



HAL
open science

Do gossips enhance group hierarchies?

Guillaume Deffuant, Omid Roozmand, Sylvie Huet

► **To cite this version:**

Guillaume Deffuant, Omid Roozmand, Sylvie Huet. Do gossips enhance group hierarchies?. Social Simulation Conference 2019, 2019, Mainz, Germany. hal-02960008

HAL Id: hal-02960008

<https://hal.science/hal-02960008>

Submitted on 7 Oct 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Do gossips enhance group hierarchies?

Guillaume Deffuant^{1,2}, Omid Roozmand¹, and Sylvie Huet^{1,2}

¹ LISC, Irstea, Aubière, France, guillaume.deffuant@irstea.fr

² LAPSCO, Université Clermont Auvergne, France.

Abstract. We consider a simple model of agents that have an opinion about themselves, about the group they belong to and about the other agents and their group. During random pair interactions, the agents modify their opinions about themselves, about their group, about the other agent and about her group and possibly about some other agents and their group (if there are gossips in the model). We assume that in the discussions, the agents do not tell directly their opinions about the agents and themselves, but a weighted average of this opinion and their group opinion. This aims at modelling socially expected behaviours that take into account the group status of an agent when talking about her (even when the agent talks about herself). Starting from neutral opinions about groups and agents, we observe the emergence of group hierarchies when gossips are activated in the model while there is none otherwise.

Keywords: Opinion dynamics · Group prejudice · Hierarchy · Gossips

1 Introduction

A recent model of opinion dynamics suggests that gossips have a negative effect on the average opinion [2]. This model is in accordance with some studies [1] that observe negative effects of gossips on group cohesion. The model can be seen as revealing the dark side of gossips, whereas the research has until now mainly focused on their bright side: gossips help reputation management [7,14] and help to solve social problems such as propagating information about cheaters or about potential partners or punishing deviations from the social norm (see a review in [11]). Also, gossips are seen to introduce indirect altruistic behaviours because agents are motivated to maintain a good reputation [13].

This paper builds on the model of [2] by associating each agent with a single group and by introducing opinions about groups in addition to the opinions about the agents. Each agent holds an opinion (a real number between -1 and +1) about herself, about each other agent and about each group. It is assumed that every agent knows to which group each agent belongs. The definition of the groups is thus independent from the network of interactions unlike in several models, for instance in [9,10]. Indeed, in this simple model, the network is complete (every agent interacts with all the others). During random pair interactions, each agent modifies her opinions about both agents and both groups in the couple, under the influence of the other, the influence being attractive. Attractive influence is

indeed most robustly observed in social-psychology (see a discussion on this topic in [8]).

Moreover, we assume that agents do not tell directly their opinion about other agents, but a weighted average of their opinion with their opinion about the group of the agent. The weighted average is defined by parameter μ which can be seen as representing the level of formalism in the interactions. Indeed, this parameter determines how important it is to take the group into account when talking about an agent. For instance, in some societies, it is expected to talk with respect about elderly people. In many languages, specific expressions and vocabulary should be used when talking to or about members of certain groups of the society. This can be related to the phenomenon of belief or preference falsification due to social pressure that is implicitly present in the early threshold model of Granovetter [11] and more explicitly in more recent research [6].

The model is designed to be as simple as possible, in order to identify clear effects [5,4] and thus does not claim to represent realistic situations. In particular, it assumes that all agents are initially interchangeable. This can be seen as a neutral hypothesis, like the one proposed in ecology by Hubbell [12]. Moreover, we suppose that initially, all the agents have a neutral opinion about all the others and themselves and about all the groups. Our aim is to study how the differentiation between agents and groups can take place only from the history of random interactions.

We observe the following patterns:

- without gossips, all opinions drift to very positive values;
- with gossips, a hierarchy of the groups emerges. In the each group, the opinions of the agents are very similar.

Therefore, the model suggests that gossips could play a major role in structuring and enhancing hierarchies between groups. We propose some preliminary explanations of these patterns which relate to two statistical biases appearing in the model, similar to the ones observed in [2].

The following section firstly describes the model; section 3 describes the patterns in more details and section 4 proposes some explanations to these observations. The last section is devoted to a discussion about the relevance of these results.

2 The model

2.1 State

The model includes N_a agents and N_g groups. Each agent M (Me) belongs to a single group $G(M)$, has an opinion a_{MY} about each agent Y (You) including herself and has an opinion $g_{MG(Y)}$ about agent Y ' group and $g_{MG(M)}$ about her own group $G(M)$; the opinions are real values between -1, the worst opinion, and +1, the best opinion. Initially, all opinions are set to 0: agents have a neutral opinion about all the others and about all groups at the beginning of the simulations.

