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What the eye does not see: visualizations strategies for the data collection of personal networks

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Abstract

The graphic representation of relational data is one of the central elements of social network analysis. In this paper, the author describe the use of visualization in interview-based data collection procedures designed to obtain personal networks information, exploring four main contributions. First, the author shows a procedure by which the visualization is integrated with traditional name generators to facilitate obtaining information and reducing the burden of the interview process. Second, the author describes the reactions and qualitative interpretation of the interviewees when they are presented with an analytical visualization of their personal network. The most frequent strategies consist in identifying the key individuals, dividing the personal network in groups and classifying alters in concentric circles of relative importance. Next, the author explores how the visualization of groups in personal networks facilitates the enumeration of the communities in which individuals participate. This allows the author to reflect on the role of social circles in determining the structure of personal networks. Finally, the author compares the graphic representation obtained through spontaneous, hand-drawn sociograms with the analytical visualizations elicited through software tools. This allows the author to demonstrate that analytical procedures reveal aspects of the structure of personal networks that respondents are not aware of, as well as the advantages and disadvantages of using both modes of data collection. For this, the author presents findings from a study of highly skilled migrants living in Spain (n = 95) through which the author illustrates the challenges, in terms of data reliability, validity and burden on both the researcher and the participants.

Keywords

Visualization, Personal networks, Social support, Analytical procedures, Meaning.

Network visualizations

Graphic representation of relational data is one of the central elements of social network analysis (Freeman, 2004). Jacob Levy Moreno produced the first sociograms in the 1930s and over the years, they have evolved from *ad hoc* drawings to sophisticated visualizations, largely due to the new possibilities offered by computer and software development (Freeman, 2000; Moreno, 1934). Since their inception, visualizations have been integrated in social network analysis in creative ways (Freeman, 2004; Hogan et al., 2007; Ryan and D'Angelo, 2018). However, the use of visualizations to depict already collected data has predominated. Such visualizations tend to be used to observe systematically the relations data and to detect emergent properties that may only be visible through the structure of the network. Visualizations are commonly

used to discover two kinds of patterns: social groups – a group of nodes highly linked to each other – and social positions – a group of nodes who are linked in the social system in similar ways (Freeman, 2000).

Only recently has the application of visualization during data collection begun to be used (Carrasco et al., 2006; Hogan et al., 2007; Maya Jariego and Holgado, 2005; McCarty and Govindaramanujam, 2005; McCarty et al., 2007; Schiffer and Hauck, 2010). There are instances where a network visualization is developed during the data collection with the help of the respondents who collaborate and work together through a collective effort. Thus, through the use of participatory tools to elaborate sociograms, participants make "implicit knowledge about networks of influences explicit" (Schiffer and Hauck, 2010, p. 242), apart from allowing the detection of conflicting goals and areas with potential for cooperation.

In this paper, we explore the contributions of visualizations when collecting personal network data, as well as its use to elicit the qualitative interpretation of individuals about their personal networks. Accordingly, we show that the graphic representation of relationships can be used in an innovative way to collect data from personal networks, both to obtain concrete information about relationships (i.e. ties and alters) and in the qualitative interpretation of interaction contexts by the informants themselves.

In the context of personal networks, most data is based on respondents reporting on the own relation of their ties (McCarty and Govindaramanujam, 2005). Visualizations are unique in providing an interactive tool for data collection, which may vary from a paper and pencil network visualization to more sophisticated technological programs to gather this kind of data. Along the past two decades, a number of software packages with an incorporated visual interface were developed making the use of visualizations during data collection possible.

The added value of visualization has been frequently sought in elements that go beyond the analytical representation of information. For example, it has been found that the hand drawings of the personal network reveal the perception of the social world by individuals (McCarty et al., 2007); the technique called "Net-Map," based on a participatory strategy, is used in the construction of a community sociogram, following a group consensus-evaluation process (Maya-Jariego, 2016, Schiffer and Hauck, 2010); and EgoWeb has been used to maximize the differentiation of groups, which allows the identification of the social circles in which the individual participates (McCarty and Govindaramanujam, 2005).

