

A 61-million-person experiment in social influence and political mobilization

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Human behaviour is thought to spread through face-to-face social networks, but it is difficult to identify social influence effects in observational studies^{9–13}, and it is unknown whether online social networks operate in the same way^{14–19}. Here we report results from a randomized controlled trial of political mobilization messages delivered to 61 million Facebook users during the 2010 US congressional elections. The results show that the messages directly influenced political self-expression, information seeking and real-world voting behaviour of millions of people. Furthermore, the messages not only influenced the users who received them but also the users' friends, and friends of friends. The effect of social transmission on real-world voting was greater than the direct effect of the messages themselves, and nearly all the transmission occurred between 'close friends' who were more likely to have a face-to-face relationship. These results suggest that strong ties are instrumental for spreading both online and real-world behaviour in human social networks.

Recent experimental studies^{6,14–16} have attempted to measure the causal effect of social influence online. At the same time, there is increasing interest in the ability to use online social networks to study and influence real-world behaviour^{17–19}. However, online social networks are also made up of many 'weak-tie' relationships²⁰ that may not facilitate social influence²¹, and some studies suggest that online communication may not be an effective medium for influence²². An open question is whether online networks, which harness social information from face-to-face networks, can be used effectively to increase the likelihood of behaviour change and social contagion.

One behaviour that has been proposed to spread through networks is the act of voting in national elections. Voter turnout is significantly correlated among friends, family members and co-workers in observational studies^{23,24}. Voter mobilization efforts are effective at increasing turnout²⁵, particularly those conducted face-to-face and those that appeal to social pressure²⁶ and social identity²⁷. There is also evidence from one face-to-face field experiment that voting is 'contagious', in the sense that mobilization can spread from person to person within two-person households²⁸. Although anecdotal accounts suggest that online mobilization has made a big difference in recent elections²¹, a meta-analysis of email experiments suggests that online appeals to vote are ineffective²⁴.

Voter mobilization experiments^{26–28} have shown that most methods of contacting potential voters have small effects (if any) on turnout rates, ranging from 1% to 10%. However, the ability to reach large populations online means that even small effects could yield behaviour changes for millions of people. Furthermore, as many elections are competitive, these changes could affect electoral outcomes. For example, in the 2000 US presidential election, George Bush beat Al Gore in Florida by 537 votes (less than 0.01% of votes cast in Florida). Had Gore won Florida, he would have won the election.

To test the hypothesis that political behaviour can spread through an online social network, we conducted a randomized controlled trial

with all users of at least 18 years of age in the United States who accessed the Facebook website on 2 November 2010, the day of the US congressional elections. Users were randomly assigned to a 'social message' group, an 'informational message' group or a control group. The social message group ($n = 60,055,176$) was shown a statement at the top of their 'News Feed'. This message encouraged the user to vote, provided a link to find local polling places, showed a clickable button reading 'I Voted', showed a counter indicating how many other Facebook users had previously reported voting, and displayed up to six small randomly selected 'profile pictures' of the user's Facebook friends who had already clicked the I Voted button (Fig. 1). The informational message group ($n = 611,044$) was shown the message, poll information, counter and button, but they were not shown any faces of friends. The control group ($n = 613,096$) did not receive any message at the top of their News Feed.

The design of the experiment allowed us to assess the impact that the treatments had on three user actions; clicking the I Voted button, clicking the polling-place link and voting in the election. Clicking the I Voted button is similar to traditional measures of self-reported voting, but here users reported their vote to their social community rather than to a researcher. We therefore use this action to measure political self-expression, as it is likely to be affected by the extent to which a user desires to be seen as a voter by others. In contrast, social desirability should not affect other user actions in the same way. Clicking the polling-place link took users to a separate website that helped them to find a polling location, and this action was not reported to the user's social community. We therefore use this action to measure a user's desire to seek information about the election. Finally, we used a group-level process to study the validated voting behaviour of 6.3 million users matched to publicly available voter records (see Supplementary Information).

