Guess You're Right on This One Too: Central and Peripheral Processing in Attitude Changes in Large Populations

Wander Jager[1] and Frédéric Amblard[2]

1:Faculty of Economics, University of Groningen, The Netherlands. w.jager@bdk.rug.nl
2: IRIT-UT1 - University of Social Sciences Toulouse 1, France. frederic.amblard@univ-tlse1.fr

Abstract
In processes of attitude change people may employ different mechanisms, for example focussing on arguments (central processing) versus focusing on the reputation of the source (peripheral processing). In this paper we formalise these processes and systematically explore how this affects the relation between two attitude dimensions. Both an aggregated correlation as a local heterogeneity index are used to explain the effects. Results indicate that peripheral processing contributes to the relation between attitudes, but only on a local level.

Keywords: social simulation, agent based simulation, opinion dynamics, social judgment theory, elaboration likelihood model.

1: Introduction

In defining an attitude to a certain object or issue people not only process arguments an favour or against this object or issue, but also may be susceptible to source effects. The latter implies that one is more likely to agree with a person that is in some respect credible. For example, my attitude towards certain brands or opinions may become more favourable knowing that respected colleagues or friends also use this product or adhere to an opinion. In theories on persuasion a distinction is made between central processing, which basically deals with the processing of arguments and information, versus peripheral processing, which is based on the processing of cues rather than arguments and information. A central theory here is the Elaboration Likelihood Model of Petty and Cacioppo (1986). A very powerful cue in peripheral processing is the source providing the information. If a certain position or attitude is advocated by a well-respected person one is more likely to shift attitude in the sources direction. Source effects are widespread, they relate to e.g. the charisma of politicians, the trust one has in the knowledge of friends and acquaintances, but also to marketing campaigns where information is being provided by trustworthy looking people (attractive people, people wearing a suit or white doctor's coat) or by famous people endorsing a product. Especially when a person's motivation to elaborate is low, and or one's cognitive processing ability is limited (i.e., complex issues, limited time), a person is more likely to engage in peripheral processing, and hence under such conditions source effect become more important. The attractiveness of the source is related to similarity of attitudes. Generally, people like to have similar opinions as people they interact with (Festinger, 1954). This implies that when engaging in peripheral processing, people may compare on an important attitude dimension how similar they are, and depending on that observed (dis)similarity either accept or reject the information of other attitude dimensions.

Whereas the basic assumption here is that people shift their position on a less important attitude dimension in the same direction as their respected friends, where this respect is based on similarity on important attitudes, virtually no empirical and laboratory studies are reported studying such multi-attitude dynamics. Also no studies have been devoted to explore how such effects might be responsible for attitude dynamics in large populations, such as the emergence of subcultures having the same attitudes. Laboratory studies in this realm are difficult to perform, as the experimenting with multiple attitudes with different importance is difficult to manipulate, especially when social interaction is the key-mechanism through which attitude positions are communicated. Whereas in principle such experiments can be designed, a more fundamental problem is how to explore such attitude dynamics in larger populations. Here social simulation is developing a framework on attitude or opinion dynamics (e.g., Latane and Nowak 1997, Galam 1999, Deffuant et al. 2001, Weisbuch et al. 2002, Deffuant et al. 2002, Hegselmann and Krause 2002, Salzarulo, 2004, Jager & Amblard, 2005a).

In a recent paper, Jager and Amblard (2005b) explored the attitude dynamics in a context where agents engage in central and peripheral processing. Central processing was formalized according to the Social Judgment Theory (SJT: Sherif and Hovland 1961). This theory is relevant in understanding how people assimilate or contrast their opinion after being confronted with another position. The basic idea of this theory is that a change of a person's attitude depends on the position of the persuasive message that is being received. If the advocated position is close to the initial position of the receiver, it is assumed that this position falls within the *latitude of acceptance* of the receiver. As a result, the receiver is likely to shift in the direction of the advocated position (*assimilation*). If the advocated position is distant to the initial position of the receiver, it is assumed that this position falls within the *latitude of rejectance* of the receiver. As a result, the receiver is likely to shift away from the advocated position (*contrast*). If the advocated position falls outside the border of the latitude of acceptance, but is not that distant that it crosses the border of the latitude of rejectance, it will fall within the *latitude of non-commitment*, and the receiver will not shift its initial position. Peripheral processing was formalized as a source effect, and implied that an assimilation on one dimension would also result in an assimilation on another dimension, regardless of the initial distance between the attitude positions. On the contrary, a contrast effect on one attitude would also result in a contract effect on the other attitude.