Visualizations often provide a narrative to the network. The structure and composition of the network are very hard to read through a matrix, especially during data collection. In contrast, graphic representations can be very efficient tools which enable both the researcher and the interviewee to see how the alters are connected visually, hence adding another layer of information during data collection, which would be ignored through a matrix. They may also be useful in depicting a wider variety of information that could be utilized to probe participants, bringing them into further discussion on their networks. For example, discussing why certain nodes are isolated from the rest of the network. Nevertheless, using this mode of data collection poses various challenges to the researchers, in terms of data reliability, validity and the added burden on both the researcher and the participants (Bastian et al., 2009).

Generating personal networks through visualizations

Personal networks may vary in size from as small as 10 to 100s or even 1000s of individuals (Killworth et al., 1990; McCarty et al., 2001; Pool and Kochen, 1978; Roberts et al., 2008). There is no clear boundary delineating personal networks except the objective of the study in question (Fu, 2005), although limiting the number to a reliable subset of alters has been a major concern in personal network analysis. The selection is based on a trade-off between an efficient data collection process and achieving the most accurate representation of respondents' personal network based on the objective of the study (Bidart and Charbonneau, 2011).

Over the years, distinct methods on how to elicit personal networks and social support networks of people have been elaborated (Agneessens et al., 2002; Barrera, 1980; Bidart and Charbonneau, 2011; Fischer, 1982; Marin and Hampton, 2007; McCallister and Fischer, 1978), whereby the main tool used is a name generator. Comparatively, it has been less common to use network visualizations to gather data on personal and social support networks (Hogan et al., 2007; Kahn and Antonucci, 1984), although it was proposed as an efficient strategy to give meaning to the contexts of interaction of the individuals (Maya Jariego and Holgado, 2005).

Data on personal networks is typically collected in three stages: name generator, dyad relation between the alters (completing an adjacency matrix) and name interpreters. For each stage, different methods have been developed to elicit the data, varying from paper methods to computer-aided programs or a mix

of both. Network visualizations can be used in all of the three stages, whether to collect data or illustrate results (Tubaro et al., 2014).

Generating names with the support of visualization techniques

Researchers have used different visual aids and techniques to enable respondents enumerate their contacts. Free-hand spontaneous drawings have been used since the origin of personal networks visualizations. Free-hand drawings are easy to use, cheap, provide additional information that could be essential in the interpretation of the network through discussion and are less prone to technical failure (Cheong et al., 2013). They are also easy to modify during the interview using pencil (Hogan et al., 2007). At times, they have been used as an alternative technique to gather information, as in a study with immigrant children, where due to the diverse ethnic backgrounds, many of the respondents did not speak, read or write the language of the host country (den Besten, 2010). Researchers opting for this approach either leave the interviewees to draw their networks with hardly any instructions or have opted for giving some basic instructions, so as to maintain some homogeneity between the maps.

A second version of this type of spontaneous representation may be acquired through the use of cards and other props to represent the actors and their power. Next, the relationships between actors are drawn. This process is usually carried out in a group, in a participatory manner, and is a way to show a shared vision about relationships in the community (Schiffer and Hauck, 2010). Despite the differences in format, it is also a creative and spontaneous description, without restrictions, of the social network.

Another common technique is concentric circles hierarchical mapping, whereby concentric circles of different sizes are used to provide a visual guide to interviewees in organizing their alters according to their closeness to ego, who tends to be placed at the center (Antonucci, 1986; Carrasco et al., 2006; Hogan et al., 2007). The number of concentric circles depends on the researcher. In previous research, we have observed the number varying from as little as 3 to up to 7 (Cheong et al., 2013; Hersberger, 2003). This approach is sometimes combined with other visual aids, such as dividing the concentric circles into 4 quadrants to gather other type of information (Ryan and D'Angelo, 2018); or the use of post-it notes which allows movability and reassessment of certain metrics on the same network (Hogan et al., 2007). An online version has also been tried by Tubaro et al. (2014), whereby respondents drew their sociogram online, an approach that according to the authors could be useful to study hidden or sensitive populations. The use of concentric circles is easy to prepare, applicable to a variety of respondents (Samuelsson et al., 1996) and depending on how you design it, may add network structural data (McCarty et al., 2007). Nonetheless, some respondents may find it challenging and confusing given it restricts them to a structure that they may not be comfortable when depicting their personal network (Ryan et al., 2014).

