Effects of the structure of personal networks in the social network of a cohort of students in transition from high school to university

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Abstract. In this paper, the normative transition of a cohort of secondary school students from Alcalá de Guadaíra who start college education in Seville is examined. The evolution of the students’ social network and the changes experienced in the composition and structure of their personal networks is analyzed. The longitudinal tracking was conducted over 17 months when respondents (n = 57) begin to distribute their time between the town in which they live and the city where they study, resulting in an increase in the frequency of commuting to the capital. This is one of the first studies collecting information from the personal networks of the members of a complete social network, and combining both personal and sociocentric indicators in the analysis. Through the models for the longitudinal analysis of social networks, using the RSIENA software, we found that the average betweenness of personal networks has a significant effect on the social network of students completing secondary education. The average betweenness also seems to influence the change rate in the sense of community with the city of residence. We conclude that the decoupling of relations, as well as active competition between multiple relationships, are two key mechanisms of changes in the structure of personal networks in the process of ecological transition.

Keywords: ecological transitions, commuting, personal networks, social networks, social networks longitudinal simulation, RSIENA.

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An ecological transition occurs when the position of a person in an environment is modified as a result of a change of role, context or both (Bronfenbrenner, 1977). Such transitions represent a change in the relationships’ pattern between the individual and the context. Consequently, these inflection points carry a risk or an opportunity.

The most widespread differentiation distinguishes between normative and non-normative transitions (Arnett, 2000, Connell & Furman, 1984, Ruble & Seidman, 1996). The former occurs to the entire population in certain evolutionary periods and / or at certain age, or they are linked to a planned itinerary institution. For example, large cohorts of individuals undergo through planned academic transitions, such as finishing primary or secondary education. On the contrary, non-normative transitions happen irregularly and are not experienced by everyone. For example, international immigration is a type of change that is only lived by a part of the population, and is irregular depending on the life cycle and socio-economic circumstances.

Such processes may have a different rate of change at the collective and individual levels (Seidman & French, 2004). Seidman and French (2004) analyzed the confluence of human development with normative ecological transitions in a longitudinal study with low-income urban adolescents. When students change schools, from primary to secondary school, their relationships with schoolmates, teachers and the family are transformed. In this case, the transition coincides with a critical evolutionary period. Although change constitutes a risk context, the presence of a group of peers - who are exposed to the same circumstances - can have a preventive value and, under certain conditions, become a context of opportunities and personal growth. Living a transition as part of a collective seems to delay slightly the changes experienced on a personal level.

In this paper, we depart from the assumption that changes in personal networks indirectly reflect the ecological transition experienced by individuals (Maya Jariego, 1999, 2006). In previous studies, we have evaluated the structure and composition of personal networks of people in geographic mobility, to describe individual psychological transformations. With a representative sample of a medium-sized city in the metropolitan area of Seville, we found an inverse relationship between the frequency of metropolitan displacements and the degree of structural cohesion of personal networks (Maya-Jariego & Holgado, 2015). In fact, in a cross-sectional survey with university students from the same city -a group characterized by being more mobile than the rest of the population- we obtained comparatively lower average centrality scores, with the exception of the
intermediation indicator (average betweenness) that was higher in the supposedly more mobile sample (Araya & Maya-Jariego, 2005; Maya-Jariego & Holgado, 2005).

Personal networks provide subjective information about the space of interpersonal relationships of the individuals. The complete social network, on the other hand, is intersubjective in character, analyzing the social interaction between a set of individuals in a given space. Centrality measures and the study of structural properties such as groupings and positions were developed almost entirely in the tradition of complete networks. A structural approach in the study of personal networks is relatively recent (McCarty, 2002). In this context, there are hardly any studies which examine the co-variation or co-determination of personal networks and complete networks, as we propose in this study. In the next section, we will explore the role of personal networks in the evolution of relationships in a cohort of students who finish their secondary education and, in a significant proportion, start their university studies.

In this empirical work, we combine two innovations. Using a longitudinal survey, we evaluate the ecological transitions (a) with structural indicators of networks and (b) at the individual and collective levels simultaneously.