We first analyse direct effects. We cannot compare the treatment groups with the control group to assess the effect of the treatment on self-expression and information seeking, because the control group did not have the option to click an I Voted button or click on a polling-place link. However, we can compare the proportion of users between the two treatment groups to estimate the causal effect of seeing the faces of friends who have identified themselves as voters (Fig. 1). Users who received the social message were 2.08% (s.e.m., 0.05%; t -test, $P < 0.01$) more likely to click on the I Voted button than those who received the informational message (20.04% in the social message group versus 17.96% in the informational message group). Users who received the social message were also 0.26% (s.e.m., 0.02%; $P < 0.01$) more likely to click the polling-place information link than users who received the informational message (Fig. 1).

Although acts of political self-expression and information seeking are important in their own right, they do not necessarily guarantee that a particular user will actually vote. As such, we also measured the effect that the experimental treatment had on validated voting, through examination of public voting records. The results show that users

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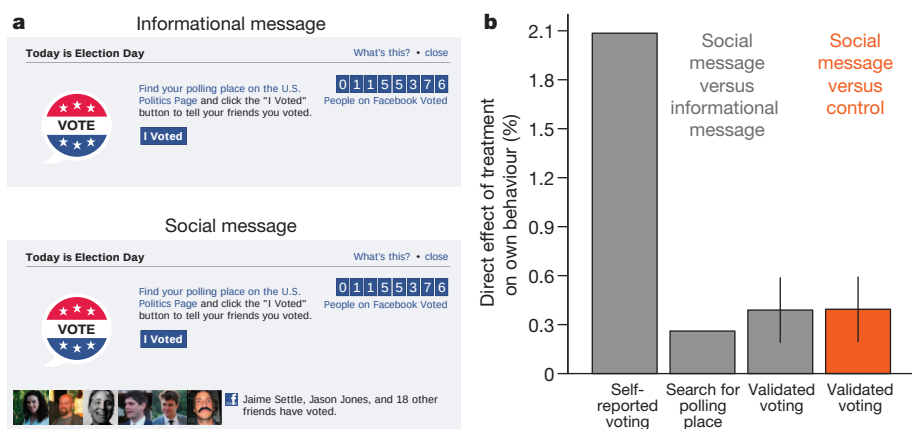


Figure 1 | The experiment and direct effects. **a, b**, Examples of the informational message and social message Facebook treatments (**a**) and their direct effect on voting behaviour (**b**). Vertical lines indicate s.e.m. (they are too small to be seen for the first two bars).

who received the social message were 0.39% (s.e.m., 0.17%; t -test, $P = 0.02$) more likely to vote than users who received no message at all. Similarly, the difference in voting between those who received the social message and those who received the informational message was 0.39% (s.e.m., 0.17%; t -test, $P = 0.02$), suggesting that seeing faces of friends significantly contributed to the overall effect of the message on real-world voting. In fact, turnout among those who received the informational message was identical to turnout among those in the control group (treatment effect 0.00%, s.e.m., 0.28%; $P = 0.98$), which raises doubts about the effectiveness of information-only appeals to vote in this context.

These results show that online political mobilization can have a direct effect on political self-expression, information seeking and real-world voting behaviour, and that messages including cues from an individual's social network are more effective than information-only appeals. But what about indirect effects that spread from person to person in the social network? Users in our sample had on average 149 Facebook friends, with whom they share social information, although many of these relationships constitute 'weak ties'. Past research indicates that close friends have a stronger behavioural effect on each other than do acquaintances or strangers^{9,11,13,21}. We therefore expected mobilization to spread more effectively online through 'strong ties'.

