Artículos

The Cohesion of National and Cultural Networks during Periods of Stress*

Cohesión de redes nacionales y culturales durante periodos de estrés

A coesão das redes nacionais e culturais em períodos de estresse

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Abstract:

Human beings tend to organize themselves in groups. These groups need to be robust to enable effective cooperation among individuals. According to some researchers (Ostrom, 1990; Suárez et al., 2011), a collective group identity based on shared cultural symbols, a shared religion or a common language is key to foster cooperation. To investigate this hypothesis, data was extracted from Twitter and two network graphs (the nodes were Twitter users and the links were the relationships among users) were created around two Spanish political parties during the 2017 Catalan elections, Ciudadanos and Podemos. On the one hand, the members of Ciudadanos' network shared ideological positioning and cultural collective identity (they identified themselves with Spanish cultural symbols). On the other hand, Podemos' members in the network shared ideological positioning but not a cultural identity (some of Podemos' users identified with Catalan symbols and others with Spanish symbols). The results of different network cohesion metrics (e.g., Clustering Coefficient and Average Distance) show that Ciudadanos' network was more cohesive than Podemos' one.

Keywords: social networks, collective identity, cohesiveness, Catalan elections.

Resumen:

Los seres humanos tienden a organizarse en grupos. Estos grupos deben ser sólidos para permitir una cooperación eficaz entre los individuos. Según algunos investigadores (Ostrom, 1990; Suárez et al., 2011), una identidad colectiva de grupo basada en símbolos culturales compartidos, una religión compartida o una lengua común es clave para fomentar la cooperación. Para investigar esta hipótesis, se extrajeron datos de Twitter y se crearon dos grafos de red (los nodos eran los usuarios de Twitter y los enlaces las relaciones entre usuarios) en torno a dos partidos políticos españoles durante las elecciones catalanas de 2017, Ciudadanos y Podemos. Por un lado, los miembros de la red de Ciudadanos compartían posicionamiento ideológico e identidad cultural colectiva (se identificaban con símbolos culturales españoles). Por otro lado, los miembros de Podemos en la red compartían posicionamiento ideológico, pero no identidad cultural (algunos de los usuarios de Podemos se identificaban con símbolos catalanes y otros con símbolos españoles). Los resultados de diferentes métricas de cohesión de la red (por ejemplo, el coeficiente de agrupación y la distancia media) muestran que la red de Ciudadanos estaba más cohesionada que la de Podemos.

Palabras clave: redes sociales, identidad colectiva, cohesión, elecciones catalanas.

Resumo:

Os seres humanos tendem a se organizar em grupos. Esses grupos devem ser sólidos para permitir uma cooperação eficaz entre os indivíduos. De acordo com alguns pesquisadores (Ostrom, 1990; Suárez et al., 2011), uma identidade coletiva de grupo baseada em símbolos culturais compartilhados, uma religião compartilhada ou uma língua comum é chave para fomentar a cooperação. Para pesquisar essa hipótese, extraíram-se dados de Twitter e criaram-se dois grafos de rede (nós eram os usuários de Twitter e Links os relacionamentos entre usuários) em torno de dois partidos políticos espanhóis durante as eleições catalãs de 2017, Ciudadanos e Podemos. Por um lado, os membros da rede de Ciudadanos compartilhavam posicionamento ideológico e identidade cultural coletiva (identificavam-se com símbolos culturais espanhóis). Por outro lado, os membros de Podemos na rede compartilhavam posicionamento ideológico, mas não identidade cultural (alguns dos usuários de Podemos identificavam-se com símbolos catalães e outros com símbolos espanhóis). Os resultados de diferentes métricas de coesão da rede (por exemplo, o coeficiente de agrupamento e distância média) mostram que a rede de Ciudadanos estava mais coesa que a de Podemos.

Palavras-chave: redes sociais, identidade coletiva, coesão, eleições catalãs.

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Introduction

The study of networks has been useful to study organizational features in different settings. A network or graph is a set of items that are called nodes or vertices, and connections among them are called links or edges (Newman, 2003). In the case of a social network (i.e., a network in which human beings intervene), there are several aspects that might be worth studying such as the nature of the individual components, their connection or, more relevant for this study, connection patterns within the network (Newman, 2010). These patterns are often studied through visual pattern recognition, but when the network is larger and more complex, they are evaluated through metrics.

In this study we will be delving into the topic of community cooperation that is pivotal to overcome difficult situations through the study of network features and its metrics. Specifically, we will study the cultural networks that arose from different cultural communities in Twitter during 2017 Catalan elections. These elections were very polarizing since although illegal, the independence of Catalonia was being pursued by some pro-independence political parties. With these events arose the problem of collective identity and groups were formed seeking cooperation and mobilization of the electorate during the elections. Therefore, this research intends to study the group configuration and cooperation of two different groups, one with a clear collective cultural identity (and thus, clear group membership) and the other with a more diffuse identity through network metrics.

Related Work

In order to study cooperation within a large group, literature about cooperation, networks in Twitter (since this is the social media data is extracted from) and the political Catalan landscape need to be reviewed.

Communities and Cooperation

Human beings are social animals. Although other animals such as bees might also be social, humans are unique in the diverse ways they cooperate (Tomasello, 2014) and the nuanced features involved in their cooperative exchanges including language, conformity (Asch, 1956), rules and social norms (Axelrod, 1986; Crowdford & Ostrom, 1995), indirect speech (Pinker, 2007), moral norms (Haidt, 2012) among others. Through game theory experiments, pro-social behaviors such as cooperation, generosity (with some conditions and limits (Deltona et al., 2011)) and social learning have been shown to be intelligent strategies to survive (as individual and as a group) from an evolutionary perspective (Dawkins, 1989; Schlag, 1998).