Location maps have also been used as visual aides to understand movement of people. In a study using geo-referencing cell phone activity, maps were used to show population flows estimated every hour within an urban environment (Ratti et al., 2006). In another study, maps were used to illustrate where community residents interacted in the city and the people they met in daily interactions (Pearce and Milne, 2010).

Finally, another very simple way to generate names is to provide different boxes in which respondents can group alters according to different categories. Name boxed may be limited by a number, or provided as an open list; and the names obtained are sometimes transferred to another type of visualization. The number of names mentioned may be influenced by the number of boxes listed in the questionnaire, with exposure to a larger amount of boxes leading to more alternatives (Vehovar et al., 2008). The characteristics and advantages of these four strategies for obtaining names and relationships are summarized in Table 1.

Establishing relations between alters with the support of visualization techniques

In order to gather data on the structure of the network, apart from the relation of each alter with ego, the researcher needs to gather data on the relation for each possible alter dyad. The adjacency matrix is the tool most commonly used for such purposes. This second stage of data collection is where the most benefits of using data visualizations are possibly noted. For example, with 30 alters interviewees have to go through 435 possible relations and hence, doing this in a document or a screen with rows and columns is much more burdensome. In fact, network researchers have recently experimented with some innovations in this area.

Using visualizations, as alternative to the adjacency matrix, respondents are engaged in a process where slowly they are unveiling their own network. The emergent visible network is a result, which tends to give immediate gratification to the respondents, especially if it is the first time they see their own net-

Table 1. Four visualization displays to gathering data of personal networks.

Display	Description	Advantages
Free hand spontaneous drawing	Respondents draw their network on a blank paper or a screen, with little instruction Sometimes, other aides, such as post-it notes, figures or colored markers are used Also applied in groups	Easy to prepare and set up. Allows participants to be creative Prompts qualitative discourse Less prone to technical failure Useful when language may be a problem
Concentric circles	Several concentric circles differing in size are used to guide the respondent in placing alters in different circles, around ego	Easy to set up and easy to use Good summary of complex relations Capture the psychological value of relationships Adds structural data
Location maps	Respondents use real maps to depict movement within a given location or to identify significant places within a location	Maps are easy to use and respondents do not need much instruction on how to use them Particularly useful for studies on mobility, migration, community behavior settings, etc
Name boxes	Consists of providing specific name boxes for respondents to list their alters	Enables respondents to list alters in a specific order Grouping names into group categories is natural and intuitive for respondents

work visualization. It provides an interactive tool which beyond making relations visible, enables both the researcher and the participant to delve deeper when trying to understand and interpret the data (Moreno, 1953). Participants tend to attempt spontaneously to justify or interpret why their sociogram looks like it does, providing an additional layer of information during the interview. In the context of migration, it allows researchers to decipher the temporal and spatial dynamics of patterns of change (Ryan and D'Angelo, 2018). On the downside, respondents may also feel exposed, and this could create some tension during the interview (Ryan et al., 2014).

Obtaining name interpreters with visualization techniques

Network visualization may also be used to gather data on name interpreters, which are aimed at providing additional information on the alters listed. Most researchers gather data on the network composition, collecting socio-demographic information, as well as evaluative data. Again in this case, the use of visualization not only makes the data collection more interactive and hence, less burdensome, but also, if planned out adequately, it can effectively accelerate the recollection phase. In the context of mobility, researchers have shown particular interest in gathering evaluative data that could enable the interpretation of the network. For instance, regarding the alters of a mobile individual is relevant to know the place where they reside, the time they have spent in the location, the frequency of contact and the duration of the tie with ego, amongst other factors (Cachia and Maya Jariego, 2018; Domínguez and Maya-Jariego, 2008; Lubbers et al., 2007; Ryan and D'Angelo, 2018).

