Minority Opinion Expression in the Presence of Perceived Majority Dominance

İrem Betül Koçak[1,2] [0000−0002−6123−1107] and Gönenç Yücel[2] [0000−0002−0998−075X]

[1] Management Engineering Department, Istanbul Technical University, 34469 Maçka, Istanbul, Turkey
[2] Industrial Engineering Department, Boğaziçi University, 34342 Bebek, Istanbul, Turkey

Abstract. Minorities may remain silent due to the fear of isolation, as suggested by the Spiral of Silence theorem, but they can overcome their silence by grouping together, a phenomenon known as homophily. In cases where there is homophily in people's rewiring actions, we observe total expression from both minorities and majorities, in contrast to societies without homophily. When people solely end their connections based on homophily but rewire randomly, we observe a minority opinions domination over the majority opinion. This study aims to investigate the dynamics of minority opinion domination and how it can be vulnerable to a single act of intervention, and the impact of agent characteristics to domination of both groups over each other.

Keywords: Opinion dynamics · Opinion expression · Spiral of Silence · Majority Illusion · ABM

1 Introduction

People communicate, make statements and expressing oneself through opinions. According to Kant, opinions are subjective thoughts that are free from the passions of people and should be expressed in a dichotomy [1]. However, the Spiral of Silence theory [2] suggests that individuals may believe they are in the minority may remain silent due to the fear of social isolation. This can result in their opinions being perceived as less widely held than they actually are, and may lead to a chain reaction where individuals with the same opinion gradually become silent over time. People may mistakenly believe that they are in the majority, even when they are actually in the minority. This can happen when people tend to connect only with others who share their beliefs or characteristics, a behavior known as homophily [3]. By clustering with others who are like them and creating safe spaces to express their differences from the larger society, people can develop the illusion that their views are widely held. This phenomenon is sometimes referred to as the "majority illusion" [4], and lead the actual majority to be silent and change the expression dynamics in the society.

In this study, we aim to examine the dynamics of both majority and minority expression in various settings and investigate the circumstances in which minorities experience complete silence or a majority illusion. While conducting our analysis, we will focus on a single minority group in society, acknowledging that minority and majority dynamics can be more complex in reality.

2 Methodology

We will use an agent-based model to study the interaction between the minority and majority groups, as well as the dynamics of their opinion expression. The model will comprise 1000 agents with a minority percentage of 20%. Each agent is expected to have an average of six connections to other agents, referred to as neighbors, with at least one neighbor. These values were selected from previous experiments in which we examined the impact of population, minority percentage, and clustering.

In the model, we initially assign opinions to the agents, and agents cannot change their opinions during simulation. However, they may change their decision to express their opinions or not based on the prevailing opinion climate of their local communities. Initially, all agents will start the model as indifferent to this climate, giving them a 50% chance of being expressive and an expected reward of zero. Expected reward refers to the agent's memory and current reward and also acts as the real determiner in the expression decision process. The way in which the expected reward changes, whether positively or negatively, between consecutive time steps plays a significant role in determining the expression decision-making process. During simulation, agents adjust their expected reward based on the opinion climate in their neighborhood. They calculate their instant rewards (IR) as shown in Equation 1. Here, $Agreeable\ Neighbors$ represents the number of expressive and same-opinion neighbors, while $Disagreeable\ Neighbors$ the number of expressive neighbors with a different opinion. The subscript i represents the agent, and t time steps.

$$IR_{it} = \frac{Agreeable\ Neighbors_{it} - Disagreeable\ Neighbors_{it}}{Agreeable\ Neighbors_{it} + Disagreeable\ Neighbors_{it}}. \tag{1}$$

Agents multiply their instant reward by their learning rate (α) to smooth it and calculate their expected reward (ER) as in Equation 2. We set the learning rate value to 0.01, which is a common value in the literature [5].