Cooperation is fostered under certain circumstances and damaged under others (Barclay, 2013). An effective way to enhance collaboration among individuals is to create groups. These groups intend to take care of the free rider problem, namely, to take the benefits of cooperative exchanges without contributing (Delton et al., 2012) through continuous cooperation (Takezawa & Price, 2010). This stability allows for repeated interactions among members of a group and so, individuals who unfairly take advantage are punished, excluded from the group and future free-riding behavior is deterred (Price et al., 2002; Tooby et al., 2006). The objective of group creation should be then, to make cohesive groups that enable a sense of belonging fostering cooperative exchanges and preventing free riding.

Groups are often created around reputation, loyalty (e.g., for loyalty in online communities (Hamilton et al., 2017)), direct and indirect reciprocity (Nowak, 2006) and homophily, namely, the tendency of individuals to associate with other individuals with whom they share similar characteristics or attributes (McPherson et al., 2001). From a different branch of research, namely, Organizational studies and behavioral

sciences, there are several theories on how (especially small and medium) groups such as firms or a group of friends are formed. According to the aspects emphasized in group formation, theories might stress spatial proximity according to Propinquity Theory (Festinger, 1950), common interactions, activities and sentiments according to the theory of social behavior (Homans, 1958), a shared goal according to balance theory (Rodrigues & Newcomb, 1980) or a short-term calculous of cost-reward according to exchange theory (Thibaut & Kelley, 1960). However, since these groups tend to be small or medium, they have less of a free-rider problem and thus they might not be helpful in explaining how large groups are created and sustained.

As mentioned above, as groups grow larger and coordination problems grow, homophily and reputation are not enough to create robust and stable groups (Traulsen & Nowak, 2006). Humans have a limited capacity to remember faces (Jenkins et al., 2018) and thus in large groups it is very complicated to keep track of reputation. Moreover, the human brain can only handle a maximum number of individual stable relationships at a time (Dunbar, 1992; Dávid-Barrett & Dunbar, 2013; Gonçalves et al., 2011). Lastly, since cooperation networks endogenously emerge based on reputation and other parochial heuristics, the growth of groups (which makes useless these heuristics) leads to fission dynamics (Gross & Dreu, 2019).

These factors that should preclude large group cooperation contradict the fact that large-group cooperation (i.e., organized collective actions) often work in achieving their objectives, and frequently with no top-down violent coercion. Specifically, successful collective actions might be the management of common-pool resources (such as irrigation systems in India (Bardhan, 2000)), local environmental control (Cardenas et al., 2000) or environmental cooperatives (Morrow & Watts, 1996). These experiences and others exhibit the chance of large-scale cooperation with a set of principles that need to be substantially more complex strategies to cope with the difficulties mentioned before.

To overcome the hurdles and make the cooperation successful, some principles of group cooperation and group configuration need to be addressed. These principles (such as decentralized monitoring, the use of gradual sanctions for misbehavior among others) first proposed by Ostrom (1990), have been empirically tested and their validity confirmed (Bardhan, 2000). In this work we will address the first design principle, namely, clear group boundary rules (the knowledge of who is in and who is out of the set of relationships).

For coordination to happen, there needs to be different layers of cooperation to make cooperation economically advantageous (design principle 8 (Ostrom, 2000)). States, nations, cities, non-governmental organizations or neighborhoods are examples of associations with different levels of engagement. Every organizational level has its own commitments (e.g., military recruitment for the state or the nation or radical activism for non-governmental organizations) and at every level there needs to be a clear understanding of group boundary. Membership of a certain group is often "marked by symbolic boundaries and involve complex rituals and beliefs that help solidify individual beliefs about the trustworthiness of others" (Ostrom, 2000, p. 149). In other words, common cultural symbols, a shared religion, shared myths, a common language create a sense of belonging (especially in very large groups such as states or nations) that enables group cooperation and constitutes a cultural community.

From Organizational studies, Institutional Theory poses that institutionalized norms, ceremonies, rites and obligations are the key to maintain the stability of a group (Greve & Argote, 2015; Meyer & Rowan, 1977). According to the thesis supported herein, this would be a suitable explanation for large group formation. However, in this study this would not be relevant since (as we will see later sections) both groups studied here (Ciudadanos and Podemos as political organizations) share the same institutional rules from the same region, Catalonia. Consequently, this feature cannot account for a difference in cohesion between these two groups in this particular case.

From the field of politics, more modern research has tackled some of these topics to explain larger groups partly with related explanations. Some researchers on Populism or Marxism theorize that groups or large-sized movements are created based on opposition to some other group (Acemoglu et al., 2013; Von Beyme, 1985). This opposition group might be corrupt elites or the privileged class respectively. These frameworks

are closely interrelated and for some of the main theorists of populism, the populist revolution could bring about a socialist revolution (Retamozo, 2017). This could imply (at least in the branch of populism that asserts that large-sized movements could be created only based on the negative) that no evident markers should be needed to create large-sized groups since everyone except for a corrupt minority would be part of the "common people". Nevertheless, it has been seen in both populist (Venezuela) and communist (USSR) revolutions, that they end up resorting to national identities or common religions to sustain or enhance the sense of unity of large groups and enables the distinction of member or non-member of the group.

In this research paper, we will be focusing on cohesion of large groups based on visible group characteristics that helps identify a cultural community. Throughout history many cultural communities have been able to cope with periods of great stress by cooperating and further integrating. As mentioned before, this was possible by forces such as religion (Suárez et al., 2011), ethnicity (Nagel, 1994) or language that fostered a sense of collective identity. Although these topics have been studied in previous literature, the focus on the field has been the interplay of these factors in the creation of a single national state level collective identity (Piacentini, 2019). In the present work, the national identities within state and regional borders were studied in the context of the 2017 Catalan elections. In these elections, there was a conflict between three groups, the Spanish cultural community, the Catalanist pro-independence group that considered itself as a separated cultural community even though they are legally Spanish and the group in between that felt both Spanish and Catalan. This created a suited scenario to study the characteristics of these communities and, its cooperation strategies through the study of their networks.