Whereas in Jager and Amblard (2005b) some preliminary results of prototypical runs were demonstrated, the current paper aims at systematically exploring the effects of central and peripheral processing on attitude dynamics.

2: The model

For the formalization of the Social Judgment Theory, which refers to central processing, we follow the model as used by Jager and Amblard (2005a). This formalization implies that we have a population with N individuals. Each individual i has got an opinion (an attitude) x_i, a threshold determining the latitude of acceptance u_i and a threshold determining the latitude of rejection T_i with $T_i > U_i$. Varying the values of T_i and U_i allows for modeling agents having different attitude structures. For example, an agent having a high ego-involvement has low values of T_i and $U_{i,}$ and is more likely to contrast his attitudes with others than agents having a low ego-involvement. The agents are scheduled to communicate on a random basis by scheduling random pairs for each time-step of the simulation. During the interaction between individual *i* and individual *j*, the following rules are applied:

$$If\ |x_i\text{-}x_j|<u_i \qquad dx_i=\mu.(x_j\text{-}x_i)$$

$$If\ |x_i\text{-}x_j|>t_i \qquad dx_i=\mu.(x_i\text{-}x_j)$$

where the parameter μ controls for the strength of influence.

The same rules are applied for the update of the opinion of the individual *j*.

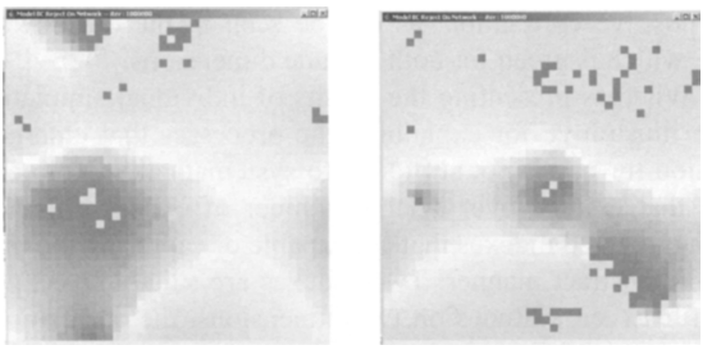
For the formalization of peripheral processing we formalized two attitude dimensions on which agents discuss (Jager & Amlard, 2005b). After encountering another agent, the attitudinal shift on one dimension will affect the shift in the other dimension, thus indicating peripheral source effects. An assimilation or contrast effect on the first attitude dimension will also translate in a similar assimilation or contrast effect in the second dimension. Here agents select attitude A for the interaction process, and depending on the outcome (assimilation, non commitment or contrast) they will also apply this outcome to the dimension B. The rule describing peripheral processing is:

$$If\ |xA_i\text{-}xA_j|<u_i \qquad dAx_i=\mu.(xA_j\text{-}xA_i) \text{ and } dBx_i=\mu.(xB_j\text{-}xB_i)$$

$$If\ |xA_i\text{-}xA_j|>u_i \qquad dAx_i=\mu.(xA_j\text{-}xA_i) \text{ and } dBx_i=\mu.(xB_i\text{-}xB_j)$$

3: Results

In Jager & Amblard (2005b) we conducted some first experiments on peripheral and central processing. In one experiment we created a condition of low ego-involvement by setting U at 1.0 and T at 1.5. For both dimensions agents engaged in central processing. In the following figure we display the results for t = 1000.000, where the color figures the opinion of the agent between -1 (red) and +1 (green) yellow coding for opinions near 0.