To distinguish users who are likely to have close relationships, we used the degree to which Facebook friends interacted with each other on the site (see Supplementary Information for more detail). Higher levels of interaction indicate that friends are more likely to be physically proximate and suggest a higher level of commitment to the friendship, more positive affect between the friends, and a desire for the friendship to be socially recognized²⁹. We counted the number of interactions between each pair of friends and categorized them by decile, ranking them from the lowest to highest percentage of interactions. A validation study (see Supplementary Information) shows that friends in the highest decile are those most likely to be close friends in real life (Fig. 2a).

We then used these categories to estimate the effect of the mobilization message on a user's friends. Random assignment means that any relationship between the message a user receives and a friend's behaviour is not due to shared attributes, as these attributes are not correlated with the treatment (see Supplementary Information). To measure a per-friend treatment effect, we compared behaviour in the friends connected to a user who received the social message to behaviour in the friends connected to a user in the control group. To account for dependencies in the network, we simulate the null distribution using a network permutation method (see the Supplementary Information). Monte Carlo simulations suggest that this method minimizes the risk of false positives and recovers true causal effects without bias (see Supplementary Information).

Figure 2 shows that the observed per-friend treatment effects increase as tie-strength increases. All of the observed treatment effects fall outside the null distribution for expressed vote (Fig. 2b), suggesting that they are significantly different from chance outcomes. For validated vote (Fig. 2c), the observed treatment effect is near zero for weak ties, but it spikes upwards and falls outside the null distribution for the top two deciles. This suggests that strong ties are important for the spread of real-world voting behaviour. Finally, the treatment effect for polling place search gradually increases (Fig. 2d), with several of the effects falling outside the 95% confidence interval of the null distribution.

To simplify the analysis and reporting of results, we arbitrarily define 'close friends' as people who were in the eightieth percentile or higher (decile 9) of frequency of interaction among all friendships in the sample (see the Supplementary Information). 'Friends' are all other Facebook friends who had less interaction. A total of 60,491,898 (98%) users in our sample had at least 1 close friend, with the average user having about 10 close friends (compared with an average of 139 friends who were not close).

The results suggest that users were about 0.011% (95% confidence interval (CI) of null distribution -0.009% to 0.010%) more likely to engage in an act of political self-expression by clicking on the I Voted button than they would have been had their friend seen no message. Similarly, for each close friend who received the social message, an individual was on average 0.099% (null 95% CI -0.042% to 0.048%) more likely to express voting.

We also found an effect in the validated vote sample. For each close friend who received the social message, a user was 0.224% (null 95% CI -0.181% to 0.174%) more likely to vote than they would have been had their close friend received no message. Similarly, for information-seeking behaviour we found that for each close friend who received the social message, a user was 0.012% (null 95% CI -0.012% to 0.012%) more likely to click the link to find their polling place than they would have been had their close friends received no message. In both cases there was no evidence that other friends had an effect (see Supplementary Information). Thus, ordinary Facebook friends may affect online expressive behaviour, but they do not seem to affect private or real-world political behaviours. In contrast, close friends seem to have influenced all three.

The magnitude of these contagion effects are small per friend, but it is important to remember that they result from a single message, and in many cases it was not possible to change the target's behaviour. For example, users may have already voted by absentee ballot before Election Day, or they may have logged in to Facebook too late to vote or to influence other users' voting behaviour. In other words, all effects measured here are intent-to-treat effects rather than treatment-on-treated effects, which would be greater if we had better information about who was eligible to receive the treatment.