**METHODS**

**Participants.** In a longitudinal study, we collected information on the social network of 69 students, who were in the last year of secondary school (Instituto Albero) in Alcalá de Guadaíra, a city in the metropolitan area of Seville (around 16 kilometers away from the capital). The second wave of data collection was conducted 17 months after the first interview, with a total of 57 respondents. In the first wave, 73 students completed the survey from a list of 77 students (94.8%). Four interviews were ruled out due to incomplete information. During the follow-up, 57 of the 69 final respondents of the first wave were surveyed, reaching 82.6 percent of the total. The first wave was made up of 31 male (44.9%) and 38 female (55.1%) students who live in Alcalá de Guadaíra, and who mostly have the expectation of living in Alcalá (36.2%) or Seville (37.7%) in the future. In the second wave there were 27 males (47.4%) and 30 females (52.6%).

**Instruments.** In both waves, information was collected on the social network of friends and acquaintances in the student cohort analyzed, individual personal networks, information on metropolitan mobility patterns, data on the distribution of time between
locations and demographic data (with n = 69 in the first wave and n = 57 in the second, in all cases).

**Social network.** Each respondent reviewed the list of the 77 enrolled in the last year of their school, indicating in each case the relationships they had with each of them. This list is an exhaustive procedure for collecting information that allows obtaining a broader number of relationships, including the weakest links. For each name, the respondents indicated the type of relationship: (1) "I am familiar with his/her name", (2) "I know him/her", (3) "we speak from time to time", (4) "we know each other " or (5) "we are friends". Although in other analysis we have worked with valued relationships (Maya-Jariego, Lubbers & Molina, in progress), in this case we dichotomized the network in two ways to analyze the network of acquaintances (≥ 2) and the network of strong ties (≥ 4). Finally, the network of acquaintances is based on 3,969 loops observed in t1 (n = 69) and 2,796 in t2 (n = 57).

**Personal networks.** The evaluation of the structure of personal networks proposed by McCarty (2002) was followed, establishing a fixed number of alters (or list of usual interpersonal contacts). In this case, a list of 45 alters and their mutual relationships was generated in each interview. As a generator of names, the Arizona Social Support Interview Schedule (ASSIS) originally designed by Barrera (1980) was used. Once the first list of names was obtained, which varied between approximately 10 and 15 alters (M = 12.55, SD = 4.59), participants were asked to complete the list until they obtained 45 names in total, mentioning people with whom they had a frequent relation. For each alter, the respondents indicated the place of residence (Alcalá, Seville or another city) and the type of relationship (distinguishing between relatives, friends, acquaintances, classmates, neighbors and "others").

A basic definition of the centrality indicators used in this article can be found in McCarty (2002). In this study, we will focus on the intermediation indicator (betweenness). Nodal intermediation centrality is the number of times a node bridges the shortest paths between pairs of actors (Freeman, 1977). The nodes that appear frequently between geodesic paths have high intermediation and usually integrate different modules or parts of the network. As a summary indicator, we used the average of the individual intermediation indicators, which generically reports on the degree of modularity of the personal network.
Metropolitan mobility and socio-demographic aspects. The survey was completed with demographic data with a focus on aspects related to geographical mobility. The respondents indicated the frequency of trips between Alcalá and Seville choosing between "less than once a month", "once a month", "once a week", "five times a week" and "once a day". They were also asked to indicate, taking as reference an ordinary week, how they distributed the 100 percent of their weekly time between the two cities.