Networks in Twitter

The data of this study was extracted from Twitter. Twitter is a social media platform that enables users to express and communicate short 140 (now up to 280) character messages directly to followers, amplify a message via retweets (Kwak et al., 2010), reply to tweets, tag tweets with hashtags or mention another user in a tweet.

Social networks in this social media platform can be created considering the interactions that emerge from retweets (i.e., a user posts a tweet and another user re-posts it) or replies (i.e., a user's tweet is replied by another user). These networks have been studied for very different reasons. Twitter networks have demonstrated to be useful to study social and protest movements, their organizational structure and to analyze the robustness and evolution of their networks (Peña-Lopez et al., 2014; Yasseri & Cihon, 2016). Borge-Holthoefer et al. (2015) looked at polarization in Twitter during the Egyptian coup d'état in July 2013. The researchers followed the two sides of the conflict on Twitter and the results showed that there was little evidence of users switching sides. This type of studies is also useful to discern the origin of movements (starting nodes), interaction between nodes or network's cohesiveness and effectiveness.

Regarding politics and the networks created in Twitter due to political events, several studies have intended to predict election results based on Twitter network features created around different political parties (DiGrazia et al., 2013; Tumasjan et al., 2010). The study of Twitter political and cultural networks has also attracted attention because it might illustrate the behavior of these communities. Several researchers have explored more generally behavioral patterns, network characteristics of the political and cultural communities (Adamic & Glance, 2005; Suárez et al., 2015). Cultural and political networks that are densely-interconnected can spread information more effectively (Conover et al., 2021). This indicates that communities and networks that are more cohesive will have a more successful information spreading, and thus cooperation will be higher in these communities.

Spanish Political Context

Since Spain transitioned to democracy in 1975, the regional institutional power in Catalonia was mainly held by Catalanist (pro-Catalan) governments. However, Catalonia has traditionally been a region of Spain divided by its national identity: whereas around half of the population identifies with the Catalan culture and language (Serrano, 2013), the other half identifies primarily as Spanish or both Spanish and Catalan (Centre d'Estudis d'opinió, 2019). Besides the presented evidence of network studies in Twitter, there are sociological evidence that these cultural communities are hermetic, and that the Catalan cultural community has narrowed the definition of who belongs to the Catalan cultural community (Hamid et al., 2019, December 13). This has created defined boundaries for both the Catalan and Spanish cultural communities.

As events developed during 2017, tension grew higher in the political arena. Following the unconstitutional declaration of independence of Carles Puigdemont, the Generalitat' s president (i.e., autonomic government of the Catalan Region) in 2017, the autonomy of Catalonia was suspended, and new elections were called. The situation further escalated when several Catalan political leaders went to jail, and the political and economic uncertainty became more acute.

In this context, the activity of two national political parties in Twitter during this turbulent period were studied: Ciudadanos and Podemos. Ciudadanos is a party founded in 2005 and it was born as a response to Catalan Nationalism. Consequently, it is decisively against the independence and its electorate identifies more with Spanish cultural community. Podemos (We Can) is a radical left-wing party founded in 2014 as a response to the crisis. Since the beginning, Podemos' has shown a mixed cultural and national identity, some of Podemos supporters in Catalonia identifies as Catalan primarily and others identifies more with Spanish culture and symbols. (Sáinz, 2017, September 05)

Hypotheses

In this study two type of Twitter networks were studied: 1) retweet network based on retweets and 2) reply and mention (i.e., mixed) network based on replies to tweets and mentions. As mentioned before, since retweets are taken as endorsements of the original tweet (Conover et al., 2021; Guerrero Solé & Lopez Gonzalez, 2017), the users in this network should be supporters. The mixed networks should have both supporters and opponents since mentioning a candidate and highlighting a negative characteristic could easily appear on the data.

H1) Retweet network will have clear support patterns.

H2) Mixed network will have a less clear distinction between advocates and detractors.

If these hypotheses are validated, then supporters would be in the retweet networks. Since the key objective of the study was to test the hypothesis that a clear cultural identity enables cohesiveness and cooperation during stressful periods (Suárez et al., 2011), the community's cohesiveness should be observed at the retweet network. If it is the case, cohesiveness of 'Ciudadanos' network (which forms a clear cultural community and thus it has precise group boundaries) measured with the social network metrics of clustering coefficient and average distance will be larger than that of Podemos.

H3) 'Ciudadanos' retweet network (i.e., supporter community) will have higher cohesiveness than 'Podemos'.

Methodology

From the 10th of November until the 11th of February 2017, 4 million tweets related to Ciudadanos, Podemos and their main leaders in Spain and Catalonia (e.g., Inés Arrimadas, Xavier Domènech) were collected using

Twitter Streaming API[1,2]. The graphs considered users as the vertices and relationships among users that arose with either retweets, replies or mentions, were the edges. The users considered were both politicians and common users. The network data was processed with Neoj4 and Gephi (Bastian et al., 2009).

Specifically, two types of graphs were created:

Retweet Graph or Network: graph could be defined as $G^r(V^r, E^r)$ *where V^r w*ere the vertices or nodes (users) and E^r were the edges (retweets) that connected one vertex with another vertex. In the graph, $V^r = \{v_1^r, v_2^r, v_3^r... v_n^r\}$ were the set of users that were retweeted by another user or that actively retweeted a tweet from another user. In the graph, the directed edge e_{ij}^r indicated that user v_i^r retweeted v_j^r.

Mixed Graph: this graph has a very similar structure to the other graph where G^{mr} (V^{mr}, E^{mr}) denotes that graph, V^{mr} are the vertices (users) and E^{mr} are the edges (mentions or replies). In this graph, $V^{mr} = \{v_1^{mr}, v_2^{mr}, v_3^{mr}... v_n^{mr}\}$ denoted all the user in the network that either were replied or mentioned by someone or that replied or mentioned someone. The edge e_{ij}^{mr} connected the user v_i^{mr} that mentioned or replied to the user v_j^{mr}.