$$ER_{it} = \alpha \times IR_{it} + (1 - \alpha) \times ER_{i(t-1)}. \tag{2}$$

After, the probability of expressing opinions (p) for all agents is determined using Equation 3. We calibrated the β, γ, and δ values to one, one, and minus five, respectively, to reflect a society that is moderately supportive of free speech and has a relationship to expected reward similar to logistic regression (see Fig. 1). Thus, if the expected reward increases toward positive values, the expression probability increases toward one, and if it decreases toward negative values, the expression probability decreases toward zero. When an agent has an equal number of agreeable and disagreeable neighbors, the instant reward is zero, and the expected reward of the agent also converges to zero over time, resulting in a 50% probability of expression. This means that the agent is equally likely to express their opinion or remain silent.

$$p_{it} = \frac{\beta}{\gamma + e^{(\delta \times ER_{it})}}. \tag{3}$$

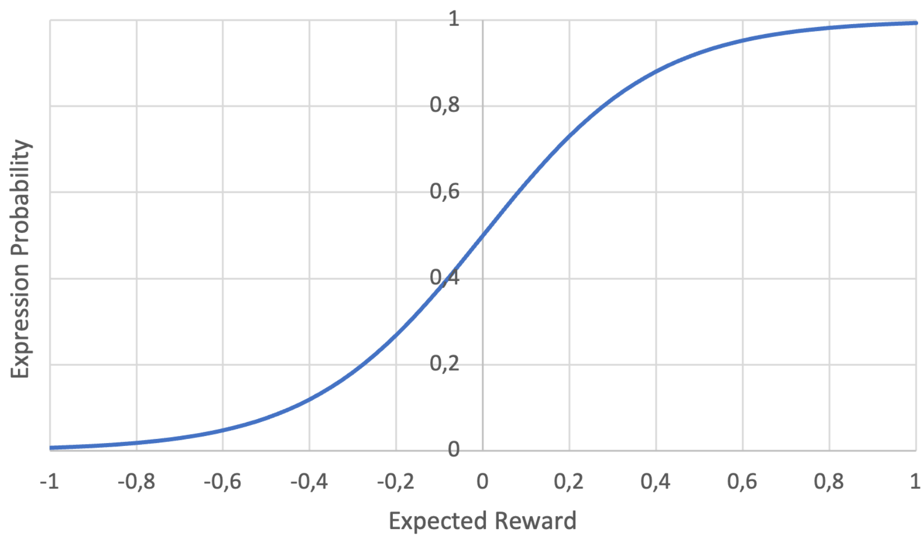

Fig. 1. Expression probability curve.

Finally, when their expected rewards change that conflict with their current expression decisions, agents reconsider their expression decisions according to the expression probability. The process is repeated until the model reaches equilibrium, which is a state where the expression decisions of all agents have stabilized and are no longer changing. During this process, agents continually adjust their expression decisions based on the evolving expression decisions of their neighbors. The expression decision process in a single time unit is summarized in Figure 2, and it shows that an agent will reconsider their opinion expression decision only if their expected reward is changing in a way that contradicts their current decision, i.e., if they are silent and their expected reward is increasing.