Sense of community. Interaction with neighbors and place attachment are basic dynamics of urban integration (Gómez-Jacinto & Hombrados-Mendieta, 1992, Sánchez-Vidal, 2001, Valera, 1997). In this study, we applied the Sense of Community Index of 12 items (Chavis, Hoge, McMillan & Wandersman, 1986), which in previous studies we have used with international immigrants (Domínguez & Maya-Jariego, 2008) and with a population in a situation of metropolitan mobility (Maya-Jariego & Armitage, 2007). As with the original, the Spanish version of the scale allowed us to evaluate the factors of belonging, influence, satisfaction of needs and shared emotional connection (Maya-Jariego, 2004, McMillan & Chavis, 1986). In this case, it was administered in duplicate, referring to the place of residence (Alcalá de Guadaíra) and to the capital city in which the respondents tend to attend their university studies (Seville). A reliability of 0.572 (t1) and 0.540 (t2) was obtained in the version referred to Alcalá; and of 0.574 (t1) and 0.508 (t2) in Seville. They are indicators that are only slightly below the usual range with this instrument, partly because of the relatively small size of the sample.

Data analysis. The 57 matrices of personal networks were analyzed with Ucinet 6 (Borgatti, Everett & Freeman, 2002). The matrices of complete networks in the two observation waves were also examined with Ucinet 6 to derive descriptive indicators and graphically represented with Visone 2.8 (Brandes and Wagner, 2004). Both the survey data and the indicators of personal and social networks were analyzed with SPSS 22. Finally, the longitudinal analysis of social networks was carried out with RSIENA (Snijders, 2001, 2005). RSIENA is based on a multinomial probability model for the creation and dissolution of social relationships within a group of actors. Specifically, it simulates the evolution of a complete network from the first observation of the network, based on a theoretical model of change. The theoretical model is composed of different functions. On the one hand, the rate function specifies which actors are more likely to
change their relationships. Second, the evaluation function specifies which relationships are more likely to change depending on each specific actor. Both functions are similar to regression functions, and include effects and parameters. The effects can be structural or related to the attributes of the actors. The parameters are estimated by comparing an iterative simulation process with the consecutive observations of the network. The model also allows the analysis of the mutual dependence of the evolution of the network and the behavior of the actors (Snijders, 2001, 2005, for an introduction in Spanish see De Federico, 2005, Maya-Jariego & De Federico, 2006).

RESULTS

Moving to a metropolitan lifestyle

In just one year and a half, students surveyed experienced significant changes in their lives, both individually and collectively. As a starting point, it is a homogenous group of 17-year-olds (M = 17.2, SD = 0.66), who live with their parents and who have lived all their lives in the same city. Seventeen months after the first interview, more than half of them started their university studies (56.4%), mostly at the University of Seville or at the Pablo de Olavide University, also in Seville. As a result, their visits to the capital became more frequent and they spend comparatively more time in Seville.

In the first wave, respondents travelled less than once a week to Seville (91.3%), while in the second observation more than half travelled five or more times per week to the capital (56.5%). As a whole, they spend almost all their time in their place of residence (86.9%), between Alcalá (63.4%) and Seville (36.6%).

These changes evolved similar to others, as for instance, community identification. In the first interview students identified more with Alcalá (M = 31.74, DT = 4.88) than with Seville (M = 27.31, SD = 4.75) (t = -5.261, p <.0001). The same is observed in the second wave. The difference between Alcalá (M = 29.69, SD = 4.72) and Seville (M = 27.94, SD = 4.36) is significant (t = -2.215, p <.0049). However, the identification with the city of residence decreases in a statistically significant way if we compare the first and the second observation (t = 2.776, p <.007).
Changes in the social network and personal networks

In terms of the complete network, the end of secondary studies initiates a gradual process of separation of relations (Maya-Jariego, Lubbers & Molina, in progress). Students who have shared the same schooling space for years during their secondary education in their school, are separated in different relationship contexts. One group starts their university studies, while others do not pursue their studies or repeat the course. Moreover, those who go to university are separated into the different faculties, in different campuses or even in different universities. This process started precisely between our two observations. However, in the evolution of the complete network, the rate of change seems slower than the one we have described comparing the variables (above) that reflect the new metropolitan lifestyle.