In order to detect communities, an algorithm needs to be used. This algorithm would need to use modularity of a partition, which is a good measure of community quality and specifically measures density within the community compared to the links across communities. In the case of our weighted networks, it is defined as:

$$Q = \frac{1}{2m} \sum_{i,j} \left[A_{i,j} - \frac{k_i k_j}{2m} \right] \delta(c_i, c_j)$$

[Formula 1. Possible objective function]

where:

$A_{i,j}$ is the weight of the edge between i and j

$k_i = \sum_j A_{i,j}$ is the sum of weights of the edges attached to vertex i

c_i is the community to which vertex i *is* assigned

$\delta(\mathbf{c_i},\mathbf{c_j})$ *equals to* 1 *if community of* i and community of j is the same *and 0 otherwise*

$$m == \frac{1}{2} \sum_{i,j} A_{i,j}$$

This could be set as an objective function to optimize and obtain the optimal solution, but it is computationally too hard (Blondel et al., 2008). Consequently, approximation algorithms need to be used. The one frequently used in research and used by Gephi is the Louvain method (Aragón, et al., 2013). This algorithm works in two phases: in the first phase all nodes are considered to be its own community. Then, for each node i, the neighbours j of i are considered and the gain in modularity that would take place by removing i from its community and placing it in j community is considered. If the modularity is larger, changes are kept. This is applied for all n nodes until a local maxima is achieved. The gain in modularity is estimated by:

$$\triangle Q = \left[\frac{\Sigma_{in} + k_{i,in}}{2m} - \left(\frac{\Sigma_{tot} + k_i}{2m}\right)^2 \right] - \left[\frac{\Sigma_{tot}}{2m} - \left(\frac{\Sigma_{tot}}{2m}\right)^2 - \frac{k_i}{2m} - \right)^2 \right]$$

<div align="right">[Formula 2. Modularity gain estimation]</div>

The second phase builds a new network whose nodes are the communities found during the first phase. Finally, this process is repeated again until the best communities (according to the modularity of a partition criterion) is achieved (Blondel et al., 2008). Using this method, nodes were colored depending on the community they belonged to. This allowed the possibility of filtering a certain community and study its features (i.e., Ciudadanos' or Podemos' retweet network). Subsequently, in order to visually differentiate communities, the layout algorithm *Force Atlas 2* was used to separate communities (Jacomy et al., 2014)[3]. This made the display of visually differentiated communities possible.

Lastly, the network of Ciudadanos (represented with the color orange in the graph) and of Podemos (in purple) were extracted and its cohesion was measured using two metrics:

The clustering coefficient defined as the probability that two nodes within the same community or group are connected (Aragón, et al., 2013). The local clustering coefficient (for one node) is estimated (in a directed graph) by:

$$C_{i,i} = \frac{/\{e_{jk}\}: v_j, v_k \in N_i, e_{j,k} \in E/}{k_i(k_i-1)}$$

<div align="right">[Formula 3. Local clustering coefficient]</div>

Being:

$\{e_{jk}\} : v_j, v_k$ represents all actual edges between node j and the k nodes within N_i neighbors.

$K_i(k_i - 1)$: all possible edges that could exist for a certain node in a network

Finally, the network clustering coefficient is estimated as the average of the clustering coefficient:

$$CG = \frac{1}{N}\sum_i C_i$$

<div align="right">[Formula 4. Network clustering coefficient]</div>

The average distance or the number of steps required on average to connect two nodes with another in the same community (in this case) (Brandes, 2001).

$$l_G = \frac{1}{n*(n-1)}*\sum_{i\neq j}d(v_i, v_j)$$

<div align="right">[Formula 5. Average distance]</div>

Where

$d(v_i, v_j)$: shortest distance between v_i and v_j
n: the number of nodes

Results

Retweet Network

In the whole picture, three clear communities were identified after applying the Louvain method and the Force Atlas2 algorithm. The clearest one was Ciudadanos's (whose color in the graph is orange) whose nodes clustered in the same area. Additionally, Podemos was another community (purple in the graph). This community also showed some integration with the exceptions of Diego Cañamero and Albano Dante-Fachin, both closer to pro-independence positions than the rest of Podemos (figure 1).
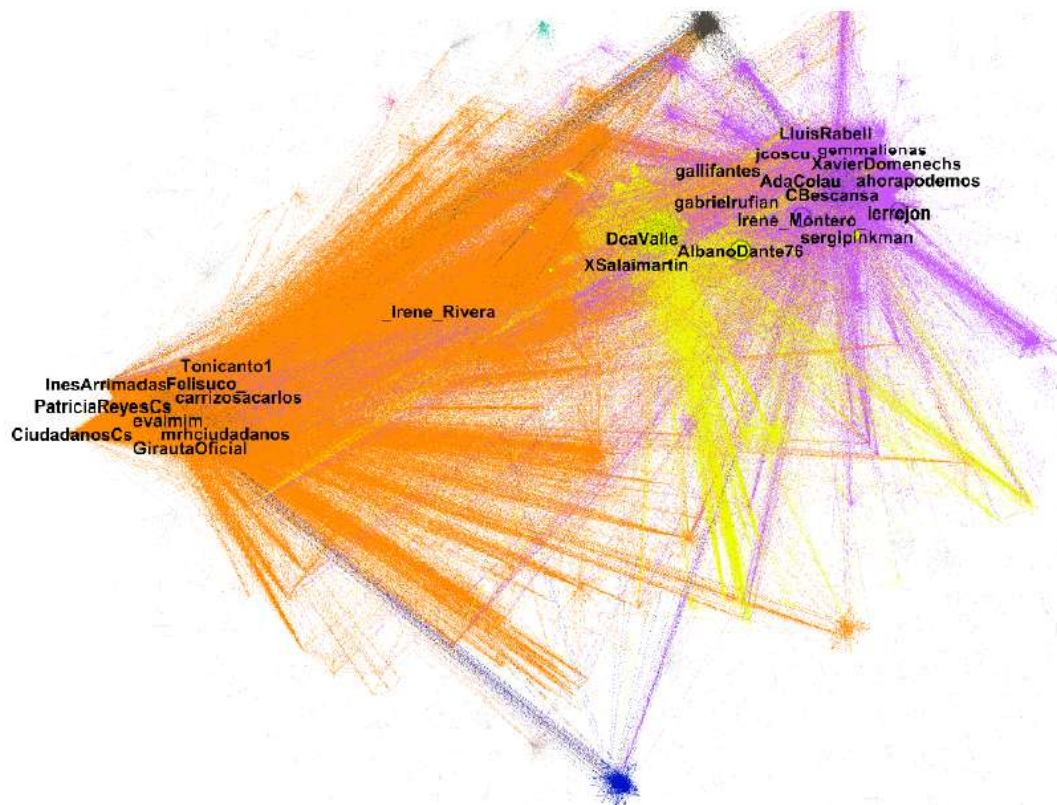