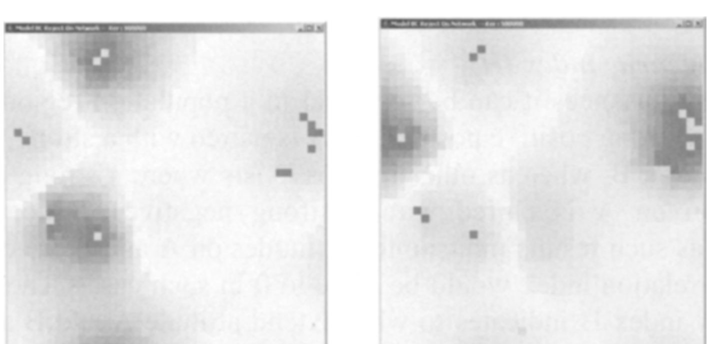


Time step 1.000.000 Attitude A Attitude B

Figure 1: Attitudes for central processing on both dimension A and B

Whereas the attitude positions on A and B seem to be unrelated, we observe contrast effects within each attitude, as represented by agents having a complete opposite attitude position than their environment.

The same experiment has also been performed for a condition where agents engage in central processing on attitude A, and peripheral processing on attitude B.



Time step 500.000 Attitude A Attitude B

Figure 2: Attitudes for central processing on dimension A and peripheral processing on dimension B

In Figure 2 it can clearly be seen that the attitude on A and B are strongly correlated. However, whereas in most situations the correlation is negative – i.e. red on A is paired with green on B – there is also a positive correlation, as can be seen in the dot down in the middle, which is green for both attitude dimensions.

Whereas presenting the results of individual simulation runs may be illustrative for explaining the processes that emerge in the simulation runs, it is not sufficient to systematically explore the dynamics that emerge over a large number of experiments. This requires aggregated indexes that are capable of capturing the processes in a more abstract manner. Two indexes are suitable to express the relation between attitudes on two dimensions, the correlation index and the heterogeneity index.

Correlation index (R)

A correlation index can be calculated over the population as a whole to express the degree of coherence between the attitude position on A and the attitude position on B. The correlation index ranges from -1 to 1. A strong negative correlation indicates that a positive value on attitude A is pared with a strong negative position on B, and vice versa. A strong positive correlation indicates that a strong positive (or negative) value on attitude B is paired with a strong positive (or negative) position on B as well. A correlation close to 0 indicates that over the population as a whole the position on attitude A is not related to the position on attitude B.

Heterogeneity index (H)

In many instances it can be seen that in a population regions exists where a strong positive position on A is paired with a strong positive position on B, whereas other regions exists where a strong positive position on A is paired with a strong negative position on B. Whereas such results indicate that attitudes on A and B are coupled, the correlation index would be close to 0 in such cases. The heterogeneity index H indicates to what extend attitude A and B are coupled, taking account of spatial differences. H is calculated as follows: For the population of n agents H is calculated as:

$$H = \frac{\sum_{i}^{n} \left| A_i - \frac{\sum_{j=1}^{4} A_j}{4} \right| + \sum_{i}^{n} \left| B_i - \frac{\sum_{j=1}^{4} B_j}{4} \right|}{2}$$

With: A_i = position of agent i on attitude dimension A

$\frac{\sum_{j=1}^{4} A_j}{4}$ = average attitude position of four neighbours on dimension A

A H value of 0 indicates that there is no difference between an agent and his neighbours, thus indicating similarity on attitudes. A fully randomised uniform distribution of attitudes results in an H of 0.75. In a polarised condition, where 50% of the agents have position -1, and 50% +1, and the agents are randomly spread, the H value will be close to 1. High values for H thus indicate a large local heterogeneity amongst agents concerning their attitude position, and a low value indicates a large similarity of agents.

Central processing

We conducted 20.000 simulations for the central processing case for 1600 agents. U was set at 1.0, and T at 1,5, thus resulting in a population having a low ego-involvement, which in previous experiments stimulated convergence on attitudes.

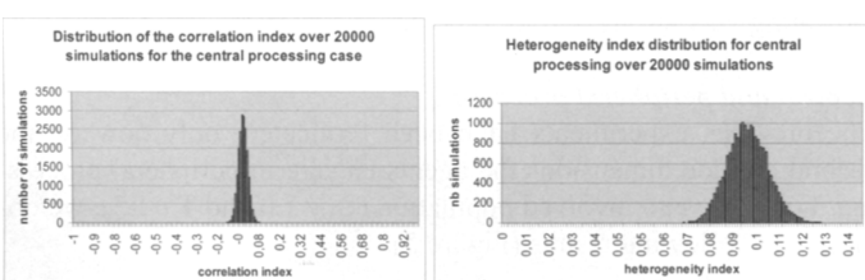


Figure 3: correlation and heterogeneity index for the central processing case (U = 1.0, T = 1.5)