Graphically, we represent agents' opinions as a matrix (see example on Figure 1), in which row number M , for $1 \leq M \leq N_a$ is the array of $N_a + N_g$ opinions that agent M has on the other agents Y and about all groups, The column number Y , for $1 \leq Y \leq N_a$ is the opinions all agents M have about Y , and the last N_g columns are the opinions of the agents about the groups. Positive opinions are represented with red shades and negative opinions with blue shades. Lighter shades are used for opinions of weak intensity (close to 0), and they get darker as the opinion becomes more polarized towards -1 or +1.

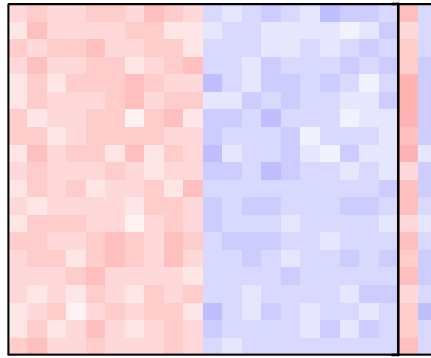


Fig. 1. Example of opinion matrix. The opinions of an agent about the other agents and about the groups are represented on a line of coloured squared. The opinions about the groups (here there are two groups) are represented on the right of the vertical black line. The red squares represent positive opinions while the blue ones represent negative opinions. The intensity of the colours represents the strength of the opinions. In this example, taken after only 200 times N_a pair interactions, the opinions are still weak.

2.2 Dynamics

At each time step, two randomly chosen agents M and Y encounter and they influence each other. Parameter μ ($0 \leq \mu \leq 1$), representing the group prejudice is supposed shared by all the agents. During pair interactions, agents Y do not express their private self-opinion a_{YY} or their private opinion a_{YM} about agent M , but socially constrained opinions A_{YY} and A_{YM} which are a weighted averages of their private opinion and their opinion about the group:

$$A_{YY} = \mu g_{YG(Y)} + (1 - \mu)a_{YY}, \tag{1}$$

$$A_{YM} = \mu g_{YG(M)} + (1 - \mu)a_{YM}. \tag{2}$$

When M gets the message A_{YY} about Y 's self opinion, a_{MY} her opinion about Y , gets closer to a noisy evaluation of A_{YY} , by adding to it $\Delta a_{MY}(t)$,

defined by the following equation, in which $R(\delta)$ designates a uniformly drawn number between $-\delta$ and δ :

$$\Delta a_{MY}(t) = p_{MY}(t)(A_{YY}(t) - a_{MY}(t) + R(\delta)), \quad (3)$$

The function $p_{MY}(t)$ is the same as in [2] and is described a little further. The change of opinion of M about $G(Y)$ the group of Y , tends also to get closer to a noisy evaluation of A_{YY} :

$$\Delta g_{MG(Y)}(t) = p_{MY}(t)(A_{YY}(t) - g_{MG(Y)}(t) + R(\delta)). \quad (4)$$

This reflects the idea that the opinion about a group is derived from the opinions about its members.

Symmetrically, the changes of opinions a_{MM} and $g_{MG(M)}$ are given by:

$$\Delta a_{MM}(t) = p_{MY}(t)(A_{YM}(t) - a_{MM}(t) + R(\delta)), \quad (5)$$

$$\Delta g_{MG(M)}(t) = p_{MY}(t)(A_{YM}(t) - g_{MG(M)}(t) + R(\delta)). \quad (6)$$

The function of influence $p_{MY}(t)$ is given by equation 7.

$$p_{MY}(t) = \frac{1}{1 + \exp\left(\frac{a_{MM}(t) - a_{MY}(t)}{\sigma}\right)}. \quad (7)$$

The function p_{MY} expresses the hypothesis that the more M perceives Y as superior to herself, the more Y is influential on M .

For one encounter between M and Y , the changes of the opinions of M are:

$$g_{MG(M)}(t+1) = g_{MG(M)} + \Delta g_{MG(M)}(t), \quad (8)$$

$$g_{MG(Y)}(t+1) = g_{MG(Y)} + \Delta g_{MG(Y)}(t), \quad (9)$$

$$a_{MM}(t+1) = a_{MM}(t) + \Delta a_{MM}(t), \quad (10)$$

$$a_{MY}(t+1) = a_{MY}(t) + \Delta a_{MY}(t), \quad (11)$$

and the changes of Y 's opinions are performed with the same equations (inverting Y and M).

When adding gossips, it is supposed that agent Y also talks to M about k agents H drawn at random and modifies the opinion of M about agents H and about their group as follows:

$$g_{MG(H)}(t+1) = g_{MG(H)} + p_{MY}(t)(A_{YH}(t) - g_{MG(H)}(t) + R(\delta)), \quad (12)$$

$$a_{MH}(t+1) = a_{MH}(t) + p_{MY}(t)(A_{YH}(t) - a_{MH}(t) + R(\delta)). \quad (13)$$

Similarly, agent M talks to Y about k agents drawn at random and modifies the opinion of Y about these agents and their group, following the same equations where Y and M are inverted.