Agents in the model can also have dynamic relationships in which they can cut their links and rewire. Because we want to maintain the same network structure throughout the simulation, they must maintain their initial number of neighbors. If an agent decides to cut a link, they can rewire, but they cannot exceed the initial number of neighbors. The cutting and rewiring process can be either random or homophily-oriented. In the random process, agents can cut one of their links with any neighbor and rewire with a random agent. In the homophily-oriented process, agents can only cut their connections with one of their disagreeable neighbors and rewire with a random agent who shares the same opinion. We plan to examine different combinations of cutting and rewiring processes and comparatively analyze their effects on the silent minority and majority percentages using the model.

```
for agents = 1, 2, ..., N do
    Calculate Instant Reward (Eq.: 1);
    Calculate Expected Reward (Eq.: 2);
    if Agent is silent then
        if Expected Reward_{i,t} > Expected Reward_{i,(t-1)} then
            Agent calculate ExpressionProbability (Eq.: 3);
        end
    end
    if Agent is expressive then
        if Expected Reward_{i,t} < Expected Reward_{i,(t-1)} then
            Agent calculate ExpressionProbability (Eq.: 3);
        end
    end
    Agent determine their expression decision based on the probability.
end
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Fig. 2. Expression decision pseudo-code.

3 Experiment Plan and Results

When the network is static, previous works have shown that the majority dominates and the minority becomes silent [7, 8]. However, when agents rewire in a homophily-oriented manner, we observed that both minority and majority agents express their opinions in the cases where links are cut randomly (i.e., H-O Type 1) and homophily-oriented (i.e., H-O Type 2). Interestingly, when agents rewire randomly but cut links homophily-oriented (i.e., H-O Type 3), we observed that minority members can silence a part of the majority and prevent them from expressing themselves. To compare the static and homophily-oriented networks, we also conducted experiments with a model in which both cutting and rewiring processes are random, known as randomly-dynamic models (R-D).

To analyze these observations, we present the results of our experiments using two different metrics: the proportion of silent minorities within the total minority population and the proportion of silent majorities within the total majority population. We replicated each experiment 50 times, and the average results in terms of these two metrics are presented in Table 1.

Table 1. Result comparison of different network types.

Network Type	Silent Minority Percentage (%)	Silent Majority Percentage (%)
Static	99.94	0.05
R-D	99.76	0.23
H-O Type 1	0.01	0.00
H-O Type 2	0.05	0.00
H-O Type 3	7.34	38.15

Table 1 shows that, in H-O Type 3, only a small percentage of minorities remain silent, while nearly 40% of the majority agents remain silent on average. This finding may seem counter intuitive, as the majority consists of 80% of the 1000 agents, outnumbering the minority.

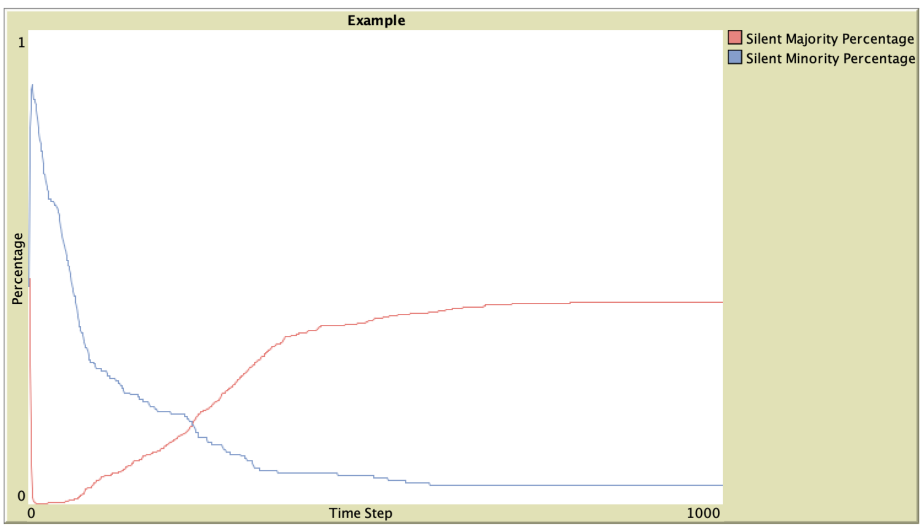

Fig. 3. Time trajectory graph of silent percentages in H-0 Type 3

One way to explain why the minority opinion is expressed more frequently as a percentage in H-O Type 3 than the majority opinion is to look at the simulation's initial setting. All agents start with 50% expressiveness, but after the first time step, most minority agents become silent because their neighbors are mostly majority agents, leading to low expected rewards. So, minorities tend to cut their links with majority members in subsequent steps. Under the randomly rewiring process, if they create links with one of the majority members, their expected their expected reward decreases, but this does not affect their expression decisions. On the other hand, if they connect with one of the other silent minorities, their expected reward increases because zero reward is still better than a negative reward. This increase in expected reward could motivate minorities to reconsider their decision to remain silent and become expressive.