Using visualization software to collect personal network data

A variety of software packages has been developed to collect data on personal networks. On the one hand, programs designed as an extension of the paper name generator, through which a list of alters can be elicited from the interviewees (e.g. EgoNet); and, on the other hand, programs that collect data through a visual interface (such as EgoWeb, Vennmaker and OpenEddi). Programs with a visual interface provide an interactive tool, which gives a fun element to the data collection phase, as well as lowers respondent burden, typically associated with collection of personal network data.

However, they pose other issues that researchers need to consider for collecting data efficiently. First, participants need to be technology conversant. Second, the researcher needs to play a more active

role in the data gathering. Unmotivated respondents might leave out some of the ties between alters, given they are not asked to evaluate each alter pair tie as in a typical adjacency matrix (McCarty and Govindaramanujam, 2005). Third, the data acquired is limited to a given template of the program used, while in free-hand drawings respondents are free to draw additional information. Finally, interviewers need to consider whether to use a computer, laptop, tablet or mobile, as well as to take into account that in some areas, there is still limited access to internet connection (Eddens et al., 2017).

A visual interface facilitates the depiction of complex structures, making them easily comprehensible, helping both the respondent and the interviewer (Gamper et al., 2012). Its structured layout provides an integrated view of relations that would be hard to perceive just through narratives (in qualitative analysis) or tables (in quantitative analysis) (Ryan and D'Angelo, 2018). In the same vein, it provides a perspective, especially in the context of interpersonal research, which cannot be gained otherwise (McCarty et al., 2007). Moreover, visualizations are created in real-time, allowing participants to see their network, edit it and comment on it. Different coding techniques yield a vast amount of data summarized within one image, also enabling interviewees to identify errors in their network. Simply changing the shape of the nodes, for instance, using triangles for men and circles for women may allow respondents to detect information in their network, which they were not consciously aware about. Finally, as any digital tool it permits easy storage, modification, reusability (Gamper et al., 2012) and comparison with other networks.

Comparison of drawings and computer-based visualizations

Different studies have compared paper and computer-based visualizations. Christopher McCarty et al. (2007) found that computer-based network visualizations rendered important details that were different from respondents' perceptions of what they had originally drawn, for example, allowing respondents to compartmentalize alters of different ethnicities. In a similar comparison used to investigate which technique was most useful in identifying cliques, groups and communities, freehand visualizations were found to be simplistic in comparison to computer-based maps, but the paper-based method allowed respondents to be more creative in differentiating between different relations present in their network (Cachia and Maya Jariego, 2010). Similarly, Hogan et al. (2007) found that the paper-based method was more visually compelling and allowed the respondents to see the network at once and to arrange the ties visually easily using post-it notes.

The most adequate method will depend on the objective of the study and the target population. For example, a highly skilled person is less likely to demonstrate reluctance to use an automated visual interface than someone who hardly knows how to use a computer, for whom the computer could already be creating a barrier that could negatively influence the interview. Sometimes, the profession of the respondents also plays an important role as found by Reyes (2016) in her study, whereby creative professionals showed a higher preference for free-hand drawing, as opposed to the use of an already pre-constructed design, such as concentric circles.

Consequently, the generation of data through visualizations remains an area of research where more studies are needed to better understand how different approaches to data visualizations could lead to less bias in the data collected. As we have shown along this introduction, there is no one single method of generating empirical data through visualizations that does not yield its challenges, in terms of reliability, ease of use and time allocated for the data collection. Network visualization is not a neutral tool, because like other instruments, it has its own bias and influence in how a personal network is visualized (Ryan et al., 2014). Moreover, the interviewer may also influence how a map is depicted (Samuelsson et al., 1996), given an interview is also a dialog between the interviewer and interviewee. A major advantage of the visualization method remains participant satisfaction and removing burden from the respondents that in itself could lead to potential problems with validity and reliability, especially when networks are too big and respondents purposely obliterate data, due to tiredness and boredom (Eddens and Fagan, 2018).