As can be seen in Figure 3 the correlation remains close to 0 for most simulations. These results indicate that the attitude position on A and B are not related when considering the population as a whole. Looking at the heterogeneity amongst the agents we observe a normal distribution of H around an average of 0.1. This low H indicates that there is strong clustering on both attitude dimensions, indicating convergence. Yet, there is still some heterogeneity amongst the agents, as can be seen in the exemplary run as presented in Figure 1. The low R indicates that the relation between the position on attitude dimension A and B is virtually absent.

We replicated this experiment with a population having a high ego-involvement (U set at 0.5 and T at 1.0, which resulted in polarisation effects in previous experiments.

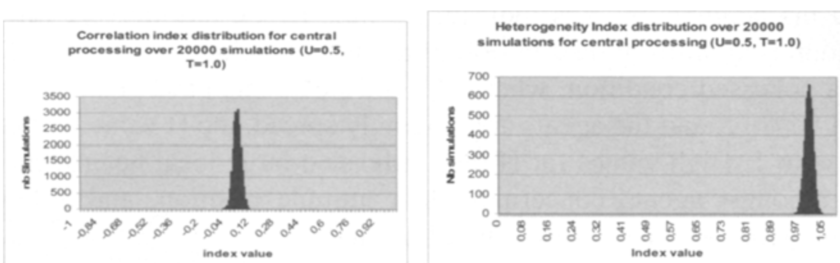


Figure 4: correlation and heterogeneity index for the central processing case (U = 0.5, T = 1.0)

It can be observed that in this condition the correlation remains close to 0, whereas the H index shows a distribution around the value of 1, indicating very strong and local polarisation effects.

Central and peripheral processing

The previous experiments have been replicated, only now on the second attitude dimensions the agents engage in peripheral processing. For a low ego involved population (U = 1.0 and T =1.5), we obtained the following results (Figure 5):

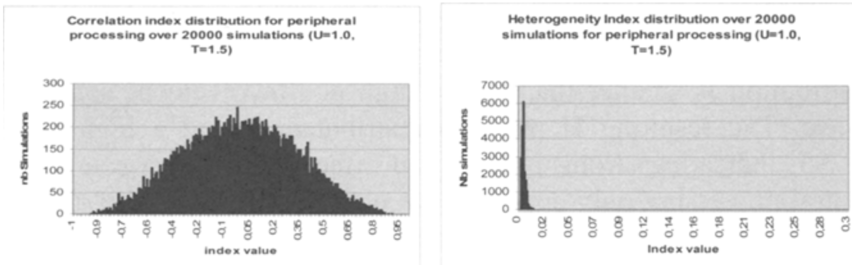


Figure 5: correlation and heterogeneity index for the central and peripheral processing case (U = 1.0, T = 1.5)

We observe a correlation distributed around 0, but with a much larger variance than in the central processing case. This indicates that many situations emerge where the attitudes are positive or negative related for the population as a whole. Looking at the heterogeneity amongst the agents we observe the value of H to be close to 0, indicating spatial clustering of attitudes. An R close to 0 paired with a low H indicates that many situations emerged where spatial clusters have emerged where A and B are uniquely coupled. Thus, four clusters may emerge: A+ B+, A+ B-, A- B+, and A- B-. On a local level the agents have a strong similarity on attitude A and B, but because in different regions the shape of this agreement is opposite, this does not translate in an overall high correlation R.

Next we replicate the high ego-involvement condition (U = 0.5, and T = 1.0), which resulted in polarisation in the central processing condition.