As the minority members express their opinions, the majority members' high expected reward starts to decrease. This triggers a reconsideration process as it contradicts their initial decision to express their opinion, leading to some majority members becoming silent (see Fig. 3). Once the majority members become silent, there is no further change in the simulation, and the model reaches equilibrium.

As a result, the majorities remain silent, even though we know they are the dominant group in society. This case resembles the tale of the "Emperor's New Clothes", where the majority of people know the truth but are reluctant to speak out. However, in order to break their silence, someone must speak up and say "the Emperor has no clothes", prompting others to voice their opinions. In our case, we intervened in the model and made a single silent majority member become expressive after the model reached equilibrium. This led to a cascade effect in which other majority members also became expressive, and minority members became silent (see Fig. 4). This can also be interpreted as the breaking of the majority's illusion of unanimity among the minorities.

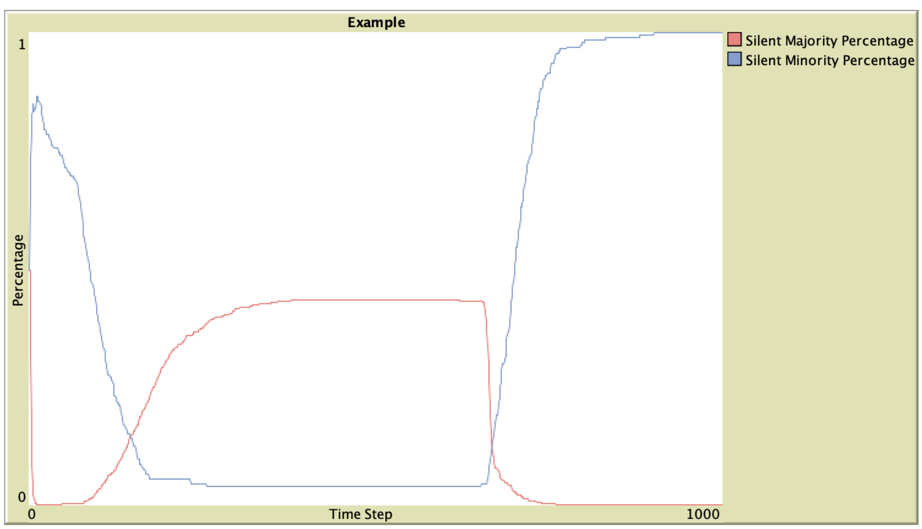

Fig. 4. Time trajectory graph with intervention.

As the suppression of the minority over a part of the majority is due to the low initial expected reward for the minority, we investigated whether this changes at different minority percentages (m). We chose minority percentages smaller than 40% to maintain the minority characteristic. Our analysis showed that when the number of minority members is extremely low, we cannot observe this suppression over the majority (see Fig. 5), since there are not enough minority members to create even local majorities to keep global majorities silent.

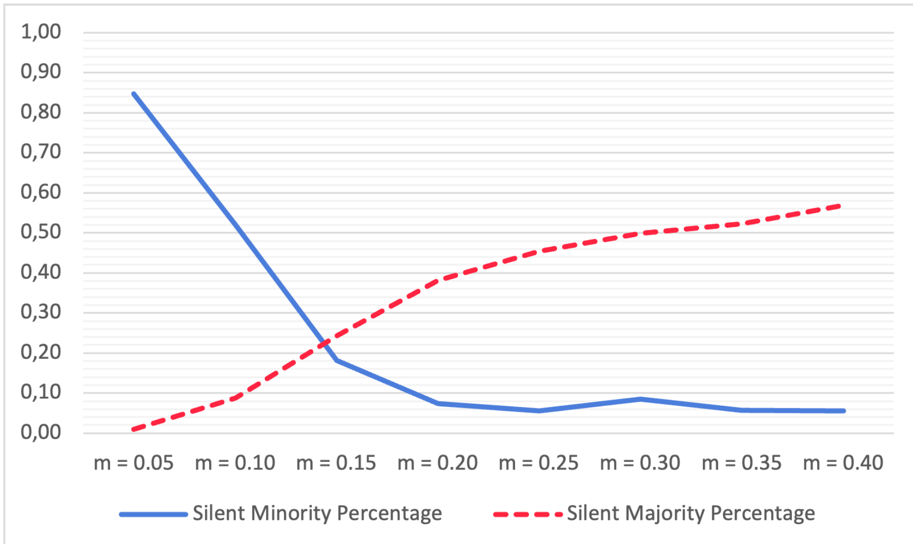

Fig. 5. Silent percentage in different minority percentages in H-O Type 3.

We have observed that different types of cutting and rewiring process produce different results, we also aim to investigate how the dynamics change when we alter the characteristics of the agents. Firstly, we introduce hardcore characteristic, as defined by Noelle-Neumann, where they express their opinions regardless of the situation [2], to half of the minority population. Interestingly, their existence does not affect the expression dynamics of the other half of the minority population in static networks. This suggests that the presence of hardcore agents does not have an impact in prompting other minorities to become expressive, indicating the limited impact of hardcore agents in changing the expression dynamics of the overall population as shown in Table 2.

When the rewiring process is homophily-oriented, we observe total expression from both groups among dynamic networks. However, since hardcore agents are never silent, the expected rewards of both minority and majority groups do not behave as they do in the base model in H-O Type 3. Therefore, we do not observe that there is a minority suppression over a part of the majority, as seen in the base model.

We also give half of the minority agents conservative characteristics, which would cause them to keep their links regardless of their neighbors' opinions and or disallow their different opinionated neighbors to cut their mutual links. We wanted to see if minorities could still dominate the majority in this setting in static networks and Table 3 shows that we observe a majority domination in this setting, as well.

