

# How Does a Minority Opinion Spread? An Agent-Based Model on the Opposition Between a Silent Majority and a Loud Minority

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## Abstract

In this paper, we propose a discrete opinion model in which two beliefs models compete. One opinion is endorsed by the vast majority of agents, but this majority remains silent and rarely expresses its opinion. Conversely, the other belief model is supported by a small minority that is very committed and does not hesitate to be loud. We observe that a very small number of individuals is necessary for the minority opinion to become the majority. However, the presence of so-called "inflexible" and "super propagators" agents can counteract this phenomenon and prevent the loud minority from propagating its view.

## Introduction

Opinion dynamics is an intriguing subject that has attracted interest from various disciplines such as sociology, psychology, economics, and political science. One of the most appropriate ways to study these phenomena is through agent-based simulations. Opinion dynamics refers to the study of the formation and evolution of opinions resulting from social interactions between agents. The analysis of the mechanisms related to the shaping and diffusion of opinions contributes to the understanding of political changes (Ben-Naim 2005), the spread of false information (Tambuscio et al. 2015), the rise of polarization (Turner, Smaldino, and others 2018), extremism (Amblard and Deffuant 2004), and many more.

The antithesis between a silent majority and a loud minority is used to establish a contrast between a small number of highly mobilized individuals who make themselves heard and a majority who rarely express their opinion publicly. The occurrence of such a phenomenon seems to be verified on social networks where the most politically committed people or those sharing extreme views express themselves far more frequently than less politically engaged individuals (Bail 2021). Nonetheless, this comparison is not entirely new and has been used in political speeches notably in 1969 by Richard Nixon in the context of the Vietnam War (King and Anderson 1971). Subsequently, this term resurfaced in the 2016 US presidential election after Donald Trump used it to refer to his supporters (Edsall 2016).

Throughout history, we have seen the emergence and imposition of new norms and beliefs initially supported only by a minority of individuals. As discussed by Guillaume Deffuant et al. (2002), a small number of radical Islamists have succeeded in imposing their beliefs in some areas of the Middle East. In the same way, some false information manages to reach a significant number of believers thanks to a minority that is very involved in the diffusion of its views (Newman et al. 2021). However, the imposition of a minority opinion on a majority does not necessarily result in a bad outcome and can lead to greater freedom and tolerance in society, as happened for instance with the suffragette's movement that contributed to women's right to vote in the United Kingdom. It is precisely this dynamic between a noisy minority and a silent majority that the proposed model is designed to explore. The main objective is to study the conditions under which a committed minority can succeed in imposing its beliefs on a majority.

## Related work

Among work related to ours, we can highlight the work on the impact of extremists on opinion dynamics (Deffuant et al. 2002), the diffusion of innovations (Deffuant, Huet, and Amblard 2005), on the conditions that make the diffusion of a minority opinion effective (Alvarez-Galvez 2016). From a more theoretical point of view, we can mention, the studies on the social influence of the minority in which Serge Moscovici (1976) emphasizes the ability of a minority to convert the majority to their ideas, as well as the concept of a spiral of silence (Noelle-Neumann 1974). This theory states that public expression of opinion is influenced by the environment. A minority's vocal expression can lead to pluralistic ignorance, where the quiet majority perceives itself as a minority. This can result in a vocal minority establishing beliefs or norms even if the majority is opposed to them.

## Experimental settings

In this section, we will explain the tools used for the simulation as well as describe the model's behavior and environment.

## Model implementation

For this research, we used the free and open-source *NetLogo* software developed by Northwestern University. This

software is distinguished by its ergonomics and its easy and intuitive handling (Tisue and Wilensky 2004).

The particularity of the model lies in the fact that we explicitly consider among the agents a committed minority and a silent majority. Moreover, we assume that the agents can move freely and are, therefore not dependent on any network structure. To be more precise, at each iteration, all agents move the same distance but in randomly determined directions. The speed of movement is identical for all agents except for the super spreaders which travel twice as fast as the other agent categories as explained in more detail below. The fact that agents can move without restriction helps us to focus more on particular points, such as the number of agents, the level of commitment, and the characteristics of minority agents allowing the propagation of a minority opinion rather than the strategic place that the minority must occupy in order to spread their belief. In addition, this model considers different possible scenarios as well as the presence of several types of agents (inflexible and super-spreaders) with the objective of measuring the effects of such agents on the dissemination of opinions.