In this paper, we limit our study to the model with the synchronous update: at each encounter all the changes of opinions (e.g. equations 3 and 4) are first computed and then the opinions are modified simultaneously (e.g. equation 8).

Overall, the dynamics includes four parameters:

- σ defines the shape of the propagation function p_{MY} ; if σ is very small, the function is very tilted, meaning that agents are subject to high influence from the ones who they evaluate better than themselves and they almost completely disregard the opinions of the ones considered lower.
- δ represents the amplitude of the uniformly distributed errors that perturb the evaluation of others' expressed opinions. This noise stands for the inability of an agent to directly access the opinion of another leading to errors of interpretation. Without it, from an initialization of all opinions at zero, there would be no opinion change at all.
- μ is the weight of the group in the expression of opinions about agents.
- k is the number of agents subject of gossips in each pair interaction.

3 Typical patterns: gossips create group hierarchies

3.1 Overview

In the region of the parameter space around $\sigma = 0.3$ and $\delta = 0.1$ as considered in [2], two types of patterns emerge:

- without gossips, the typical pattern shows an average opinion about each group and about their members which is close to 1, with a strong homogeneity within the groups. The average of the opinion about the group is very close to the average of the opinion about its members. The group of highest average reputation changes frequently. A typical example is shown on Figure 2, panel (a). The result is the same with a larger number of groups and for different values of μ .
- with gossips, the typical pattern shows a hierarchy between the groups that may take a long time to establish, as shown on figure 3. The number of agents subject of gossips (k) should be increased with the number of groups in order to get a complete hierarchy. With smaller values of k , there might be several groups with an average opinion close to 1 (not represented on the figures).

Figure 3 shows examples of typical trajectories of the average opinion about the agents of each group (which is very close to the average opinion about the group). On panel (a), the pattern of panel (a) of figure 2 emerges rapidly and remains very stable. On panels (b), (c) and (d), the hierarchy of the groups emerges progressively and tends to stabilise when the average opinions are regularly distributed on the opinion axis.

3.2 Stability of group hierarchy emerging with gossips.

We now observe the patterns obtained with gossips over a longer period of time (1 million times N_a pair interactions). Figure 4 shows the average value of the opinion in each of the 4 groups each 1000 times N_a pair interactions, it appears that the hierarchy can change over time and that there some groups may remain close to each other for very long periods.

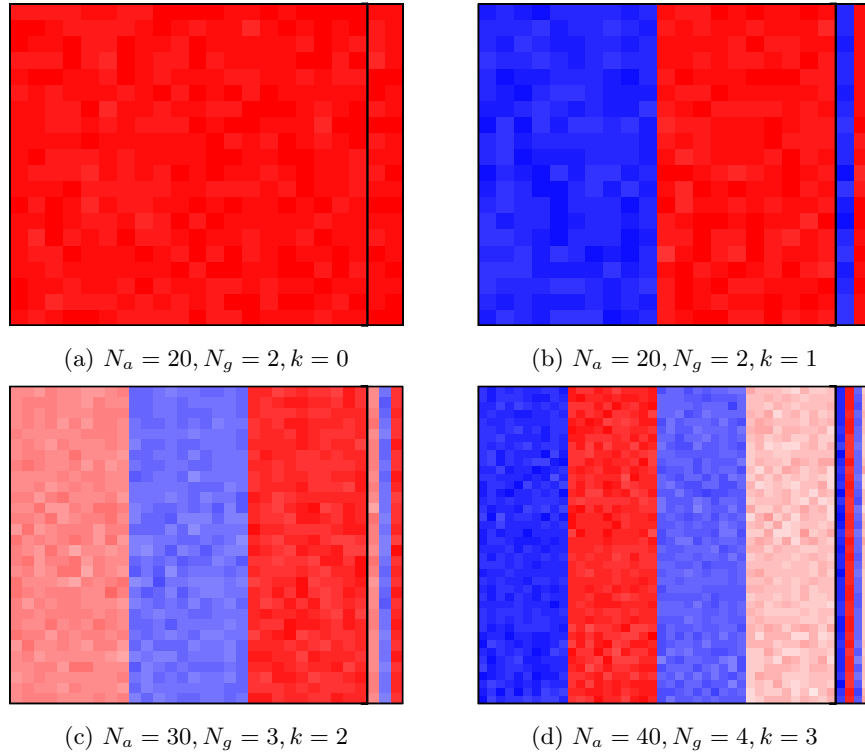


Fig. 2. Typical patterns for $\mu = 0.5$ (prejudice for groups), $\delta = 0.1$ (noise) and $\sigma = 0.3$ (influence function parameter) after $200,000 \times N_a$ random pair interactions. The opinions of an agent about the others and about the groups are represented by coloured squared (red are positive and blue negative) on a line of the matrix. The opinions of the agent about the groups are on the right of the black vertical line. Panel (a) without gossips. The opinions about the agents of the two groups are positive and very similar. Panel (b) 2 groups with gossips ($k = 1$). Panel (c): 3 groups with gossips ($k = 2$). Panel (d): 4 groups with gossips ($k = 3$). When there are gossips, a hierarchy between the groups is established.