FIGURE 1
Spanish and Catalonia politicians' retweet graph; Resolution set at 5
Source: Own work (Monroig, 2018).

The last detected community was pro-independence politicians and users (colored as yellow). In general, this shows that the algorithm could easily differentiate communities in the retweet network and that all supporters tended to cluster together. Consequently, Hypothesis 1 is confirmed. Moreover, the retweet network could be thought of as the network whose members share some political ideas and are more or less integrated.

Mixed Network

As can be easily seen, the mixed network, that included both mentions and replies, was much more diffused. This shows that in this network there are both supporters and opponents of the politicians. Moreover, nodes

that share party and/or political orientation are often in different communities (e.g., Ines Arrimadas and Carlos Carrizosa, both from Ciudadanos are in different communities) (figure 2).
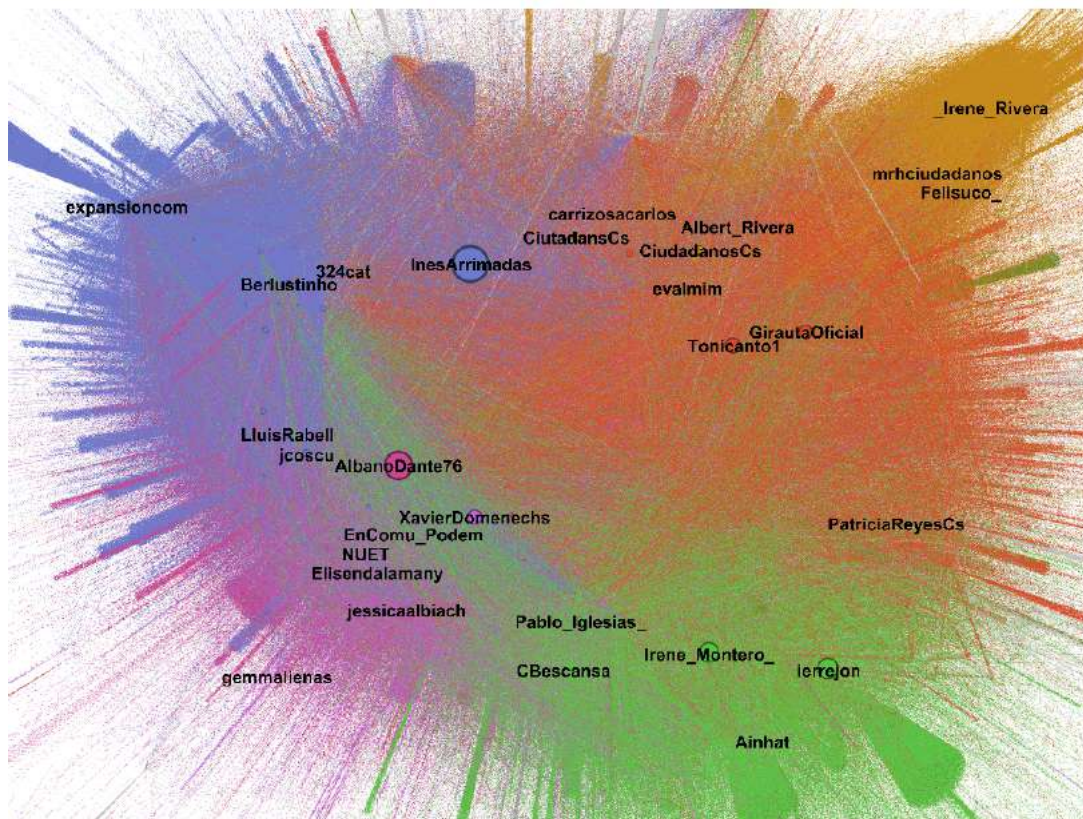

FIGURE 2
Spanish and Catalonia politicians' mixed graph; Resolution set at 5
Source: Own elaboration (Monroig, 2018).

All this would confirm hypothesis 2. Furthermore, it would also indicate that in order to study the cohesiveness of a certain community, it is the retweet network that should be looked at.

Community Cohesiveness

Since the objective of this study was to investigate whether a common culture and language are useful to increase cohesion and thus increase cooperation within a cultural community, only the supporter network was considered. This network could be understood as a group whose members (i.e., users) share some political ideas. However, even though they both share context in which the network emerged and cohesion around an ideology, Ciudadanos' had a clear cultural collective identity (most members of their network identified themselves as Spanish and most likely most spoke Spanish as their first language) and Podemos did not. Podemos was divided over the debate on the independence because part of this electorate identified with the Spanish cultural symbols and myths and the other part with the Catalan ones. Therefore, according to the theory, these facts should lead to Ciudadanos' network to be more integrated than that of Podemos.