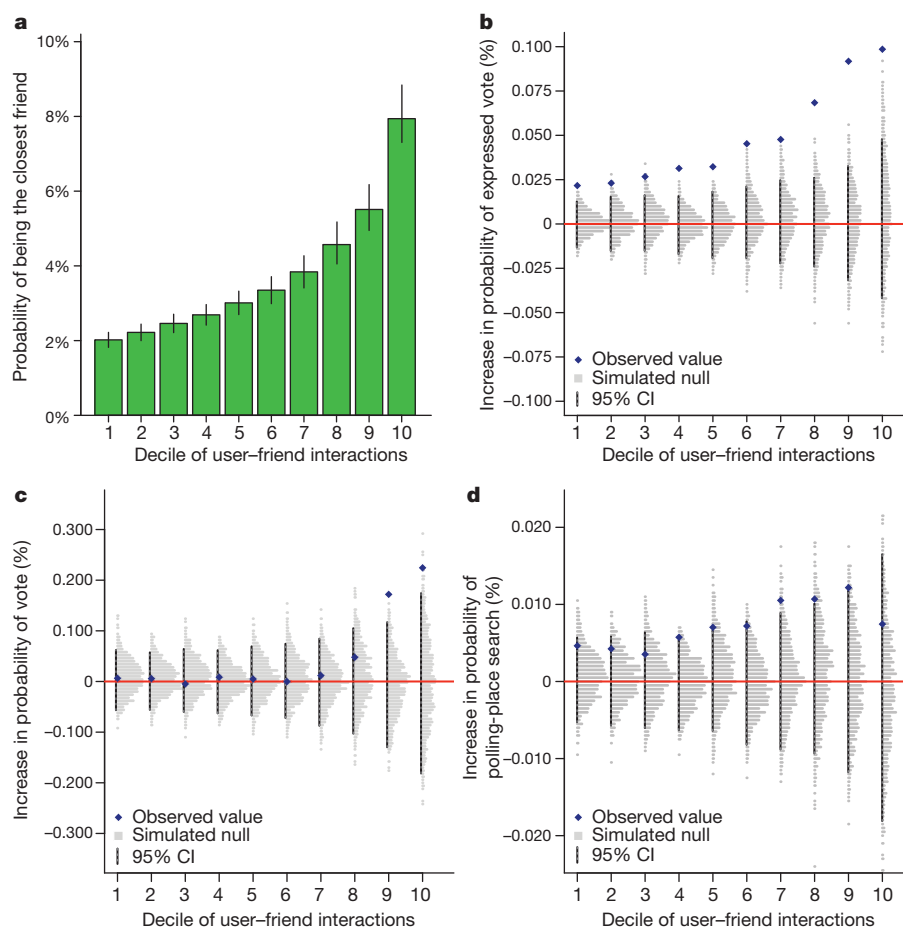


Figure 2 | The effect of mobilization treatment that a friend received on a user's behaviour. **a–d.** A validation study shows that at increasing levels of interaction, Facebook friends are more likely to have a close real-world relationship (**a**; see also the Supplementary Information). As the interaction increases, so does the observed per-friend effect of friend's treatment on a user's

expressed voting (**b**), validated voting (**c**) and polling-place search (**d**). Blue diamonds indicate the observed treatment effect. Horizontal grey bars show the null distribution derived from simulations of identical networks in which the topology and incidence of the behaviour and treatment are the same but the assignments of treatment are randomly reassigned.

Moreover, the scale of the number of users, their friendship connections and the potential voters in a given election is very large. We estimated the per-user effect (the per-friend effect multiplied by the average number of friends per user) and the total effect (the per-user effect multiplied by the total number of users) on the behaviour of everyone in the sample (see Supplementary Information). The results suggest that friends generated an additional 886,000 expressed votes (+1.4%, null 95% CI –1.1% to 1.1%), and close friends generated a further 559,000 votes (+0.9%, null 95% CI –0.3% to 0.3%). In the Supplementary Information we also show that close friends of close friends (2 degrees of separation) generated an additional 1 million expressed votes (+1.7%, null 95% CI –0.8% to 0.9%). Thus, the treatment clearly had a significant impact on political self-expression and how it spread through the network, and even weak ties seem to be relevant to its spread.

However, the effect of the social message on real-world validated vote behaviour and polling-place search was more focused. The results suggest that close friends generated an additional 282,000 validated votes (+1.8%, null 95% CI –1.3% to 1.2%) and an additional 74,000 polling-place searches (+0.1%, null 95% CI –0.1% to 0.1%), but there is no evidence that ordinary friends had any effect on either of these two behaviours. In other words, close friendships accounted for all of the significant contagion of these behaviours, in spite of the fact that they make up only 7% of all friendships on Facebook.