In order to better evaluate the stability of the hierarchies and the respective positions of the different groups in the hierarchy, when μ varies, we performed the following experiments: For μ varying from 0.1 to 0.9, by intervals of 0.1, repeat ten times:

- run 100,000 rounds of N_a pair interactions (time for establishing the first hierarchy);
- run 1 million rounds of N_a pair interactions and compute the average opinion of the groups according to their order in the hierarchy and the average number of position changes in the hierarchy from a given position, each 100,000 rounds of N_a pair interactions;

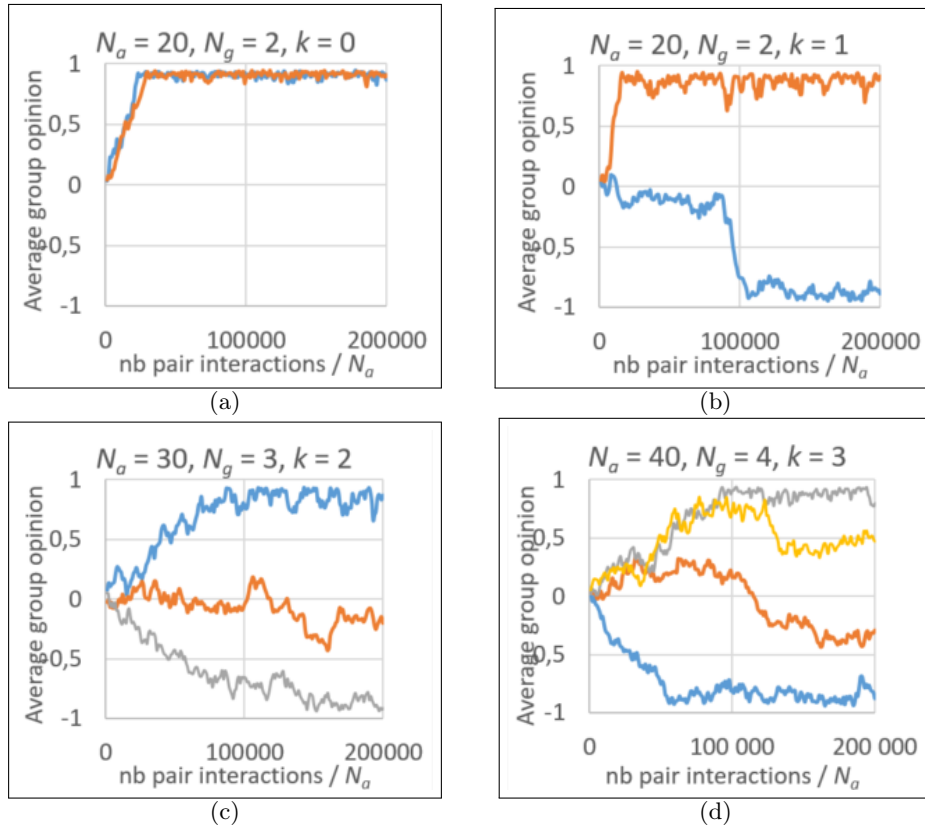


Fig. 3. Typical trajectories of the average opinion for each group over $200,000 \times N_a$ random pair interactions for $\mu = 0.5$ (prejudice for groups), $\delta = 0.1$ (noise) and $\sigma = 0.3$ (influence function parameter). Panel (a) without gossips. The opinions about the agents of the two groups are positive and very similar. k is the number of agents subject of gossips at each interaction. Panel (b) 2 groups with gossips ($k = 1$). Panel (c): Three groups with gossips ($k = 2$). Panel(d): 4 groups with gossips ($k = 3$). The hierarchy takes longer to establish when there are more groups.

- compute the average opinion about the groups over the ten replicas and the standard deviation as well as the average number of position changes in the hierarchy and its standard deviation.