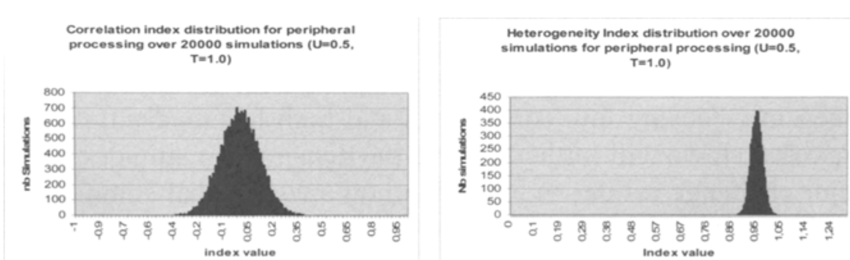


Figure 6: correlation and heterogeneity index for the central and peripheral processing case (U = 0.5, T = 1.0)

Whereas the correlation between A and B still shows much more variety than in the central processing condition, we observe that the distribution is smaller than in the high ego-involvement condition above. The resulting H index is distributed around a high value of .93, indicating strong polarisation effects. In comparison to the central processing only condition we observe that adding peripheral processing reduces this polarisation slightly, and causes that more often a correlation emerges between A and B.

4: Conclusions

The results show that peripheral processing on the second attitude dimension causes that the relation between attitude position A and B become stronger. This is partly visible on an aggregated level, as the correlation between attitude A and B is more often deviating from 0. However, a large number of runs resulted in correlations close to 0, indicating a low relation on the aggregate level. However, under the condition of a low ego-involvement, the heterogeneity index shows that the average difference between agents and their neighbours is quite low, indicating a strong relation on the local level. This implies that a kind of local neighbourhoods emerge where attitudes on two distinct issues are related in a different way than in other neighbourhoods. This reflects the emergence of subcultures, for example where constellations of attitudes emerge, or where preferences for products or brands are related. For example, in the Netherlands the clothing brand of Lonsdale was very popular amongst extreme right-wing youngsters, whereas in other countries this relation is absent, or sometimes even opposite. On the contrary, when ego-involvement is high, peripheral processing only has a minor effect on correlation and clustering. When people are contrasting a lot on one attitude dimension, they will also contrast on the peripheral processed attitude dimension, causing low correlations and high heterogeneity. In future research we will further explore the dynamics of attitudes, and a major challenge resides in exploring how mass-medial communications or 'viral communication strategies' addressing selected clusters of agents may interfere with these attitude dynamics.

References

Deffuant, G., D. Neau, F. Amblard, F. and G. Weisbuch (2001). Mixing beliefs among interacting agents. *Advances in Complex Systems, 3*, 87-98.

Deffuant, G., F. Amblard, G. Weisbuch and T. Faure (2002). How can extremism prevail? A study based on the relative agreement interaction model. *Journal of Artificial Societies and Social Simulation, 5(4).*

Festinger, L. (1954). A theory of social comparison processes. *Human Relations, 7,* 117-140.

Galam, S. (1999). Application of Statistical Physics to Politics. *Physica A, 274*, 132-139.

Hegselmann, R. and U. Krause (2002). Opinion dynamics and Bounded Confidence Models, Analysis and Simulation. *Journal of Artificial Societies and Social Simulation, 5(3).*

Jager, W., & Amblard, F. (2005a). Uniformity, Bipolarization and Pluriformity Captured as Generic Stylized Behavior with an Agent-Based Simulation Model of Attitude Change. *Computational & Mathematical Organization Theory, 10 (4)* pp. 295-303(9).

Jager, W., Amblard, F. (2005b).Multiple attitude dynamics in large populations. Paper presented at the Agent 2005 Conference on: *Generative Social Processes, Models, and Mechanisms,* Argonne National Laboratory, The University of Chicago, October 13-15, 2005.

Latane, B. and A. Nowak (1997). Self-Organizing Social Systems: Necessary and Sufficient Conditions for the Emergence of Clustering, Consolidation, and Continuing Diversity. In G.A. Barnett and F.J. Boster (Eds.) *Progress in Communication Sciences,* Ablex Publishing Corporation.

Petty, R.E., Cacioppo, J.T., (1986). *Communication and persuasion: central and peripheral routes to attitude change.* New York: Springer Verlag.

Salzarulo, L., (2004). Formalization of self-categorization theory to simulate the formation of social groups. Paper presented at the second European Social Simulation conference, 16-19 September, Vallodalid, Spain.

Sherif, M. and C.I. Hovland (1961), *Social Judgment.*Yale University Press, New Haven, CT.
Weisbuch, G., G. Deffuant, F. Amblard, F. and J.-P. Nadal (2002). Meet, discuss and segregate!. *Complexity, 7(3)*, 55-63.