The network of acquaintances increases slightly in density and in the average centrality between both observations. Specifically, the density goes from 0.846 to 0.876, and the average degree from 58.368 to 60.440. The proportion of missing data in t2 is 0.320. However, as can been seen in Figure 1, the changes that are noticed in the network depend on the type of relation on which the analysis is focused. As can be seen in the graph, the process of partial disintegration in the network can be more obvious if we focus on strong ties, whether they are friendship links or people with whom they have "friendship" (Figure 1). In fact, the network of weak ties (with values from 1 to 3) increases in density (from 0.558 to 0.627) while the network of strong ties (values 4 and 5) decreases (from 0.307 to 0.249) during the same period. The figure also shows that those who do not finish high school are on the periphery of the friendship network and would possibly be the first to disassociate themselves from the complete network in the process of disintegration (Figure 1).

--- See FIGURE 1 (end of the document) ---

In terms of the personal networks, there seems to be a slight reduction in structural cohesion (Table 1). Specifically, personal networks have a lower average degree centrality (t = 3.025, p <.004) and lower density (t = 2.928, p <.005), while significantly increasing in average betweenness centrality (t = -2.181, p <.033). The transition between the two socio-geographical contexts seems to lead to significant changes in the structure.
of the personal network, which could in turn enable the individual in his/her integration into the new context.

Table 1. T-test for paired samples: personal networks of students entering the university

<table>
<thead>
<tr>
<th></th>
<th>First wave (t1)</th>
<th>Second Wave (t2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Av. Degree</td>
<td>41.02</td>
<td>11.20</td>
</tr>
<tr>
<td>Av. Closeness</td>
<td>53.08</td>
<td>16.47</td>
</tr>
<tr>
<td>Av. Betweenness</td>
<td>1.58</td>
<td>0.46</td>
</tr>
<tr>
<td>Av. Eigenvector</td>
<td>18.57</td>
<td>1.13</td>
</tr>
<tr>
<td>Av. Density</td>
<td>0.64</td>
<td>0.19</td>
</tr>
<tr>
<td>N. Cliques</td>
<td>63.68</td>
<td>62.67</td>
</tr>
<tr>
<td>N. Components</td>
<td>1.47</td>
<td>1.23</td>
</tr>
</tbody>
</table>

In a previous study, with a cross-sectional sample of university students from Alcalá, we observed a significant correlation between the density of the students’ personal networks and the average degree centrality ($r = 0.187$, $p < .05$), average closeness ($r = 0.183$, $p < .05$) and average eigenvector ($r = 0.171$, $p < .05$) (Araya & Maya-Jariego, 2005, Maya-Jariego & Holgado, 2005). However, in this case none of the 56 bilateral correlations between the indicators of centrality of the personal networks and the complete social network were significant, in either of the two waves. In the next section, we will explore the effect of the structure of personal networks in two longitudinal models.

**Analysis of longitudinal simulation of social networks**

For this section, information on personal networks was inputted as individual co-variants in RSIENA (Snijders, 2001, 2005). For this, we use the centrality indicator that in the previous analysis we found that it tends to increase throughout the process of socio-geographical transition: average betweenness.

Using the network of acquaintances, we created a model taking density, reciprocity, transitivity and gender similarity as endogenous factors, given their relevance in the evolution of young people's social networks (e.g., Knecht, Snijders, Baerveldt, Steglich & Raub, 2010; Lubbers, Snijders & Van Der Werf, 2011). On the other hand, as
an indicator of personal networks, the average betweenness of the personal network observed in the first wave was incorporated. This indicator, which was introduced as a co-variate in the RSIENA model, represents the modularity of the personal network and we use it in the model to predict two trends: the probability of forming bonds (and not breaking them), and the rate with which the ties change. We also evaluate the impact of both personal networks variables on the rate of change of the entire network.

Both in the network of acquaintances and in the network of friends, it is observed that the rate of change (that is, creating non-existent ties and dissolving existing ties) is high. The significant negative effect of density suggests that the likelihood of maintaining existing ties or creating new ties with random people is low. A trend, on the other hand, expected in high school students in the process of disintegration. However, both for weak ties and for strong bonds, it is observed that the structural embeddedness protects the ties against their breaking. If a tie is reciprocal or if the pair has relationships with third parties, the tie is more likely to be maintained (or a new one formed if it did not previously exist). We also observed that it is easier to maintain links between students of the same gender (or that new ties are formed if they did not exist in the first wave), than among students of different genders.