The results of these experiments are reported on Figure 5. Several features are noticeable:

- From $\mu = 0.1$ to $\mu = 0.7$, the highest group in the hierarchy is more stable than the others and the average opinion about it is close to 1, whereas the average opinions about the other groups is below 0. The changes of hierarchy between the other groups are frequent;

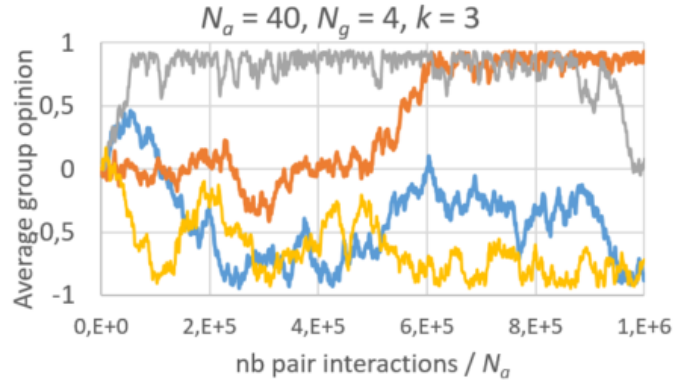


Fig. 4. Example of trajectories of the average opinion about each group for $N_a = 40$, $N_g = 4$, $k = 3$ over one million times N_a random pair interactions.

- For $\mu = 0.8$ and $\mu = 0.9$, this tends to be the opposite, the lowest group in the hierarchy is the most stable, with a much lower stability in general than for low values of μ ;

Moreover, when increasing parameter k , the number of agents about which gossips take place, the hierarchies become less and less stable and beyond a threshold of k all groups tend to collapse close to opinion -1.

4 Some explanation of the patterns

4.1 Case of a single group

We start by considering the model with a single group, thus providing the behaviour of a group when the interactions take place only between agents of the same group.

In this case:

- without gossips ($k = 0$) all the opinions rapidly increase to a value close to 1 and fluctuate around it,
- with gossips about only one agent ($k = 1$) the opinions of the group remain close to each other and fluctuate on all positions of the opinion axis;
- with gossips about more than one agent ($k > 1$) the opinions rapidly decrease to a value close to -1 and fluctuate around it.

Hence the negative effects of gossips observed in [2] is significantly enhanced by the introduction of the group.

We perform the following experiment in order to evaluate the evolution of the average self-opinion, opinion about others and about groups in the first iterations:

- For $k = 0, 1, 2, 3$, repeat 20 times:

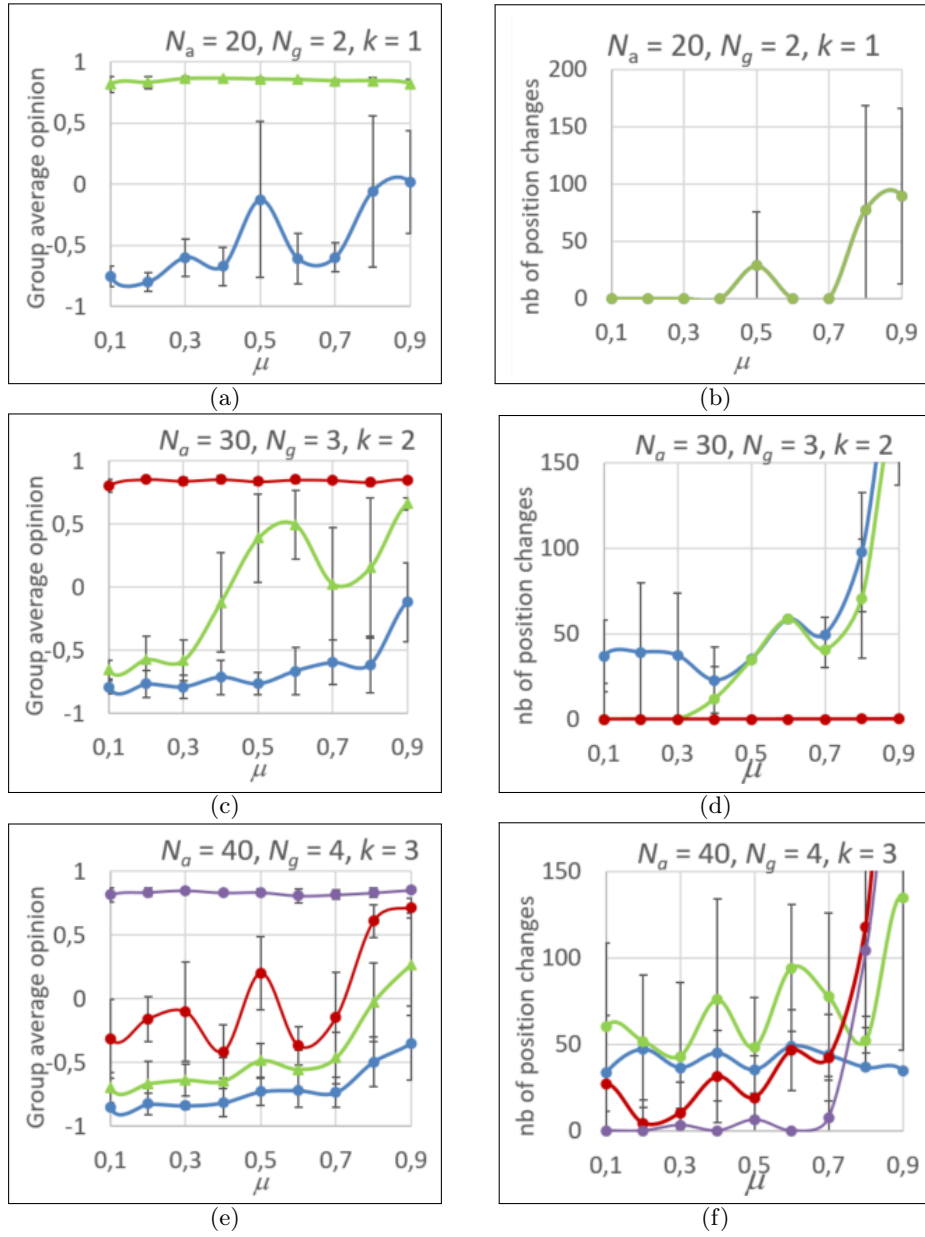


Fig. 5. Panels (a), (c) and (e): average positions of the group hierarchy when μ (group prejudice) varies. The averages computed on 1 million rounds of N_a pair interactions, the error bars corresponds to the standard deviation of the positions computed every 100,000 rounds of N_a pair interactions. Panels (b), (d) and (f): average number of position changes in the hierarchy from different positions.

- Repeat 1000 times:
 - * initialise the model with $N_a = 10$, $N_g = 1$, all opinions at 0;
 - * run 50 rounds of N_a pair iterations and compute the average of self opinions, average of opinions about others, average opinion about groups every 10 times N_a pair iterations;
- compute the average of self-opinions and opinions about others and about groups and associated standard deviations over the 20 repetitions.

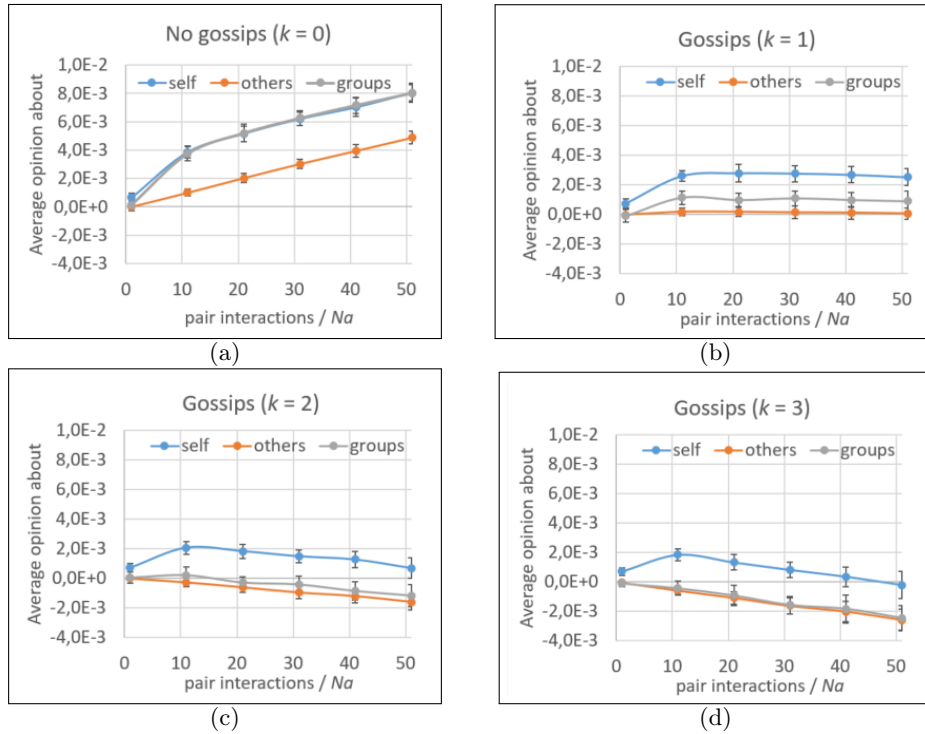


Fig. 6. Effect of gossips on average opinions about self, others and group in the first 50 times N_a pair iterations for the model with a single group and $N_a = 10$.