This study

In this paper, we explore four contributions related to the use of network visualization in the context of data collection, based on our study on a group of highly skilled migrants living in Spain (n = 95). First, we explore a procedure in which network visualizations are integrated with traditional name generators. Second, we examine the network visualization as a tool for qualitative interpretation for the participant during data collection. Third, we compare how spontaneous, hand-drawn sociograms differ to analytical visualizations elicited through visualization software packages. Finally, we analyze different strategies on how respondents can use network visualizations to

identify communities in networks. For each section, we draw on our research to explore and discuss the methodological opportunities and challenges in using network visualizations during the data collection and their potential use in the future.

Participants

This research is based on data from 95 foreigners residing in Seville for a study that aimed at understanding how the type of mobility could influence the composition and structure of personal networks (Cachia and Maya Jariego, 2018). Respondents belonged to four different foreign communities in Seville: Erasmus students (n = 33); partners of a research institute, as part of the Joint Research Centre of the European Commission (n = 25); Japanese flamenco artists (n = 19); and musicians from the royal symphonic orchestra of Seville (n = 18). A high proportion of the respondents were female (70%) and the age of the respondents varied, with a majority belonging to the 21–41 age group (62%). The majority of respondents possessed post-graduate degrees (36%) or a degree (35%), for which we classified this population as highly skilled migrants, a population which has been less studied in the context of migration (Ryan et al., 2014). Interviews were conducted in English and lasted between 50 and 75 minutes.

Methods and procedure

Data of this study was collected in two steps, using e-mail and face-to-face interviews. The first step of data collection consisted in a multiple name generator collected through a document sent by e-mail. In our study, participants were contacted prior to being sent the name generator and in most cases their names had been referred by friends through a snowball sampling. This helped in establishing a higher response rate. We ensured that participants were given clear instructions on how to complete the multiple name generator, with very precise instructions on how to fill the list of alters and an example to refer to should one get confused. The instructions were tested with five people of different nationalities for whom English was not the first language prior to starting the interviews and changes were made accordingly. Upon receipt of the name generator document, the researcher would set up the interview. On average, data collection from the two modes was separated by a week.

In the second phase, participants were invited to attend an interview, during which three network visualizations were completed. First, participants produced a freehand drawing of their network. Second, using Vennmaker (Schönhuth et al., 2012), respondents represented the structure and composition of their personal networks. Finally, using the same software, in a third visualization they were asked to elicit alters' attributes. Vennmaker allows researchers to develop the personal networks with the respondents through visualization and to produce network data based on the visualization. It calculates basic network metrics and the network map can be exported as a matrix that could be imported in other programs, such as Ucinet or Visone.

For this study, in the evaluation of the personal network, a fixed size of 30 alters was selected. This network size incorporates the major sources of social support according to previous research, which has shown that alters strongly connected with ego tend to be few varying between 2–30 (Wellman, 2007), with inner most layer of a network, known as support clique averaging to five members and the next layer known as sympathy group oscillating between 12–15 members (Dunbar and Spoors, 1995; Milardo, 1992; Roberts et al., 2009). Second, this is a network large enough for structural network analysis, based on previous findings (McCarty, 2002; Maya-Jariego, 2018). On the other hand, this is a network size which is feasible in time during the data collection, given we wanted to administer 11 name interpreters for each 30 alters. Finally, the limit of 30 was stablished to produce a legible representation, reducing the cognitive load and the concentration required to remember all the visual cues and instructions. Previous research has shown that when the number of alters is high, it becomes a challenge to visualize (Ryan et al., 2014). These decisions were based on reaching an equilibrium between data collection efficiency through the gathering of data in the least time possible (Bidart and Charbonneau, 2011), and data reliability, both in terms of composition and structure (McCarty, 2002).