For its part, the average betweenness indicator of the personal network seems to influence significantly the evolution of the entire network. Students with personal networks with higher betweenness (or indirectly, more modular networks) registered lower changes than people with lower betweenness in their networks. At the same time, weak ties were more likely to persist and respondents were less likely to develop new weak ties with people they did not know before. Being used to managing social relationships divided between different groups, or areas with few relationships with each other, possibly created a better management in maintaining the weak ties of the school. However, they were less likely to maintain strong ties in the student network, and hence, the breakup of their friends was significantly more likely. That is, the less integrated friendships in the personal network seem more vulnerable and more likely to disappear.
Table 2. The personal network as a predictor of the evolution of the socio-centric network (n = 69).

<table>
<thead>
<tr>
<th>Effects</th>
<th>Network of acquaintances</th>
<th>Network of strong ties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate function</td>
<td>AES</td>
<td>S.E.</td>
</tr>
<tr>
<td>Rate of change (base)</td>
<td>20.8440**</td>
<td>1.1788</td>
</tr>
<tr>
<td>Effect of betweenness of the personal network in the rate of change</td>
<td>-0.0061*</td>
<td>0.0027</td>
</tr>
<tr>
<td>Evaluation function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Out-degree (density)</td>
<td>-1.8572**</td>
<td>0.1276</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>0.5308**</td>
<td>0.1090</td>
</tr>
<tr>
<td>Transitivity</td>
<td>0.0279**</td>
<td>0.0018</td>
</tr>
<tr>
<td>Gender similarity</td>
<td>0.1574*</td>
<td>0.0680</td>
</tr>
<tr>
<td>Betweenness of the personal network</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creation of new ties</td>
<td>-0.0071**</td>
<td>0.0024</td>
</tr>
<tr>
<td>Maintenance of existing ties</td>
<td>0.0107**</td>
<td>0.0020</td>
</tr>
</tbody>
</table>

\( n = \) number of actors; \( AES = \) average effect size; \( SE = \) standard error; missing values: fraction of 0.320.

The average betweenness is an indirect indicator of the process of transition at the individual level, in this case, initiating first year university studies. It can also be a result of a personal competence related to knowing how to manage relations in different social spaces, or simply to the result of dividing time between different social circles.

With the RSIENA model, we have shown that the average betweenness of personal networks seems to play a role in the evolution and rate of change of the complete social networks of students in the process of geographic relocation and / or personal transition. With complementary analysis, we found that other structural indicators of personal networks had less influence and hence, we did not present them in the analysis. What type of interaction occurs then between the properties of the personal network and the dynamics of the entire network?

Two processes seem to run in parallel. On the one hand, sharing the normative transition is reflected in the maintenance of weak ties with the school's weak ties (while those who remain in secondary school can begin to disconnect from the rest). However, secondly, the normative transition also means opening up to new relationships and over time could lead to the incorporation of new friendly relationships in the personal space. New relationships that, at least in the initial phases, will be less embedded in the whole personal network. At the moment, in the observation period analysed, we could verify a significant trend between those with a personal network with higher average betweenness to lose some of their strong ties. Therefore, it seems to work as an element of individual
predisposition in a gradual process of disintegration of the network of high school classmates.

**DISCUSSION**

In this research, we have shown that the indicators of average centrality of personal networks indirectly reflect the process of geographical relocation at the individual level. Specifically, during the most active phase of ecological transitions, personal networks seem to experience an increase in the average degree of betweenness. On the other hand, the average betweenness of personal networks also seems to influence the evolution and the rate of change of the social network of students in the process of relocation and / or personal transition. Finally, as we also discuss below, the process of relocation could slow down the students’ changes at the individual level.