### Model dynamics

In this study, we propose a straightforward discrete model of opinion diffusion based on the presumption that opinions can only spread through direct interaction between two agents. This mechanism can represent an exchange between individuals that takes place both online (e.g. an exchange via email or instant messaging applications) and offline (e.g. a face-to-face discussion). There are two competing beliefs; one noted A is shared by a silent majority of agents while an active and engaged minority shares the other belief noted B. All the agents share one or the other opinion, and none of them are neutral. Only one parameter influences the way information is spread, which is the degree of commitment of the majority noted  $c_A$  and the level of commitment of the minority noted  $c_B$ . Each time an agent  $i$  with belief A encounters an agent  $j$  with belief B, we can model the probability that agent  $i$  succeeds in persuading the agent  $j$  as follows  $p_{i,j} = c_{A,B}$  with  $0 \leq c_{A,B} \leq 1$ . {For example, if an agent  $i$  with a commitment level of 0.80 encounters agent  $j$ , then agent  $i$  will have an 80% chance of changing the agent  $j$ 's opinion. The number of runs for each possible combination of parameters is  $n = 50$ , the total amount of agents noted  $N$  is always equal to 500, and the simulation stops when an opinion propagates entirely or when the number of ticks reaches 5000.

The level of commitment  $c$  differs for each agent and follows a normal distribution with  $\sigma = 0.2$ . There are four possible commitment levels based on the mean of the distribution:

1. low when  $\mu = 0.25$
2. medium when  $\mu = 0.5$
3. strong when  $\mu = 0.75$
4. very strong when  $\mu = 1$

### Agent's types

Most of the agents are said to be normal, but two other types of agents with particular attributes are introduced in the course of the model in order to test various hypotheses.

1. Inflexible agents are individuals who are confident in their opinions and, therefore never change their beliefs. An inflexible who believes in A or B will be loyal to his conviction throughout the simulation. The proportion of inflexible is noted  $p_{iA}$  for those in the majority and  $p_{iB}$  for those in the minority.
2. Super-spreaders sometimes also referred to as opinion leaders which are agents playing a disproportionate role in the diffusion of an opinion because of the large audience they have. In our model, super-spreaders can move faster than other agents and have a very strong level of commitment  $c$ . These characteristics allow them to spread opinions A or B more effectively. The proportion of super-spreaders is noted  $p_{ssA}$  for those in the majority and  $p_{ssB}$  for those in the minority.

### Scenario descriptions

This paper explores three scenarios with a gradual increase in complexity that we will describe in more depth below:

1. The first case is the model in its simplest version. There is a mass of agents  $N = 500$  with neither inflexible nor super-spreader. The proportion of agents  $N_B$  constituting the vocal minority can account for 1 to 20% of  $N$ .  $c_A$  and  $c_B$  varies freely between low and very high for both types of agents.
2. In the second scenario, we introduce inflexible agents. These agents can be found among the vocal minority and the silent majority.  $p_{iA}$  and  $p_{iB}$  can range from 0 to 40% of  $N_{A,B}$ . We distinguish two situations, in the first one,  $N_B = 5\%$  of  $N$ , and in the second one,  $N_B = 10\%$  of  $N$ . Since in scenario 1, we have been able to evaluate the importance of the commitment in the diffusion of the minority point of view, we are now considering only instances where the minority is noisy, and the majority is silent. Therefore,  $c_A$  varies between low and medium and  $c_B$  between medium, high, and very high.
3. Finally, in the last situation considered, we introduce inflexible and super-spreaders simultaneously. Similarly to the previous case explored, we have a situation where  $N_B = 5\%$  of  $N$  and a second where  $N_B = 10\%$  of  $N$ .  $p_{iA}$  and  $p_{iB}$  can vary from 0 to 30%. We assumed that since the minority is noisy and engaged,  $p_{ssB}$  can reach a higher percentage than  $p_{ssA}$ , which means there are proportionally more super-spreaders among the minority than among the silent majority. Therefore,  $p_{ssB}$  can be set from 10 to 30%, while  $p_{ssA}$  range from 0 to 20%.

