estimates the impact

<sup>2</sup>We did not adopt Hazard Model for the analysis, because adoption time does not implicate the degree of social influence in our context. First, adoption time depends more on users' habit of using WeChat. For

of two dimensions of product types: search/experience goods and status/non-status goods in Section 7.1:

$$\log\left(\frac{Pr(Y_{ij} = 1)}{1 - Pr(Y_{ij} = 1)}\right) = \alpha + \beta_0 * S_{ij} + \beta_1 * P_j + \gamma_1 * S_{ij} * P_j + \epsilon_i \quad (6.1)$$

$Y_{ij}$  is a dummy variable to indicate whether  $user_i$  clicked  $ad_j$  during their first ad impression.  $S_{ij}$  is a dummy variable to indicate whether user-ad pair  $(i, j)$  is in the treatment group with a social cue on  $ad_j$ .  $P_j$  is a vector of product-type dummies, each of which indicates whether the product in  $ad_j$  is experience good or search good and whether it is status good or non-status good. The coefficient  $\beta_0$  captures the marginal impact of a social cue on ads adoptions, irrespective of the characteristics of individuals, affiliated friends, brands, products and delivery week. The coefficient  $\beta_1$  captures the effect of product types on the tendency of users and their affiliated friends to spontaneously adopt an ad, in the absence of influence ( $S_{ij} = 0$ ). This indicates how product types affect the variation in correlated peer behaviors explained by homophily. The coefficient  $\gamma_1$  captures the impact of product types on the influence.

We also include a comprehensive set of covariate controls in analyses and control for their effects on both clicking and social influence. First, since different ads target different users, it is necessary to control for the variables used for ads targeting. Our experiment was conducted at the very early experimental stage of WeChat Moments Ads. The targeting conditions were, therefore, simple and clear, which is mainly based on users' age, gender, and city. Previous studies also suggest that individual demographic characteristics indeed affect social influence significantly (e.g., Aral and Walker 2012). Second, we also controlled for characteristics of the affiliated friends whose social cue was displayed on the ads during users' first impressions of the ad. Targeting conditions of ads also partly decide the demographic conditions of affiliated friends. Both influence and susceptibility are the key factors that

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example, the users who are more addicted to WeChat may open WeChat earlier and thus adopt the ads earlier. Second, we only study the peer effects on users' very first reactions to the ads. The variation of (relative) adoption time is very small and trivial.

drive social influence (Aral and Walker 2012). As a result, it is necessary to take affiliated friends' demographic characteristics into consideration. Third, we used a dummy variable to indicate whether a brand was among the 100 Best Global Brands by Interband to control for the big brand effects on clicking and on social influence. Brand characteristics were shown to affect word of mouth(?) and may thus associate with social influence. Fourth, since our experimental period covered Christmas and New Year holidays, we included week dummies to control for the time effects on clicking and social influence. Finally, users adoption outcomes may be correlated because they may receive more than one ads in the experiment. To account for this, the model employs White robust standard errors.

## 6.2. Results

Although subjects demographics and WeChat activity patterns were the same, their responses to the ads differed significantly across groups. First, the survival curves compared the cumulative response rate of subjects in different groups during their entire lifecycle of an ad impression, showing that the curves of the groups associated with more social cues were always above the curves of the groups associated with less social cues (See Figure ??). This indicates that the response rates of the groups associated with more social cues are always higher than those of the groups associated with less social cues during the entire lifecycle of an ad impression.

Second, T-tests show that the click rate and like rate significantly increase as the number of social cue increases ( $p < 0.001$ ); follow rate significantly increases as the number of social cue increase from zero to a maximum of one, although the follow rate did not change significantly as the number of social cue increases from a maximum of one to organic number (See Figure ??). These evidences generally confirm that the peer influence is positive.

Both Figure ?? and ?? show that the marginal effect of social cues is larger than the effect of additional social cues for all types of responses to ads. Since not all the subjects in the group with a maximum of one social cue had more than one affiliated peers and thus had



one displaying social cue, the difference between the group without any social cue and with a maximum of one social cue is the lower bound for the marginal effects of peer influence. For very similar reason, the difference between the group with a maximum of one social cue and that with organic social cues is the lower bound for the effects of additional social cues (i.e. more than one vs. one).

To assess the different effects of social cues on the public and private response to ads, I compared the influence between the two types of responses. The results show that the effects of social cues of clicking and following are smaller than those of liking. Compared to no like displayed, displaying a like caused a 28.9% relative increase in like rate, which is larger than the 3.9% relative increase in click rate and 5.1% relative increase in follow rate. Compared to displaying a maximum of one like, displaying organic likes caused a 12.9% relative increase in like rate, which is larger than 0.69% relative increase in click rate and a 1.69% relative increase (insignificant) in follow rate in numbers. These show that peers endorsements of ads exerted greater influence on liking (i.e. public response) than on clicking and following (i.e. private response).