The 30 names were elicited through a multiple name generator consisting of eight questions based on previous social support studies (Barrera, 1980; Burt, 1984; Fischer, 1982; Marin and Hampton, 2007; van der Poel, 1993; Wellman, 1979; Wellman and Wortley, 1990). The eight questions corresponded to emotional support, instrumental support, social companionship, co-presence and other types of support. Given our interest in mobility, a specific name generator was added to identify which alters provoke travel from our respondents. The use of several name generators ensured that the research gathered data about a multidimensional definition of support, hence, obtaining a more accurate representation of the total social support network (Marin and Hampton, 2007; van der Poel, 1993). Single-name generator may be

much faster, but might result in forgetting individuals who are significant but not easily remembered (Bidart and Charbonneau, 2011). As demonstrated by Marin (2004), using different name generators may also be a way of avoiding association bias, whereby individuals only name persons who belong to the same group or belong to a similar activity.

Using visualizations in empirical network data collection

Integrating visualization with traditional name generators

Graphical representation of relationships can be used effectively in the collection of empirical network data. In this section, we will examine two different ways in which it can be carried out. On the one hand, visualization is a device that can be used to generate names and relationships, either by itself or in combination with traditional name generators. On the other hand, once we have a finished network, the visualization enables the informant to interpret the personal network and give meaning to the resulting structure.

Generating names and relations through visualizations

The traditional procedure to obtain a personal network usually consists of a name generator that provides a list of names and the matrix of actors, completed by the respondents. Alternatively, it has been comparatively much less frequent to use visualization to obtain information about personal networks. In this case, the nodes and relationships are represented progressively, as the data is collected, which reinforces the process of collecting information. There are some computer programs, such as VennMaker or Visone, that make it possible for researchers to start with a graphical input to develop a personal network, without the need to start from a previous data adjacency matrix. Accordingly, these programs may be incorporated directly in an interview, or in a survey, that is, in the process of data collecting. In general, the graphic interface is attractive to the informant and facilitates the respondents in remembering information. Moreover, it reduces fatigue and can be quite efficient.

On the other hand, it is relatively more difficult to follow the same systematic and exhaustive collection of information that is typical of traditional name generators, in which the relationship between each pair of actors is examined separately. Therefore, it is important that the researcher is aware that some information may be lost, or that the usual analytical protocol is not completed.

In our study with four immigrant groups in Seville, respondents were provided with a variety of coding tools, given to them sequentially at different stages, so as to avoid confusion. The list of alters, which the respondents listed in the name generator was inputted by the researcher in VennMaker and hence, during the interview, the respondents already had their list of alters displayed on the left-hand side of the program (see Figure 1, left). Ego was removed from the map, to avoid redundant information, given ego is connected to all alters. Respondents were instructed to move alters freely from the column on the left of the map space and to place alters wherever they liked on the map space.

Once all alters were in the map space, a systematic information collection procedure was followed, dyad after dyad, which was not considered finalized until questions about all the potential relations between alters were asked. In our case, a relation was established if alters knew each other and would salute each other in the absence of ego, as shown in Figure 1. Respondents were instructed to use a line between alters to indicate a relation between alters. During pretesting, we found that dividing the screen in four with a cross and suggesting respondents to start with relations of alters in the left bottom square and go clockwise, enabled participants not to get confused and forget any alter in the process. While this suggestion was voluntary, all the participants opted to establish the relations using this order. Through this visualization, we obtained the adjacency matrix of our respondents, given the program we used provide the possibility to export the data of the visualization into an adjacency matrix.

In our study, we have observed that when using a software package for data collection, the presence of the researcher is a way of assuring that the data collected is complete, avoiding problems related to structure and composition due to incomplete networks as suggested by McCarty and Govindaramanujam (2005). During the data collection it is not uncommon for some participants to feel exposed sometimes even embarrassed or simply get tired, hence, it is important that the researcher steps in and helps with the network visualization. We have noticed that participants, especially those were less technology conversant, got tired quicker and were happy that the research could help with the visualization. During the network drawing on VennMaker, participants instinctively moved some alters around, in order, to be able to see the network better. VennMaker allows the