As explained before, the metrics of the two communities checked were the clustering coefficient (CC) and average distance (AD). A higher CC would imply that the community has its nodes connected among them. In this line, a lower AD would mean that even though two nodes are not directly connected, information (in this type of networks) can be easily reach through other close nodes.

The results of the retweet graph confirmed the hypothesis: Ciudadanos had a lower average distance (4 vs 4,755), with the fact that they are more well connected within the network. Moreover, Ciudadanos' network had a higher clustering coefficient (0,162 vs 0,094) than Podemos'. This shows that it was more likely that the nodes of Ciudadanos' network were connected than that of Podemos' (Monroig, 2018).

These results mean that Ciudadanos' support network was more effective in the circulation of information and in the cooperation during the period of the study.

Discussion and Limitations

As discussed above, group integration and cohesiveness is helpful in periods of great stress where the survival of the group is being endangered due to natural catastrophes (Suárez et al., 2011), political tension and polarization or economic crisis since it fosters cooperation.

The findings of this study show that groups that form a cultural community tend to be more integrated and robust. In this case, Ciudadanos and Podemos were two political parties from which social networks in Twitter emerged. The nodes that belonged to the supporter network were part of the political community of one of either party. However, whereas Ciudadanos' network conformed a solid cultural network, Podemos did not. Consequently, Ciudadanos' network showed more cohesion (nodes were more closely interconnected). This might have influenced in Ciudadanos' growth in Catalonia (especially in regional elections) and might mean that the *supporter* network is better equipped to handle stressful periods as a robust single community.

In the political realm, populist theorists have hypothesized the end of the right-left divide. However, there seems to be a regrouping and creation of a new right and a new left. Laclau (2007) theorized that a necessary condition for populism to succeed is the creation of a clear demarcation between the group with unsatisfied social demands and the privileged. It seems to be what has been happening in the political realm with minority groups whose demands are supposedly unsatisfied such as women, indigenous people or Muslim people among others that have created the new left coalition. It is still a matter open to discussion whether this coalition will be stable or not. However, according to the theory considered in this paper, this wide group could be stable since it uses easily identifiable markers (such as gender, race or traditional religious clothes). The new right has its focus on traditional national identity which would include traditional cultural communities or a shared language. It is still an open question which of these two political coalitions will be better organized and will prevail.

Even though this study points to the conclusions mentioned before about the important role of language and visible markersin group stability, this research had some limitations. The users considered in the study were from Catalonia and Spain. Consequently, the party regional organization might have influenced the results of the cohesiveness metrics. For this reason, the metrics were calculated only considering the network of both parties from Catalonia and the results still hold. Additionally, the party of Podemos in Catalonia had internal problems which might have influenced not only the political leaders but also the electorate. Another possible limitation of this work was the prominence of cultural polarization in the debates which might have skewed the results. This influence then, might have made the cultural issue more important than usual and thus, making Ciudadanos network more active and connected. If that were the case and the study was carried out during a period when the debate over identity or culture was not predominant, cohesiveness of both communities should be indistinguishable or very similar. This line of research could be pursued to check further the validity of the results of this study.

In conclusion, the cohesiveness of the group has been shown to be facilitated by language and other external markers that helps identify a member and a non-member. This identification is a necessary (but not enough)

condition to have a stable and cohesive group and prevent free-riding. These evidences have implications for cooperation within stable political and cultural networks (Suárez et al., 2015).

References

Acemoglu, D., Egorov, G., & Sonin, K. (2013). A Political Theory of Populism. *Quarterly Journal of economics, 128*(2), 771-805. https://doi.org/10.1093/qje/qjs077

Adamic, L. A., & Glance, N. (2005). The Political Blogosphere and the 2004 U.S. Election: Divided they blog. *Proc. 3rd Intl. Workshop on Link Discovery (LinkKDD)*, 36-43. https://doi.org/10.1145/1134271.1134277

Aragón, P., Kappler, E. K., Kaltenbrunner, A., Laniado, D., & Volkovich, Y. (2013). Communication Dynamics in Twitter during Political Campaigns: The Case of the 2011 Spanish National Election. *Policy and Internet, 5*(2), 183-206. https://doi.org/10.1002/1944-2866.POI327

Asch, S. E. (1956). Studies of Independence and Conformity: I. A Minority of one against a Unanimous Majority. *Psychological Monographs: General and Applied, 70*(9), 1-70. https://doi.org/10.1037/h0093718

Axelrod, R. (1986). An Evolutionary Approach to Norms. *The American Political Science Review, 80*(4), 1095-1111.

Barclay, P. (2013). Strategies for Cooperation in Biological Markets, Especially For Humans. *Evolution and Human Behavior, 34*(3), 164-175. https://doi.org/10.1016/j.evolhumbehav.2013.02.002

Bardhan, P. (2000). Irrigation and Cooperation: An Empirical Analysis of 48 Irrigation Communities in South India. *Economic Development and Cultural Change, 48*(4), 847-865. https://www.journals.uchicago.edu/doi/abs/10.1086/452480

Bastian, M., Heymann, S., & Jacomy, M. (2009). Gephi: an Open Source Software for Exploring and Manipulating Networks [conferencia]. *Proceedings of the Third International ICWSM Conference* (pp. 361-362). Association for the Advancement of Artificial Intelligence. San Jose, Costa Rica.

Blondel, V., Guillaume, J., Lambiotte, R., & Lefebvre, E. (2008). Fast Unfolding of Communities in Large Networks. *Journal of Statistical Mechanics: Theory and Experiment.* https://iopscience.iop.org/article/10.1088/1742-5468/2008/10/P10008/pdf

Borge-Holthoefer, J., Walid, M., Darwish, K., & Weber, I. (2015). Content and Network Dynamics behind Egyptian Political Polarization on Twitter. *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW 2015)*, Vancouver.