To put these results in context, it is important to note that turnout has been steadily increasing in recent US midterm elections, from 36.3% of the voting age population in 2002 to 37.2% in 2006, and to

37.8% in 2010. Our results suggest that the Facebook social message increased turnout directly by about 60,000 voters and indirectly through social contagion by another 280,000 voters, for a total of 340,000 additional votes. That represents about 0.14% of the voting age population of about 236 million in 2010. However, this estimate does not include the effect of the treatment on Facebook users who were registered to vote but who we could not match because of nicknames, typographical errors, and so on. It would be complex to estimate the number of users on Facebook who are in the voter record but unmatchable, and it is not clear whether treatment effects would be of the same magnitude for these individuals, so we restrict our estimate to the matched group that we were able to sample and observe. This means it is possible that more of the 0.60% growth in turnout between 2006 and 2010 might have been caused by a single message on Facebook.

The results of this study have many implications. First and foremost, online political mobilization works. It induces political self-expression, but it also induces information gathering and real, validated voter turnout. Although previous research suggested that online messages do not work¹⁹, it is possible that conventional sample sizes may not be large enough to detect the modest effect sizes shown here. We also show that social mobilization in online networks is significantly more effective than informational mobilization alone. Showing familiar faces to users can dramatically improve the effectiveness of a mobilization message.

Beyond the direct effects of online mobilization, we show the importance of social influence for effecting behaviour change. Our

validation study shows that close friends exerted about four times more influence on the total number of validated voters mobilized than the message itself. These results are similar to those from a prior network simulation study based on observational data that suggested each act of voting on average generates an additional three votes as this behaviour spreads through the network³⁰. Thus, efforts to influence behaviour should pay close attention not only to the effect a message will have on those who receive it but also to the likelihood that the message and the behaviour it spurs will spread from person to person through the social network. And, in contrast to the results for close friends, we find that Facebook friends have less effect. Online mobilization works because it primarily spreads through strong-tie networks that probably exist offline but have an online representation. In fact, it is plausible that unobserved face-to-face interactions account for at least some of the social influence that we observed in this experiment.

More broadly, the results suggest that online messages might influence a variety of offline behaviours, and this has implications for our understanding of the role of online social media in society. Experiments are expensive and have limited external validity, but the growing availability of cheap and large-scale online social network data¹⁷ means that these experiments can be easily conducted in the field. If we want to truly understand—and improve—our society, wellbeing and the world around us, it will be important to use these methods to identify which real world behaviours are amenable to online interventions.