### Experimental results

In this section, we will highlight our main findings and results considering the three cases considered.

## Scenario 1

Symbols	Description	Values of tested parameters
$N_A$	Number of agents in the silent majority	499, 495, 450, 400
$N_B$	Number of agents in the loud minority	1, 5, 50, 100
$c_A$	Commitment degree of the silent majority	low, medium, high, very high
$c_B$	Commitment degree of the loud minority	low, medium, high, very high

Table 1: Tested values of the parameter space for scenario 1.

In scenario 1, there are only two possible outcomes. Either the noisy minority manages to impose its view on all the agents, or the silent majority manages to contain the diffusion of opinion A and totally imposes opinion B. In addition, opinion dynamics are such that the outcome may change with identical parameters. For this reason, in order to measure the impact of these parameters, it is necessary to examine the frequency with which one belief or the other manages to impose itself entirely in relation to the total number of times this particular situation has been simulated. The objective is to observe whether the large numerical difference between the proponents of opinions A and B can be balanced by a commitment advantage for the minority. To correctly measure the first point, the degree of commitment is identical between the majority and the minority. For instance, a minority and a majority with both a medium level of commitment.

When  $N_B$  represents 1% of the total amount of agents, their number is too small, and opinion B never succeeds in imposing itself. In contrast, as soon as  $N_B$  reaches 5% of N, opinion B prevails between 6 and 12% of the time gradually rising to between 24 and 30% of the cases when  $N_B$  represents 20% of N. As the minority narrows its numerical gap, it becomes easier for them to spread their views. The fact that even in a minority situation and with an equivalent level of commitment, the minority opinion sometimes manages to gain the upper hand is due to a random process. Indeed, in a certain number of cases, the minority opinion starts to spread and we observe a snowball effect allowing the minority opinion to prevail. However, as we shall observe, the importance of size appears to be less important than that of commitment. Indeed, when there is one single degree of difference in commitment between  $N_A$  and  $N_B$  it is sufficient for the minority to prevail almost systematically (between 90 and 100% of the cases) even when  $N_B$  represents only 1% of N. A further increase in the commitment gap (e.g. a majority with a consistently low commitment and a minority with a high or very high commitment) has two effects, to make opinion B prevail in 100% of situations regardless of  $N_B$  and increase the speed at which the minority fully imposes its opinion.

The size of the minority has a non-negligible effect on the diffusion of minority views. However, the impact of agents' level of commitment seems to play a much more important role in the diffusion of the minority view by considerably expanding its circulation. A commitment advantage can therefore clearly outweigh a large numerical disadvantage.

## Scenario 2

Symbols	Description	Values of tested parameters
$N_A$	Number of agents in the silent majority	475, 450
$N_B$	Number of agents in the loud minority	25, 50
$c_A$	Commitment degree of the silent majority	low, medium
$c_B$	Commitment degree of the loud minority	medium, high, very high
$p_{iA}$	The proportion of inflexible among the silent majority	5% by 5% increase starting from 0% up to 40%
$p_{iB}$	The proportion of inflexible among the loud minority	5% by 5% increase starting from 0% up to 40%

Table 2: Tested values of the parameter space for scenario 2.

In the presence of inflexible agents, the outcome differs from that of the first scenario since it is no longer possible for one or the other of the opinions to prevail totally. For the silent majority, the presence of inflexible agents plays an essential role in preserving their opinion. We observe a linear relationship between the percentage of inflexible and the number of individuals sharing belief A. For example, in the situation visualised in Figure 1 where  $N_B$  have a high level of commitment and  $N_A$  have a low level of commitment, an increase in  $p_{iA}$  of 5% results in an increase of  $N_A$  that ranges from 7.6 to 8.2%. When  $c_A$  is low and  $c_B$  is very high, this increase varied between 6.2 and 7.4%.