Brandes, U. (2001). A Faster Algorithm for Betweenness Centrality. *Journal of Mathematical Sociology, 25*(2), 163-177. https://doi.org/10.1080/0022250X.2001.9990249

Cardenas, J. C., Stranlund, J. K., & Willis., C. E. (2000). Local Environmental Control and Institutional Crowding-Out. *World Development, 28*(10), 1719-1733. https://doi.org/10.1016/S0305-750X(00)00055-3

Centre d'Estudis d'opinió (2019). *Baròmetre d'Opinió Política.* 2a onada. http://www.rtve.es/contenidos/documentos/barometro_ceo_julio_2019.pdf

Conover, G., Ratkiewicz, F., Flammini, & Menczer. (2021). Political Polarization on Twitter. *Proceedings of the International AAAI Conference on Web and Social Media, 5*(1), 89-96. https://ojs.aaai.org/index.php/ICWSM/article/view/14126

Crowdford, S. E., & Ostrom, E. (1995). A Grammar of Institutions. *American Political Science Review, 89*(3), 582-600. https://doi.org/10.2307/2082975

Dávid-Barrett, T., & Dunbar, R. I. (2013). Processing Power Limits Social Group Size: *Proceedings. Biological sciences, 280*(1765), 20131151. https://doi.org/10.1098/rspb.2013.1151

Dawkins, R. (1989). *The Selfish Gene.* Oxford University Press.

Delton, A. W., Cosmides, L., G. M., E., T., & Tooby, J. (2012). The Psychosemantics of free Riding: Dissecting the Architecture of a Moral Concept. *Journal of Personality and Social Psychology, 102*(6), 1252-1270. https://doi.org/10.1037/a0027026

Deltona, A. W., Krasnowa, M. M., Cosmidesa, L., & Toobya, J. (2011). Evolution of Direct Reciprocity Under Uncertainty Can Explain Human Generosity in One-Shot Encounters. PNAS, 108(32). https://www.pnas.org/doi/full/10.1073/pnas.1102131108

DiGrazia, J., McKelvey, K., Bollen, J., & Rojas, F. (2013). More Tweets, More Votes: Social Media as a Quantitative Indicator of Political Behavior. *PLOS ONE, 8*(11). https://doi.org/10.1371/journal.pone.0079449

Dunbar, R. I. (1992). Neocortex Size as a Constraint on Group Size in Primates. *Journal of Human Evolution, 22*(6), 469-493. https://doi.org/10.1016/0047-2484(92)90081-J

Festinger, L. (1950). The Spatial Ecology of Group Formation. En S. S. L. Festinger, *Social Pressure in Informal Groups* (pp. 146-161). Stanford University Press.

Gonçalves, B., Perra, N., & Vespignani, A. (2011). Modeling Users' Activity on Twitter Networks: Validation. *PLoS ONE, 6*(8). https://doi.org/10.1371/journal.pone.0022656

Greve, H., & Argote, L. (2015). Behavioral Theories of Organization. En J. D. Wright, *International Encyclopedia of the Social & Behavioral Sciences* (pp. 481-486). Elsevier.

Gross, J., & Dreu, C. K. (2019). The Rise and Fall of Cooperation Through Reputation and Group Polarization. *Nature Communications, 10*(776). https://doi.org/10.1038/s41467-019-08727-8

Guerrero Solé, F., & Lopez Gonzalez, H. (2017). Government Formation and Political Discussions in Twitter: An Extended Model for Quantifying Political Distances in Multiparty Democracies. *Social Science Computer Review, 37*(1), 3-21. https://doi.org/10.1177/0894439317744163

Haidt, J. (2012). *The Righteous Mind: Why Good People Are Divided By Politics and Religion.* Pantheon Books.

Hamid, N., Pretus, C., & Sheikh, H. (2019, December 13). How Catalonia's Push for Independence has Scrambled Spanish Politics. *Washington Post.* https://www.washingtonpost.com/politics/2019/12/13/how-catalonias-push-independence-has-scrambled-spanish-politics/

Hamilton, W., Zhang, J., Danescu-Niculescu-Mizil, C., Jurafsky, D., & Leskovec, J. (2017). Loyalty in Online Communities. *Proceedings of the International AAAI Conference on Web and Social Media, 11*(1), 540-543. https://ojs.aaai.org/index.php/ICWSM/article/view/14972

Homans, G. (1958). Social Behavior as Exchange. *American Journal of Sociology, 63*(6), 597-606. https://www.jstor.org/stable/2772990

Jacomy, M., Venturini, T., Heymann, S., Bastian, M., & Muldoon, M. R. (2014). ForceAtlas2, a Continuous Graph Layout Algorithm for Handy Network Visualization Designed for the Gephi Software. *PLoS ONE 9*(6): e98679. https://doi.org/10.1371/journal.pone.0098679

Jenkins, R., Dowsett, A. J., & Burton, A. M. (2018). How Many Faces do People Know? *Proc. R. Soc. B, 285*, 20181319. https://doi.org/10.1098/rspb.2018.1319

Kwak, H., Lee, C., Park, H., & Moon, S. (2010). What is Twitter, a Social Network or a News Media? *Proceedings of the 19th International Conference on World wide web (WWW '10). Association for Computing Machinery,* New York, NY (pp. 591–600). https://doi.org/10.1145/1772690.1772751

Laclau, E. (2007). Ideology and post-Marxism. *Journal of Political Ideologies, 11*(2), 103-114. https://doi.org/10.1080/13569310600687882

McPherson, M., Smith-Lovin, L., & Cook, J. (2001). Birds of a Feather: Homophily in Social Networks. *Annual Review of Sociology, 27*, 415-444. https://doi.org/10.1146/annurev.soc.27.1.415

Meyer, J. W., & Rowan, B. (1977). Institutionalized Organizations: Formal Structure as Myth and Ceremony. *The American Journal of Sociology, 83*(2), 340-363. http://www.jstor.org/stable/2778293

Monroig, R. (2018). *Social Networks, Political Discourse and Polarization during the 2017 Catalan election.* https://ir.lib.uwo.ca/etd/5556

Morrow, E. C., & Watts, R. (1996). Donor-initiated common pool resource institutions: The case of the Yanesha Forestry Cooperative. *World Development, 24*(10), 1641-1657. https://doi.org/10.1016/0305-750X(96)00064-2

Nagel, J. (1994). Constructing Ethnicity: Creating and Recreating Ethnic Identity and Culture. *Social Problems, 41*(1), 152-176. https://doi.org/10.1525/sp.1994.41.1.03x0430n

Newman, M. (2003). The Structure and Function of Complex Networks. *SIAM Review, 45*, 167-256. https://doi.org/10.1137/S003614450342480

Newman, M. (2010). *Networks An Introduction.* Oxford University Press.