The results are reported on Figure 6. In all cases, the average self-opinion is consistently higher than the average opinion about others. This feature has been already observed in [2]. The average self-opinions are always growing in the 10 first rounds of N_a pair interactions. Then, it continues to grow almost linearly for $k = 0$ (no gossips, panel (a)), it remains stable for $k = 1$ (panel (b)) and it decreases for $k = 2$ (panel (c)) and $k = 3$ (panel (d)). The average opinion about others is monotonous, increasing for $k = 0$, stable $k = 1$, decreasing for $k = 2$ and $k = 3$. The average opinion about the group is almost equal to the average

self-opinion for $k = 0$, and then it gets closer and closer to the average opinion about others when k increases.

Qualitatively, it appears therefore that the increasing negative bias on the opinion about others compensates the opinion increase due to the positive bias on the self opinion when $k = 1$ and is stronger when $k > 1$, leading to a general opinion decrease which is enhanced by a decrease of the opinion about the group. Overall, compared with the model of [2], the model with a single group shows a stronger drift to the positive opinions when there are no gossips and a stronger drift to the negative opinions when the gossips are such that $k > 1$, because the average opinion about groups tends to be more and more aligned on the average opinion about others, as k increases.

4.2 Interactions between groups.

In order to evaluate the effect of a group on the other, we focus on the case of two groups, and we perform the following experiments:

- For the initial opinion about group 1 (*op1*) varying from -0.9 to 0.9 by intervals of 0.1, repeat 10 times:
 - Repeat 1000 times:
 - * Initialise the agents opinions with:
 - all the opinions about agents of group 1 and all opinions about group 1 are initialised at *op1*;
 - all the opinions about agents of group 2 and all opinions about group 2 are initialised at 0.
 - * perform 100 rounds of N_a random interactions between agents of group 1 and group 2, with all opinions about agents of group 2 fixed.
 - * compute the average change of self-opinion of agents of group 1, the average change of opinion of agents of group 1 about other agents of group 1 and the average change of opinion of agents of group 1 about group 1 over the 1000 repetitions;
 - compute the average and standard deviation on the average opinion changes on the 10 repetitions.

The results of these experiments in the case of two groups of 10 agents and $\mu = 0.3$ are reported on Figure 7, the error bars being the standard deviation obtained on the 10 repetitions.

For $k = 0$ (left panel of Figure 7), the opinion of agents of group 1 about other agents in group 1 does not change because the interactions take place only between agents of group 1 and agents of group 2, and during these interactions, only the opinions about other agents of group 2 could be modified (and this is not the case because opinions about agents of group 2 are fixed). The average change of self-opinion of agents of group 1 is positive except for an initial opinion about group 1 close to 1, with a maximum reached for an initial opinion about group 1 lower than 0. The average change of opinions of agents of group 1 about group 1 shows a similar shape but is a bit lower, with a maximum reached for

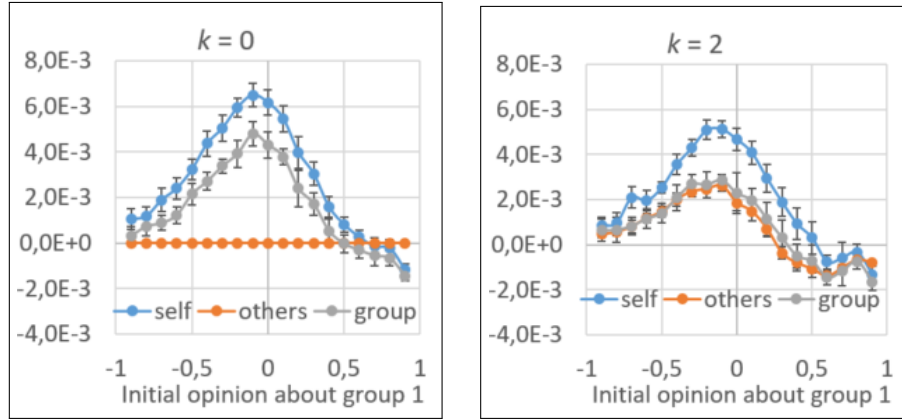


Fig. 7. Experiments on $N_g = 2$ groups of $\frac{N_a}{2} = 10$ agents. The horizontal axis represents the initial opinion about agents of group 1. The graphs are the average change of opinions of agents of group 1 about self, others in group 1, and group 1 after 100 rounds of N_a random pair interactions with group 2 about which opinions are all fixed to 0, for no gossips ($k = 0$ left panel) and for gossips about two agents ($k = 2$ right panel). The prejudice for group is $\mu = 0.3$.

the same initial opinion about group 1. It is noticeable that both curves are strictly positive for initial opinions about group 1 from -1 up to 0.5 and very lowly negative beyond 0.5. Therefore the effect of group 2 is mainly to increase the opinions of agents of group 1 about themselves and about group 1. This effect reinforces the tendency of the opinions to grow because of the interactions within the groups when there is no gossips, shown previously.