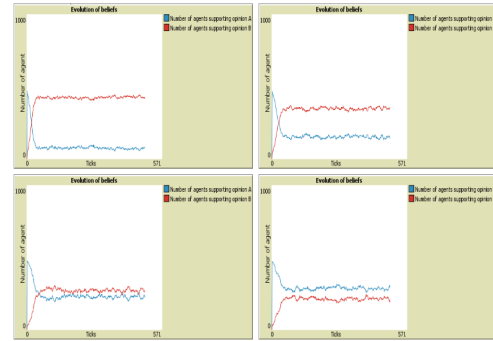


Figure 1: The impact of inflexible agents on the dynamic opinion of opinion A, with  $N_A = 475$ ,  $N_B = 25$ ,  $c_A$  sets at low,  $c_B$  sets at high  $p_{iA}$  varying between 10 and 40% and  $p_{iB}$  fixed at 15%.

Despite this effectiveness, more than a reasonable number of inflexible individuals is needed to prevent the spread of opinion B. Nonetheless, the combination of an increase in  $N_A$  and  $p_{iA}$  is more effective in stemming the spread of opinion B than a simple growth in the proportion of inflexible. In a case where  $c_A$  moves from low to medium, the relationship is no longer completely linear. Indeed, a 5% rise in  $p_{iA}$  increases the percentage of agents believing in opinion A by between 17.2 and 27.2%. It is also worth noting that with  $p_{iA} = 25\%$ , opinion B cannot propagate properly, and at the end of the simulations,  $N_B$  represents only a tiny fraction of N ( $> 3\%$ ). In the situation where  $c_B$  is very high, and  $c_A$  is medium, we recover the linear relationship observed earlier. An increase of 5% in  $p_{iA}$  results in a growth in  $N_A$  that varies between 11.6 and 12.8%, a higher percentage than when the majority had a low commitment. On the noisy minority side, the addition of inflexible agents does not exhibit an apparent effect on

the circulation of opinion B. Their presence, regardless of their amount, does not particularly facilitate the diffusion of belief B.

The presence of a fraction of agents confident in their beliefs among the majority population contributes to curbing the spread of the minority opinion, even when the proponents of this opinion are highly engaged in the dissemination of their idea. However, a similar effect does not seem to operate for the partisans of the minority viewpoint.

### Scenario 3

Symbols	Description	Values of tested parameters
$N_s$	Number of agents in the silent majority	475, 450
$N_l$	Number of agents in the loud minority	25, 50
$c_s$	Commitment degree of the silent majority	low, medium
$c_l$	Commitment degree of the loud minority	medium, high, very high
$p_{iA}$	The proportion of inflexible among the silent majority	5% by 5% increase starting from 0% up to 30%
$p_{iB}$	The proportion of inflexible among the loud minority	5% by 5% increase starting from 0% up to 30%
$p_{ssA}$	The proportion of super-spreader among the silent majority	0%, 1%, 5%, 10%, 20%
$p_{ssB}$	The proportion of super-spreader among the loud minority	5% by 5% increase starting from 10% up to 30%

Table 3: Tested values of the parameter space for scenario 3.

In this last scenario we explore the effect of super-spreaders' introduction and their interaction with other types of agents. The first observation visualized in Figure 2 is that for the silent majority, the presence of super-spreaders increases the diffusion of opinion A and therefore counteracts the diffusion of opinion B by the loud minority. Their effect becomes strong as soon as  $p_{ssA} = 5\%$  of  $N$ . Then, super-spreaders' impact is accentuated as  $p_{ssA}$  reaches 10% and 20% of  $N$ . Logically, super-spreaders' influence on the spread of opinion B tends to decrease as the majority-minority commitment gap increases, but it remains important. In addition, we also notice a complementarity between  $p_{ssA}$  and  $p_{iA}$ . When these two types of agents are introduced simultaneously, the effect on belief A is greater than if these two categories of agents are added separately. Thus, the combination of inflexible and super-spreaders can effectively stem the loud minority's spread of opinion B.