Nowak, M. A. (2006). Five Rules for the Evolution. *Science, 314*(5805), 1560-1563. https://doi.org/10.1126/science.1133755

Ostrom, E. (1990). *Governing the Commons: The evolution of Institutions for Collective Action.* Cambridge University Press.

Ostrom, E. (2000). Collective Action and the Evolution of Social Norms. *Journal of Economic Perspectives, 14*(3), 137-158. https://www.aeaweb.org/issues/130

Peña-Lopez, I., Congosto, M., & Aragon, P. (2014). Spanish Indignados and the Evolution of the 15M Movement on Twitter: Towards Networked Para-Institutions. *Journal of Spanish Cultural Studies, 15*(2), 189-216. https://www.doi.org/10.1080/14636204.2014.931678

Piacentini, A. (2019). State Ownership and "State-Sharing": The Role of Collective Identities and the Sociopolitical Cleavage between Ethnic Macedonians and Ethnic Albanians in the Republic of North Macedonia. *Nationalities Papers, 47*(3), 461-476. doi:10.1017/nps.2018.8

Pinker, S. (2007). The Evolutionary Social Psychology of Off-Record Indirect Speech Acts. *Intercultural Pragmatics, 4*(4), 437-461. https://doi.org/10.1515/IP.2007.023

Price, M. E., Cosmides, L., & Tooby, J. (2002). Punitive Sentiment as an Anti-Free Rider Psychological Device. *Evolution and Human Behavior, 23*, 203–231. https://www.cep.ucsb.edu/papers/freerider.pdf

Retamozo, M. (2017). La teoría del populismo de Ernesto Laclau: una introducción. *Estudios Políticos, 41*, 157-184. https://doi.org/10.1016/j.espol.2017.02.002

Rodrigues, A., & Newcomb, T. M. (1980). The Balance Principle: Its Current State and its Integrative Function in Social Psychology. *Revista Interamericana de Psicología, 14*(2), 85–136. https://psycnet.apa.org/record/1982-23513-001

Sáinz, J. (2017, septiembre 05). El "sí" ganará con un 72% y un 50% de participación si se celebra el referéndum. https://www.elespanol.com/espana/politica/20170904/244226382_0.html

Schlag, K. H. (1998). Why Imitate, and If So, How? *Journal of Economic Theory, 78*(1), 130-156. https://doi.org/10.1006/jeth.1997.2347

Serrano, I. (2013). Just a Matter of Identity? Support for Independence in Catalonia. *Regional & Federal Studies, 23*(5), 523-545. https://doi.org/10.1080/13597566.2013.775945

Suárez, J. L., Mcarthur, B., & Soto-Corominas, A. (2015). Cultural Networks and The Future of Cultural Analytics. *Proceedings of Culture and Computing.* Doi: 10.1109/Culture.and.Computing.2015.37

Suárez, J. L., Sancho-Caparrini, F., & Vásquez, S. (2011). The Potosí Principle: Religious prosociality fosters self-organization of larger communities Under extreme natural and economic conditions. *Literary and Linguistic Computing, 27*(1), 25-38. https://doi.org/10.1093/llc/fqr043

Takezawa, M., & Price, M. E. (2010). Revisiting "The Evolution of Reciprocity in Sizable Groups": Continuous Reciprocity in the Repeated N-Person Prisoner's Dilemma. *Journal of Theoretical Biology, 264*(2), 188-196. https://doi.org/10.1016/j.jtbi.2010.01.028

Thibaut, J. W., & Kelley, H. H. (1960). The Social Psychology of Groups. *Social Forces, 38*(4), 367-368.

Tomasello, M. (2014). The Ultra-Social Animal. *European Journal of Social Psychology 44*(3), 187-194. doi: 10.1002/ejsp.2015

Tooby, J., Cosmides, L., & Price, M. E. (2006). Cognitive Adaptations for n-person Exchange: The Evolutionary Roots of Organizational Behavior. *MDE Manage Decis Econ., 27*(2-3), 103-129. doi: https://doi.org/10.1002/mde.1287

Traulsen, A., & Nowak, M. A. (2006). Evolution of Cooperation by Multilevel Selection. *PNAS, 103*(29), 10952-10955. https://doi.org/10.1073/pnas.0602530103

Tumasjan, A., Sprenger, T. O., Sandner, P. G., & Welpe, I. M. (2010). Predicting Elections with Twitter: What 140 Characters Reveal about Political Sentiment. *Fourth International AAAI Conference on Weblogs and Social Media*. AAAI Publications.

Von Beyme, K. (1985). Karl Marx and Party Theory. *Government and Opposition, 20*(1), 70-87. http://www.jstor.org/stable/44483550

Yasseri, T., & Cihon, P. (2016). A Biased Review of Biases in Twitter Studies on Political. *Frontiers in Physics, 4*(34). https://doi.org/10.3389/fphy.2016.00034

Notes

*   Research Article
1   The keywords used in the queries of the API were the names of the candidates.
2   The leaders whose tweets were collected, and the number are reported in the appendix.
3   Force Atlas 2 is a layout algorithm that highlights community structure. It might help to better interpret how close two nodes and/or communities are.