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- Berger, J. & Le Mens, G. How adoption speed affects the abandonment of cultural tastes. *Proc. Natl Acad. Sci. USA* **106**, 8146–8150 (2009).
- Borgatti, S. P. *et al.* Network analysis in the social sciences. *Science* **323**, 892–895 (2009).
- Ohtsuki, H., Hauert, C., Lieberman, E. & Nowak, M. A. A simple rule for the evolution of cooperation on graphs and social networks. *Nature* **441**, 502–505 (2006).
- Onnela, J. P. & Reed-Tsochas, F. Spontaneous emergence of social influence in online systems. *Proc. Natl Acad. Sci. USA* **107**, 18375–18380 (2010).
- Apicella, C. L., Marlowe, F. W., Fowler, J. H. & Christakis, N. A. Social networks and cooperation in hunter-gatherers. *Nature* **481**, 497–501 (2012).
- Aral, S. & Walker, D. Identifying influential and susceptible members of social networks. *Science* **337**, 337–341 (2012).
- Centola, D. An experimental study of homophily in the adoption of health behavior. *Science* **334**, 1269–1272 (2011).
- Gonzalez-Bailon, S., Borge-Holthoefer, J., Rivero, A. & Moreno, Y. The dynamics of protest recruitment through an online network. *Sci. Rep.* **1**, 197 (2011).
- Christakis, N. A. & Fowler, J. H. Social contagion theory: examining dynamic social networks and human behavior. Preprint at <http://arXiv.org/abs/1109.5235v2> (2011).
- Aral, S., Muchnik, L. & Sundararajan, A. Distinguishing influence-based contagion from homophily-driven diffusion in dynamic networks. *Proc. Natl Acad. Sci. USA* **106**, 21544–21549 (2009).
- Christakis, N. A. & Fowler, J. H. The spread of obesity in a large social network over 32 years. *N. Engl. J. Med.* **357**, 370–379 (2007).
- Fowler, J. H. & Christakis, N. A. The dynamic spread of happiness in a large social network. *Br. Med. J.* **337**, a2338 (2008).
- Christakis, N. A. & Fowler, J. H. The collective dynamics of smoking in a large social network. *N. Engl. J. Med.* **358**, 2249–2258 (2008).
- Salganik, M. J., Dodds, P. S. & Watts, D. J. Experimental study of inequality and unpredictability in an artificial cultural market. *Science* **311**, 854–856 (2006).
- Centola, D. The spread of behavior in an online social network experiment. *Science* **329**, 1194–1197 (2010).
- Fowler, J. H. & Christakis, N. A. Cooperative behavior cascades in human social networks. *Proc. Natl Acad. Sci. USA* **107**, 5334–5338 (2010).
- Lazer, D. *et al.* Computational social science. *Science* **323**, 721–723 (2009).
- Ellison, N. B., Steinfield, C. & Lampe, C. The benefits of facebook “friends”: Social capital and college students’ use of online social network sites. *J. Comput. Mediat. Commun.* **12**, 1143–1168 (2007).
- Traud, A. L., Kelsic, E. D., Mucha, P. J. & Porter, M. A. Comparing community structure to characteristics in online collegiate social networks. *SIAM Rev.* **53**, 526–543 (2011).
- Granovetter, M. The strength of weak ties. *Am. J. Sociol.* **78**, 1360–1380 (1973).
- Christakis, N. A. & Fowler, J. H. *Connected: The Surprising Power of Our Social Networks and How They Shape Our Lives* (Little, Brown, and Company, 2009).
- Nickerson, D. W. Does email boost turnout? *Q. J. Polit. Sci.* **2**, 369–379 (2007).
- Kenny, C. B. Political participation and effects from the social environment. *Am. J. Pol. Sci.* **36**, 259–267 (1992).
- Huckfeldt, R. & Sprague, J. *Citizens, Politics, and Social Communication: Information and Influence in an Election Campaign* (Cambridge Univ. Press, 1995).
- Gerber, A. S. & Green, D. P. Does canvassing increase voter turnout? A field experiment. *Proc. Natl Acad. Sci. USA* **96**, 10939–10942 (1999).
- Gerber, A. S., Green, D. P. & Larimer, C. W. Social pressure and voter turnout: evidence from a large-scale field experiment. *Am. Polit. Sci. Rev.* **102**, 33–48 (2008).
- Bryan, C. J., Walton, G. M., Rogers, T. & Dweck, C. S. Motivating voter turnout by invoking the self. *Proc. Natl Acad. Sci. USA* **108**, 12653–12656 (2011).
- Nickerson, D. W. Is voting contagious? Evidence from two field experiments. *Am. Polit. Sci. Rev.* **102**, 49–57 (2008).
- Vitak, J. *et al.* It’s complicated: Facebook users’ political participation in the 2008 election. *Cyberpsychol. Behav. Soc. Netw.* **14**, 107–114 (2011).
- Fowler, J. H. in *The Social Logic of Politics: Personal Networks as Contexts for Political Behavior* (ed. Zuckerman, A.) 269–287 (Temple Univ. Press, 2005).

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