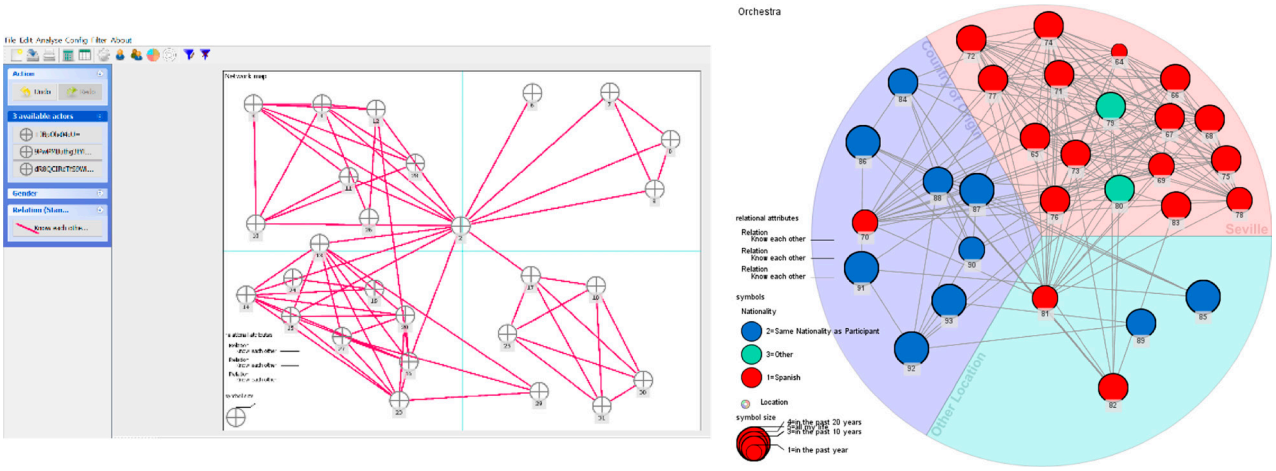


Figure 1: Two visualizations presented to respondents. Left: basic network diagram before geographical classification of alters. This graphic was elaborated during the interview, in interaction with the interviewee. Right: personal network of a musician of the Royal Symphony Orchestra of Seville. Colors represent nationalities of alters: red, Spanish nationality; blue, same nationality as the respondent; green, other nationalities. Three areas distinguish the location of residence of alters: Seville (Spain), home country, other locations. The size of the node represents the duration of the tie, the bigger the node the longer the respondent knew alter.

movement of alters, without altering the relations with alters. This was interesting because it demonstrated how participants looked for solutions and were not taken aback by seeing their visualization on a laptop opposed to findings in previous research (Hogan et al., 2007).

Giving meaning to visualizations of personal networks

When a graphic representation of the personal network is shown to the participant, a conversation about the properties of the visualization naturally arises. Spontaneously, participants are interested, sometimes expressing surprise reactions to what they see. Generally, it is easy to elicit interpretations that try to explain the resulting graph. The interviewees provide a context to understand the overall structure, the existing groupings or the position of some individuals (alters). Often, they resort to their biographical trajectory to give meaning to the composition or structural properties of the personal network.

As shown in a previous study (Maya Jariego and Holgado, 2005), on average informants tend to divide their personal network into four groups which often correspond to the family, a group of friends, co-workers (or student friends) and a fourth context of alternative interaction, for instance, friends from a swimming club. They also tend to highlight around three key actors – who may be a partner, parents or a close friend – usually characterized by their significant connection to several of the groups identified in the personal network.

When describing the visualization, attention is normally focused on the central space and then moved to the periphery. The interpretation focuses on those individuals who seem to have a more prominent role in terms of centrality, or who connect several subsets in the network. In addition, respondents frequently resort to the identification of social groups, organizing their interpersonal space according to the usual interaction contexts. We have summarized the qualitative description strategies of personal networks in Table 2.