### **6.3. Robustness Checks**

#### **6.3.1. Social Influence in Multiple Impression**

#### **6.3.2. Comparing Liking vs. Clicking**

In theory, homophily and influence can both explain the temporal clustering of behaviors among linked friends. Homophily is the tendency of similar people to associate together. Socially connected individuals always exhibit correlations in their preferences and therefore behaviors. Homophily is the theoretical foundation of social targeting, in which relationship information and peers behaviors are applied to improve the predictions of ones preferences in products. Individuals are often influenced by their peers' behaviors and therefore to engage with ads.

In the group without any social cues, only homophily<sup>3</sup> causes the correlated behaviors between the subjects and their peers who endorsed the ads. In the group with social cues, influence and homophily both contribute to such correlated behaviors. I used two groups of subjects in the current analysis, in which subjects have exactly the same number of affiliated peers who was either shown (i.e. group A) or not (i.e. group B). The difference in response rate between the two groups is considered to be caused by peer influence. The ratio of the difference in response rate between group A and group B to the response rate of group A can represent %influence that explains the clustering of behaviors among peers.

I found that both homophily and influence account for correlated behaviors among peers. Social influence explains more of the clustering of liking (Mean = 52.6%, SD = 0.0314) than that of clicking (Mean = 22.8%, SD = 0.0761) and following (Mean = 20.7%, SD = 0.141) (See Figure ??). Influence and homophily therefore explains the similar level of the correlated behaviors of liking among linked friends. However, homophily accounts more for the clustering of clicking and following than influence. Social targeting is thus a more effective strategy for inducing clicking and following (i.e. private behavior) than influence, while influence and homophily are equally important in inducing liking (i.e. public behavior).

## 7. BEHAVIORAL MECHANISM

The preceding analysis did not treat the social cues differently from one another and only focuses on the number of them. However, relationships between different pairs of users can be very different. I now examine the effects of tie strength of social cues on response rates and compare them between public and private behaviors. To do that, I only focus on the group, in which there are 2,467,212 ad-user pairs with more than one affiliated peers, one of whom was shown.

Tie strength was measured based on the communicating frequency between two users  $i$  and  $j$  on WeChat messaging and define tie strength as the fraction of users  $i$ 's communications

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<sup>3</sup>External factors could be another cause of correlated behaviors among friends. Here I did not consider it and there is also no reason for me to assume external factor is an important factor in my context.

that were directed to user  $j$  during the 28 days prior to the experiments ((Burke and Kraut 2014), (Bakshy et al. 2012)). Subjects sent or received messages on WeChat messenger more than 90% of the days during the 28 days prior to the experiments. The high activeness of WeChat users makes my measure of tie strength valid.

The results show that for the users in the group with a single social cue, their like rate, click rate and follow rate generally increases as the tie strength of the social cue increases (See Figure ??). Figure ?? shows that like rate increases more than click rate, as the tie strength increases, indicating that the tie strength may have larger effects on liking than on clicking. The difference between liking and following are not very clear from the graph.

Figure ?? only provides a glimpse on the potential larger effects of tie strength on the public responses than on the private responses. The increasing trend between the tie strength and the response rate may also come from the correlated preferences of ads between the individuals and their close friends. The model specification in the next section will provide more accurate evidence of the effects of tie strength and control for the attributes of subjects and their peers, which may also cause the positive correlations between the tie strength and response rate.

### 7.1. Interacting With Friends' and Users' Characteristics

### 7.2. Interacting With Number of Social Cues

## 8. CONCLUSION AND IMPLICATIONS

Although peer influence has been of central importance in social-science research, very little is known about the heterogenous peer influence across different behaviors. However, it is very meaningful to learn the exact difference in peer influence across behaviors because influence always occurs over certain types of behaviors. As a result, the research question of this study is fundamental and important. This is among the first studies showing that characteristics of behaviors can affect the degree, to which individuals are influenced by

their peers. I found that public observability encourages peer influence.

I designed and analyzed a large-scale randomized field experiment comparing the peer influence between public and private behaviors. I found that the public behaviors are associated with significantly greater peer influence than the private behaviors, and tie strength generally has larger effects on the public behaviors than on the private behaviors. In theory, compliance, one of the motivations of normative influence, only occurs, when individuals believe that their behaviors are visible or known to others (i.e. in public behaviors), and is the main reason for the differences in peer influence between public and private behaviors. Public behaviors, associated with more types of influence than private behaviors, therefore are likely to be susceptible to a greater peer influence. Compliance motivates individuals to conform to another or a group, in order to gain a potential reward or to avoid a potential punishment associated with that another or that group. People tend to comply to a person, when they are strongly connected with each other. Close friends are more likely to be able to reward or punish an individual. Tie strength therefore may have stronger effects on public behaviors than on private behaviors. The results from the experiments largely confirm the predictions of the theory, which also indicate that compliance is indeed a very important motivation of individuals to be influenced by others. The lower bound of marginal effects of social cues on liking (i.e. public responses to ads) is 28.9%, much larger than and very different from that on clicking (3.9%) and following (5.1%) (i.e. private responses to ads).

