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Social judgment theory based model on opinion formation, polarization and evolution

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HIGHLIGHTS

- We introduce a model of opinion formation with opinion polarization.
- The rules of our model are consistent with the social judgment theory.
- We study the dynamics of this model by simulations and mean-field analysis.
- The model shows opinion clustering and opinion polarization.
- We prove that punctuated equilibria in opinion can occur in a complete network.

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ABSTRACT

The dynamical origin of opinion polarization in the real world is an interesting topic that physical scientists may help to understand. To properly model the dynamics, the theory must be fully compatible with findings by social psychologists on microscopic opinion change. Here we introduce a generic model of opinion formation with homogeneous agents based on the well-known social judgment theory in social psychology by extending a similar model proposed by Jager and Amblard. The agents' opinions will eventually cluster around extreme and/or moderate opinions forming three phases in a two-dimensional parameter space that describes the microscopic opinion response of the agents. The dynamics of this model can be qualitatively understood by mean-field analysis. More importantly, first-order phase transition in opinion distribution is observed by evolving the system under a slow change in the system parameters, showing that punctuated equilibria in public opinion can occur even in a fully connected social network.

1. Introduction

Opinion formation and evolution are interesting and important subjects of research in social psychology. Many experiments and theories have been conducted and proposed [1,2], including the elaboration likelihood model, the heuristic–systematic model and the cognitive dissonance theory. In particular, Sherif et al. proposed the well-known social judgment theory (SJT) [1–4] in the 1960's to explain the microscopic behavior of how individuals evaluate and change their opinions based on interaction with others.

The basic idea of SJT is that attitude change of an individual is a judgmental process. According to SJT, describing the stand of an individual as a point in a continuum of possible opinions is not adequate because the individual's degree of tolerance is also important in determining his/her response to external stimuli and persuasion [3,4]. In particular, a presented opinion

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is acceptable (unacceptable) to a person if it is perceived to be sufficiently close to (far from) his/her own stand point. This presented opinion is said to be in his/her latitude of acceptance (rejection). A presented opinion is neither acceptable nor objectable if it is perceived to be neither close to nor far from the individual's own stand point. This opinion is said to be in his/her latitude of noncommitment. Clearly, these three latitudes differ from person to person and they depend on factors such as individual's ego involvement and the person's familiarity of the subject of discussion [1–4]. When the presented opinion is in one's latitude of acceptance (rejection) or perhaps also in the nearby latitude of noncommitment, assimilation (contrast) occurs in the sense that the presented opinion is perceived to be closer to (farther from) one's stand point than it truly is. Moreover, this positively-evaluated (negatively-evaluated) opinion may cause the person to move his stand point toward (away from) it. The greater the difference between the individual's and the presented opinions, the more the resultant attitude change in general. The phenomenon of moving away from the presented opinion through contrast is called the boomerang effect [1–4]. The opinion change due to boomerang effect, however, is generally smaller than the opinion change induced by assimilation. Thus, not every psychological experiment unambiguously shows its existence [2], making it perhaps the most controversial part of the SJT. In fact, some social psychologists do not consider the boomerang effect to be one of the core thesis of SJT and some even cast doubt on its existence [1]. Here we adopt the view that the boomerang effect is one of the central themes of SJT whose effect, in general, is rather weak in comparison to the opinion change due to assimilation. Finally, whenever the presented opinion is in the person's latitude of noncommitment which is not close to his/her latitudes of acceptance or rejection, then there is little chance for him/her to change his/her mind. Consequently, the most effective method to successfully persuade an individual is to present the opinion near the boundary of his/her latitudes of acceptance and noncommitment [2]. And just like most theories in social science, the above findings should be interpreted in statistical sense rather than as definitive rules governing every single persuasion and discussion [1–4]. Thoroughly studied and advanced by social psychologists, SJT is one of the most important theories in the field and is strongly supported by many psychological experiments especially concerning the latitudes of acceptance and noncommitment [2–6].

Recently, physical scientists entered this field by studying the more macroscopic aspects of the problem such as opinion formation and evolution in a social network using simple models and computer simulations [7]. The variety of models proposed include the use of discrete or continuous opinions, discrete or continuous time, homogeneous or heterogeneous agents, fully connected or more realistic social networks [7–27]. Of particular importance is the continuous opinion agent-based model in a fully connected network introduced by Deffuant et al. (D–W Model) with the feature that players only have latitudes of acceptance and noncommitment so that only the effect of assimilation is considered [9,11]. The appeal of this model is that it can be simulated efficiently by computers and its dynamics can be qualitatively understood. This model is also consistent with the social psychologists' finding that opinions can be reasonably well represented and measured as a continuum [12,28]. However, the absence of contrast and boomerang effect implies that D–W Model cannot be used to simulate opinion polarization in the real world in which opinions of the supporters of very different viewpoints become much more extreme.

Various modifications of the D–W Model have been proposed [15–21,23–27,29–31]. To account for opinion polarization, some modified this model by introducing inflexible or contrarian players [20,23,24,26,29–31], stochastic boomerang effect in the region of assimilation [19,25] and vector-valued opinions [25]. These models are not fully compatible with the SJT as the agents' response in the latitude of rejection due to contrast are not properly treated. This is not ideal because in order to understand the macroscopic origin of opinion formation and polarization, one should combine the strengths of social psychology and physical science communities by introducing D–W-based models of opinion evolution whose rules are consistent with SJT. In fact, this approach is beginning to gain acceptance among social psychologists [32]. Actually, the only SJT-based models we aware of are the ones proposed by Jager and Amblard (J–A Model) [15] and its recent extension by Crawford et al. [27] as well as the model of Huet et al. [16]. Jager and Amblard studied their model only by Monte Carlo simulation with very limited sample and agent sizes [15]. The work of Crawford et al. was more extensive, which included a simple analysis on eventual opinion distribution of the agents [27]. Note that both the models of Jager and Amblard [15] and Crawford et al. [27] involved agents with opinions on one issue only. In contrast, the model of Huet et al. [16] studied the response of agents based on their opinions on two issues by Monte Carlo simulation up to 5000 agents.

While these works [15,16,27] point to the right direction, we argue in Section 2 that the microscopic rules adopted in their models are questionable. Here we first proposed a minimalist SJT-based model of opinion formation by extending the J–A Model in Ref. [15]. This minimalist model is free of the questionable assumption implicitly used in Refs. [15,16,27]. Then in Sections 3 and 4, we report that our minimalist model is simple enough to be studied both semi-analytically and numerically, and at the same time refined enough to show opinion polarization even in the case of homogeneous agents. By studying the agents' dynamics in Section 4, we can understand the process of opinion clustering. In particular, using a simple mean-field analysis, we find that the most important parameters to determine the formation of extreme opinion clusters as well as the coexistence of both extreme and moderate opinion clusters are the values of two parameters d_1 and d_2 to be defined in Section 2 which determine the widths of the regions for assimilation and boomerang effect to occur. Our analysis also shows that other factors such as network topology, agent's heterogeneity, and the detailed response dynamics due to assimilation and boomerang effect chiefly affect the opinion formation timescales. More importantly, we find in Section 5 that first-order phase transition in opinion clustering can occur occasionally when the widths of the assimilation and boomerang effect regions change very slowly. This shows that punctuated equilibrium in opinion distribution – the observation that opinion distribution change often comes in a short burst between a long period of stasis, a notion first pointed out by Gould and Eldredge [33] in evolution biology – can occur even in a fully connected network, repudiating