The effect of super-spreaders on minority opinion is affected by the number of super-spreaders from the majority side. As illustrated in Figure 2, if  $p_{ssA}$  is zero or equal to 1%, super-spreaders have a near-zero effect on the diffusion of opinion B because the difference in the degree of commitment is sufficient for opinion B to prevail. Nevertheless, when  $p_{ssA}$  increases,  $p_{ssB}$  plays a more important role since, as stated above, an important presence of super-spreaders considerably strengthens the spread of belief A. When  $p_{ssA} = 5\%$  of  $N$ , the presence of  $p_{ssB}$  allows opinion B to compete with opinion A. When the percentage of  $p_{ssA} = 10\%$  or  $20\%$  of  $N$ , the effect of  $p_{ssB}$  is to prevent the minority from disappearing altogether. No matter the value of  $p_{ssB}$ , opinion B remains in the minority but a more or less substantial minority depending on the value of  $p_{ssB}$ .

The presence of super-spreaders of opinion A ( $p_{ssA}$ ) is an effective way to accelerate the spread of opinion A and curb the spread of opinion B by the loud minority, with

stronger effect as  $p_{ssA}$  increases. In addition, the combination of inflexible and super-spreaders can effectively stem the spread of opinion A. Regarding opinion B, the effect of super-spreaders is almost null when  $p_{ssA}$  is low but amplifies as  $p_{ssA}$  increases.

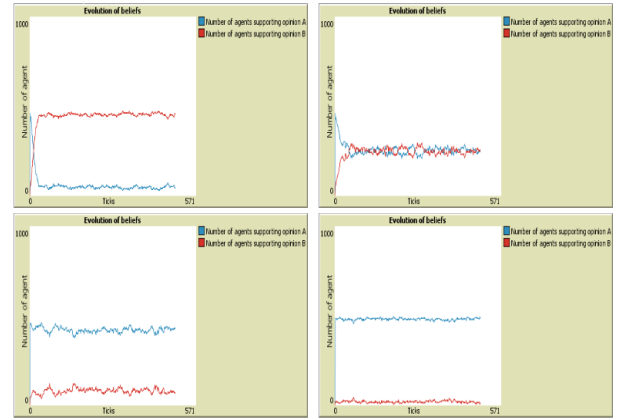


Figure 2: The strong influence of super-spreaders on belief A, with  $N_A = 475$ ,  $N_B = 25$ ,  $c_A$  sets at low,  $c_B$  sets at high,  $p_{iB}$  and  $p_{iA}$  fixed at 0%,  $p_{ssA} = 1, 5, 10$  and  $20\%$  and  $p_{ssB}$  fixed at  $20\%$ .

### Concluding remarks

Through this simple model of opinion dynamics, we illustrated the influence of the minority on changes in beliefs and opinions. We can summarize our main findings as follows :

1. When a minority is more committed than the majority, it only takes a tiny number of individuals for the minority opinion to eventually evolve into the majority opinion.
2. As soon as the individuals constituting the majority are sure of their beliefs, they become less permeable to other opinions. In a sense, this can be beneficial in situations where the minority opinion is harmful, as in the case of false information. However, being sure of one's beliefs can also delay the adoption of norms and ideas that could benefit the majority, such as those about the environment or women's rights.
3. Depending on their numbers, super-spreaders have the ability to either speed up or slow down the spread of minority opinion depending on which side of the spectrum they are.

Our results are in line with various numerical simulations (Couzin et al. 2011) and work on animal groups (Couzin et al. 2005) that have shown the possibility for highly mobilized minorities to impose themselves on a majority. Furthermore, the findings of scenario 2 also confirm the important role of inflexible individuals in slowing down the diffusion of an opinion (Yildiz et al. 2013). Finally, the simulation results of scenario 3 corroborate the already theorized (Katz and Lazarsfeld 2017) and tested (Grinberg et al. 2019) role of super-spreaders in the diffusion of ideas and opinions.

## Acknowledgments

This work is supported by the French government, through the 3IA Côte d'Azur Investments in the Future project managed by the National Research Agency (ANR) with the reference number ANR-19-P3IA-0002.

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