Phase transitions in the q-voter model with independence on a duplex clique

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We have generalized the q-voter model with independence (noise) p [1] for duplex cliques. This kind of a network consists of two distinct levels (layers), each of which being represented by a complete graph (clique) of size N. Levels represent two different communities (e.g. Facebook and the school class), but composed of exactly the same people which means that each node possesses a counterpart node in the second level. Such an assumption reflects the fact that we consider fully overlapping levels, being an idealistic scenario. We also assume that each node possesses the same state on each level which means that the examined society consists only of non-hypocritical individuals. We consider two criteria of level dependence – first related to the peer pressure (AND and OR) and the second to the status of independence (GLOBAL and LOCAL). AND dynamics is more restrictive and node changes its state only if *both levels* suggest changes, in the OR version *one level* is enough to change individual's state. For GLOBALdynamics agent is independent on both levels, whereas in the LOCAL case the person might be independent in one clique and not in the other. For all considered rules (GLOBAL&AND, GLOBAL&OR and LOCAL&AND), the system undergoes continuous order-disorder phase transition at $p = p_c(q)$ for $q < \widetilde{q}$ and discontinuous for $q \geq \widetilde{q}$, where p_c and $\widetilde{q}$ are rule-dependent. GLOBAL&AND rule leads to a trivial result identical with the monoplex case for a doubled value of q. For GLOBAL&OR dynamics p_c is larger than for the monoplex network but q, for which the transition switches from continuous to discontinuous, is identical with monoplex case, i.e. $\widetilde{q} = 6$. In contrast to other rules, we find a qualitative change for LOCAL&AND as the phase transition becomes discontinuous for $\widetilde{q} = 5$. The case of LOCAL independence is not only less trivial, but also the most interesting from the social point of view. It should be remembered that conformity (and simultaneously independence) is relative, i.e. individuals always conform in respect to the particular social group and there are many factors that influence the level of conformity. It means that the same individual may conform to one group and behave independently in respect to another. Therefore the idea of local independence is highly justified in modeling social systems.

[1] P. Nyczka et al. Phys. Rev. **E86**, 011105 (2012).