For $k = 2$ (right panel of Figure 7), the graphs of average change of group 1 agents' self-opinion and of opinion about group 1 have similar shapes as when $k = 0$, but they are a bit lower. The decrease of the positive effect is likely to be due to the negative bias about others that is increased by gossips (see [2]). The average change of the opinion about others in group 1 is almost equal to the change of opinion about the group. The overall effect is clearly positive from the initial opinion about group 1 at -1 to a value a bit lower than 0.5, which implies a general tendency to increase the opinion about agents of group 1. This effect is opposite to the tendency of opinions to decrease because of their interactions inside group 1, shown previously, and the combination of both effects leads average opinion about each group that can increase or decrease, depending on which effect dominates.

Further investigations are necessary in order to explain how the highest group can remain very stable with an opinion close to 1 in some cases (see Figure 5).

5 Discussion

The model suggests that taking into account the group status when talking about agents tends to increase the similarity of opinions in each group. More importantly perhaps, the model suggests that gossips may play an important role in the emergence of group hierarchies. Indeed, when there are no gossips, starting from being neutral, all the opinions increase to a value close to 1. When there are gossips, relatively stable hierarchies between the groups emerge.

The positive bias for self-opinion and the negative bias for the opinion about others, identified in [2], seem to play a major role in the pattern emergence. Indeed, there is a level of gossips for which the interactions within the group tend to systematically decrease the average opinions about the agents of this group and about the group itself. The effect of gossips is smaller on the effect of the interactions between different groups. This effect is indeed overall to increase the opinions about the groups, even in the presence of gossips, and it compensates the decreasing effect of the gossips inside the groups.

These conclusions could be related to observed social dynamics. First, the model suggests that there is an interest to direct gossips on external groups, because it seems that there is a general positive effect on the group opinions in doing so. This reminds the old recipe of demagogues to direct debates about alien populations in order to gain popularity. Second, it suggests that the combination of group identities and gossips increases the conviction about group inequalities. This could be yet another warning about online social networks which tend to increase dramatically the possibilities for gossiping as well as for entrenching group identities.

These conclusions should nevertheless be more robustly established by further studies of the model. In particular, it seems important to study the effect of group size (and of groups of different sizes) and of more frequent interactions between agents of the same group than between agents of different groups. Finally, the effect of the dynamics of vanity (see [3]) on the emergence and stability of group hierarchies would be important to study as well.

6 Acknowledgement

This work has been partly supported by the Flagera project FuturICT2.0.

References

1. Cox, B.: What is hopi gossip about? information management and hopi factions. *Man* **5**, 88–98 (1970)
2. Deffuant, G., Bertazzi, I., Huet, S.: The dark side of gossips: Hints from a simple opinions dynamics model. *Advances in Complex Systems* **21** (2018)
3. Deffuant, G., Carletti, T., Huet, S.: The leviathan model: Absolute dominance, generalised distrust and other patterns emerging from combining vanity with opinion propagation. *Journal of Artificial Societies and Social Simulation* **16**(23) (2013)

4. Deffuant, G., Moss, S., Jager, W.: Dialogues concerning a (possibly) new science. *Journal of Artificial Societies and Social Simulation* **9**(1) (2006)
5. Deffuant, G., Weisbuch, G., Amblard, F., Faure, T.: Simple is beautiful...and necessary. *Journal of Artificial Societies and Social Simulation* **6**(1) (2003)
6. Duggins, P.: A psychologically-motivated model of opinion change with applications to american politics. *Journal of Artificial Societies and Social Simulation* **20**(1) (2017)
7. Euler, N.: *Handbook of language and social psychology*, chap. Gossiping, pp. 317–338. John Wiley & Sons (2001)
8. Flache, A., Maes, M., T. Feliciani a, d.E.C.B., Deffuant, G., Huet, S.: Models of social influence: Towards the next frontiers. *Journal of Artificial Societies and Social Simulation* **20**(4) (2017)
9. Gargulio, F., Huet, S.: Opinion dynamics in group based society. *Euro-physics letters* **21**(107) (2010)
10. Gargulio, F., Huet, S.: New discussions challenge the organisation of societies. *Advance in Complex Systems* **15**(07) (2012)
11. Giardini, F., Conte, R.: Gossip for social control in natural and artificial societies. *Simulation* **88**(1), 18–32 (2012)
12. Hubbell, S.: *The Unified Neutral Theory of Biodiversity and Biogeography*. Princeton University Press. (2001)
13. Panchanathan, K., Boyd, R.: Indirect reciprocity can stabilize cooperation without the second-order free rider problem. *Nature* **432**, 499–502 (2004)
14. Piazza, J., Bering, J.: Concerns about reputation via gossip promote generous allocations in an economic game. *Evolution of Human Behavior* **6**, 487–501 (2008)