This study introduces an innovation when examining the co-evolution of social networks and personal networks. We provide empirical evidence that allowed us to consider the indicators of betweenness centrality in the personal network as an indirect proxy of the ecological transitions on the individual level. In this case, we used a generic indicator of average centrality: average betweenness. It would be interesting to reproduce these same observations with indicators of centralization (e.g., betweenness centralization) or of the distribution of relationships between internal and external ties to the group (e.g., E-I index). But even with a generic indicator of structural cohesion, a significant evidence in the evolution of relationships was observed in students’ ecological transition.

The results should be interpreted with caution. Among other limitations, the RSIENA simulation models were applied in an exploratory way. We only have two longitudinal observations - a small fraction of data was lost between both-, and personal network data were incorporated without statistical normalization treatments. However, it is one of the first evidence of the relationship between structural properties of the network at the individual level and the dynamics of a complete network. In addition, the data suggest the critical role of the peer group in normative transitions.

Secondly, the group of friends and acquaintances with whom the transition is shared from secondary education to university education (or other personal journeys), is an important reference for changes that occur at the individual level. It is the collective that connects the social space of origin, in this case the city in which they were born and lived all their lives, with the new institutional and geographical context. Students in the
process of relocation could slow down individual transitions, acting as a temporary buffer and providing support. In normative transitions, a student is not isolated in a new social space, but is integrated into a collective that accompanies him/her throughout the process of change. In fact, the peer cohort, in this case the group of students who completed secondary education, forms the most immediate social structure of which it is a part.

At the end of secondary school, the relation network of last year students enters a gradual process of disintegration. In this context, the evolution of the social network seems to be influenced by dynamics of decoupling (Grossetti, 2005) and competition between multiple active relationships (Maya-Jariego, 2006). This process is more evident when taking into account the strength of the relationship in the dynamics of complete networks (Maya-Jariego, Lubbers & Molina, in progress). However, the exploratory models with the acquaintances network allow us to point out some trends that would be interesting to document in future research.

On the one hand, the individual stops attending a set of relationships whose interaction was linked to the institutional context of reference, in this case secondary school. These relationships become latent and no longer part of the interpersonal interactions of day-to-day, as happens with active contacts. However, some of the strongest relationships, especially the bonds of friendships, are decoupled, that is, they become independent of the institutional context in which they originated and accompany the individual in a new stage of their life cycle.

On the other hand, starting studying in a city different from the place of residence, the activity of the individual is distributed between two differentiated socio-geographical spaces. In some way, the previous relationships compete with the new ones. Each person has a limited capacity for starting and maintaining relationships. So that the development of relationships of friendship and friendship in a new social space, such as the university context, introduces new relationships that are not embedded with the previous ones and transform, at least temporarily, the structure of the personal network.

As the results of this work seem to illustrate, a decrease in the degree of cohesion of personal networks could be an indication of ecological transition. Students in a pattern of metropolitan mobility (round trip), and who distribute their time between two locations, experience an increase in the degree of betweenness in their personal networks. In turn, these types of structures are better predisposed to the incorporation of new relationships. Hence, the collective distribution of personal networks with higher average betweenness could indirectly report on the relational lability in a given cohort. That is,
individuals in transition are more likely to be open to the formation of new relationships, giving rise to communities with a higher rate of relational change. This is what happens, for example, in the case of Erasmus students (Cachia, 2014, De Federico, 2003).

Both the decoupling dynamics and the competition between multiple active relationships make it necessary to take into account the type of relationship and the strength of the link in future studies. It is likely that the greatest proportion of changes in ecological transitions take place in the periphery of the network, with the substitution of weak links by others. However, the observations in this paper lead us to believe that changes, proportionally less numerous, in relationships with a moderate and high psychological value have a more far-reaching impact on the structure of personal networks and complete networks.

References


Figure 1. Network of weak ties and network of strong ties in t1 and t2. The network of weak ties is elaborated with relationships in which "the name is familiar", they know each other or "speak from time to time". The network of strong ties corresponds to relationships in which "they have enough relationship" or are friends. The blue nodes indicate respondents who are studying in Alcalà and the red respondents in Seville.