Table 2. Results obtained with hardcore minorities.

Network Type	Silent Minority Percentage (%)	Silent Majority Percentage(%)
Static	99.94	0.05
R-D	99.76	0.23
H-O Type 1	0.05	0.00
H-O Type 2	0.01	0.00
H-O Type 3	7.34	38.14

The findings suggest that conservative agents' inherent characteristics, make it difficult for minorities to connect with each other, increase their expected reward, and reconsider their silence. This silence persists even when non-conservative agents are allowed to rewire in a homophily-oriented manner in H-O networks, as shown in Table 3 where almost all non-conservative minorities are expressive, and conservative minorities remain silent. This indicates that the local trends play a crucial role in enabling minorities to express their opinions, and the global trend of speaking up by other minorities alone may not be sufficient. As Granovetter famously stated [9], weak ties are more effective in spreading new ideas and opinions. Therefore, the limited connections of conservative agents make it challenging for their perspectives to diffuse throughout the network. This result highlights that conservative communities can restrict the dissemination of freedom among group members, as well.

Table 3. Results obtained with conservative minorities.

Network Type	Silent Minority Percentage (%)	Silent Majority Percentage(%)
Static	99.94	0.04
R-D	99.55	0.39
H-O Type 1	47.04	1.25
H-O Type 2	48.45	0.03
H-O Type 3	50.55	26.13

Our analysis reveals that in H-O Type 3, the percentage of the silent minority is higher than the silent majority. This suggests that if we disallow minorities from cutting links and rewiring, they will no longer experience an increase in their expected reward. This contradicts our findings in the base model. Still, a smaller percentage of majority members may become silent, even if the minority is not allowed to cut links and rewire. This can also be explained by the concept of majority illusion which occurs in some small communities where the local majority is the actual minority.

4 Conclusion

The fact that majorities become silent despite their numerical dominance highlights the importance of local communities in shaping people's expression decisions, rather than global dominance, as suggested in the literature [2, 6].

The findings of this study support the spiral of silence theory in static networks and demonstrate the potential for minorities to break the spiral of silence through homophily [7], which can create a society where minorities develop a majority illusion. However, in this setting, the minority lacks the support to maintain dominance and could easily be silenced by an intervention that prompts a majority agent to speak up, leading to all majority members expressing their opinions. This cascade effect can be seen as a reversal of the spiral of silence, which presents an intriguing avenue for future research. This highlights the change-driven nature of opinion expression dynamics in the study, where even a small change in expected reward can lead to significant shifts in expression behavior.

We also explore the impact of different characteristics of minority agents and observe that they can lead the model in various directions. We find that the hardcore personality of some minorities does not encourage other minorities to speak up, and conservative agents are likely to remain silent if they cannot communicate with new people. Therefore, further research could investigate the reverse spiral of silence and the complete expression of both groups by utilizing various types of networks and examining the impact of diverse individual and societal characteristics, both within the minority and majority groups.

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