Social advertising utilizes the information of peers' behaviors both to target the potential customers (i.e. social targeting) and to influence users to aware the associated brands or products. Homophily and influence both contribute to the temporal clustering of behaviors among linked friends, and also the mechanisms of social advertising. Homophily is the principle that similar people tend to associate together, while influence refers to the facts that individuals are often influenced by others, especially friends. The results of my study show that homophily explains more of the temporal clustering of private behaviors, such as

clicking and following than influence. Thus social targeting is a more effective strategy than including social cues to induce the private responses to ads, which are more of a concern for advertisers. However, peer influence and homophily are almost equally important for promoting the public responses to ads, such as liking. This work thus sheds light on how social ads can be effectively designed to promote certain types of behaviors and to attract potential customers. This study also quantified the marginal effects of a social cue in social ads, which have not been accurately measured in previous research (e.g. (Bakshy et al. 2012), (Tucker 2012)). I found that marginal effects is much larger than the effects of including more than one social cues. This information is very meaningful for product managers, providing scientific support to including a social cue.

Moreover, understanding the peer influence in public and private behaviors is practically crucial. In social networks, behaviors can always be classified either broadcasted to others or not. Product managers often face the question of whether users' behaviors should be propagated to their peers or not. Broadcasting would lead to a greater diffusion of information and potentially higher financial returns. On the other hand, it would make the design more complex, as one must accommodate a larger amount of information. My results show that the influence has greater effects on the behaviors, which are broadcasted to others and thus lead to further influence in future, than the behaviors, which are private and not known by the peers. This is encouraging, which indicates that broadcasting such behaviors will indeed lead to a great extent of diffusion of those behaviors.

## References

- S. Aral and D. Walker. Identifying Influential and Susceptible Members of Social Networks. *Science*, 337(July):337–341, 2012. ISSN 0036-8075. doi: 10.1126/science.1215842.
- Sinan Aral, Lev Muchnik, and Arun Sundararajan. Distinguishing influence-based contagion from homophily-driven diffusion in dynamic networks. *Proceedings of the National Academy of Sciences of the United States of America*, 106:21544–21549, 2009. ISSN 0027-8424. doi: 10.1073/pnas.0908800106.
- E Bakshy, D Eckles, R Yan, and I Rosenn. Social influence in social advertising: evidence from field experiments. *Proceedings of the 13th ACM Conference on Electronic Commerce*, 1(212):146–161, 2012. doi: 10.1145/2229012.2229027. URL <http://dl.acm.org/citation.cfm?id=2229027>.
- Yann Bramoull, Habiba Djebbari, and Bernard Fortin. Identification of peer effects through social networks. *Journal of Econometrics*, 150(1):41–55, 2009. ISSN 03044076. doi: 10.1016/j.jeconom.2008.12.021.
- Moira Burke and Robert E. Kraut. Growing closer on facebook. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems - CHI '14*, pages 4187–4196, 2014. ISBN 9781450324731. doi: 10.1145/2556288.2557094. URL <http://dl.acm.org/citation.cfm?id=2611222.2557094>.
- M Deutsch and H B Gerard. A study of normative and informational social influences upon individual judgement. *Journal of abnormal psychology*, 51(3):629–636, 1955. ISSN 0096-851X. doi: 10.1037/h0046408.
- Harold H Kelley. Attribution Theory in Social Psychology. *Nebraska Symposium on Motivation*, 15: 192–238, 1967. ISSN 0070-2099(Print).
- Charles F. Manski. Identification of Endogenous Social Effects: The Reflection Problem. *The Review of Economic Studies*, 60(3):531, 1993. ISSN 00346527. doi: 10.2307/2298123. URL <http://restud.oxfordjournals.org/lookup/doi/10.2307/2298123>.
- B Sacerdote. Peer effects with random assignment: Results for Dartmouth roommates. *The Quarterly Journal of Economics*, 116:681–704, 2001. ISSN 1556-5068. doi: 10.1162/00335530151144131. URL <http://qje.oxfordjournals.org/content/116/2/681.short>.
- CR Shalizi and AC Thomas. Homophily and contagion are generically confounded in observational

social network studies. *Sociological Methods & Research*, 40(2):211–239, 2011. URL <http://smr.sagepub.com/content/40/2/211.short>.

C. Tucker. Identifying Formal and Informal Influence in Technology Adoption with Network Externalities, 2008. ISSN 0025-1909.

C E Tucker. Social Advertising. 2012. URL SSRN:<http://ssrn.com/abstract=1975897>.