Visualizations provide the possibility to code the data in a way that is easy for both the participant and the researcher to understand the data. As can be observed in Figure 1 (right), which corresponds to an orchestra musician, a great deal of information can be depicted in one visualization. In this graph, we have used the color of the nodes to indicate the nationality of the nodes, the size of the nodes to indicate the duration of the tie and the map space to depict the location of alters mentioned. The graph suggests a respondent who is well settled in Seville, with a great proportion of important ties being Spanish, who also reside in Seville. The size of the nodes indicate that the respondent has possibly lived for a long time in Seville, given the respondent has known a high proportion of the local alters for more than 10 years. As typical in most immigrant networks, in the country

Table 2. Qualitative description of personal networks.

Strategies	Description	Implications
Concentric circles	Comments are organized in segments of relative importance, from the inside out	Center-periphery logic
Relative importance of individuals	The role of alters with greater centrality and intermediation stands out	Strong ties Brokers
Groups	Subsets of alternatively densely connected are identified	Social circles Contexts of interaction Communities of belonging
Isolates	An explanation is often given to explain why certain nodes are isolated	Accessibility to alternative social circles

of origin, alters are of the same nationality of the respondent. The nodes in the third location typically indicate previous movement of the ego, however, in this case, given alters are Spanish and of the same nationality of the ego, their position may suggest that it is alters who have moved to another location. The interview with the respondent was an opportunity to check that all this information was correct, as well as confirming the hypothesis that researchers derived from its interpretation.

In our study, the first graphical representation of the network provided a good base for discussion. In general, respondents were pleasantly surprised to see their network and often, commented spontaneously without any prompting on the structure of their network. Primarily, respondents often discussed the groupings of their network; as well as, identifying the groups and what type of relation they represented, as for instance, these are my friends from primary school, or these are family members who have moved to another country. Typically, respondents also discussed alters who are central in their network in terms of connections, which instinctively were often depicted in the center of the network space, as can be seen in Figure 1 (left). At the same time, most of the respondents would describe isolates in the network, such as Node 6 in Figure 1 (left). We sensed that typically respondents wanted to give an explanation why these nodes were so isolated in their network.

We also used a second map, which facilitated information on the geographical distribution of the respondents' contacts. In this case, the relations covered a transnational space, between the country of origin and the receiving country (and sometimes even with a third geographical space, when the individual has previous itinerant trajectory). It is usual that the "there" and the "here" appear in the qualitative description of the graphic representation. This configuration introduces a greater fragmentation in personal networks (Maya-Jariego and Armitage, 2007), very evident for example in the case of Erasmus students, with a short stay at destination. It also entails that the informants explain the changes that their personal network has experienced from a functional point of view. For example, it is typical that a group of strong ties are in the country of origin, while the rest (with whom now there are no opportunities for daily interaction) have passed into a latent state. On the other hand, the greater relative presence of weak ties in the new space of sociability (in this case, Seville) may depend on the length of stay and the type of mobility undertaken by the individual (Cachia and Maya Jariego, 2018). Previous mobility will also result into a more fragmented personal network, given alters may be more dispersed than if the respondents have only lived in one foreign location. Respondents with more dispersed networks, very frequent among the itinerant workers of the European Commission, were surprised that a good proportion of their social support network were living in other locations and immediately, tried to explain why their network was so fragmented. This visualization prompted discussion on how respondents receive social support from distance alters, whereby respondents discussed how they connected with these alters through media communications or periodic visits and how living in different location has led to a higher dispersion of alters.

As we have already indicated, the visualization of the data following a core-periphery scheme is intuitive for the informants. The interpretation is usually guided by the layout of subsets that corresponds to the most significant social contexts in which the individual participates. In addition, special attention is paid to alters that are more significant from a personal point

of view, either because you have a more intense relationship with them, spend more time with them, or are providers of multiple types of social support.

What is in a graph? Contributions of a systematic and analytical approach

One conclusion that we can derive from the previous analysis is that the way the data are presented visually is not inconsequential, since it can potentially affect the perception of the respondents or the type of comments and interpretations prompted from the graph. Next, we explore the value added by the analytical representation of networks when compared with other strategies individuals follow to spontaneously describe their network. Finally, this will allow us to highlight the value of network analysis visualization in identifying underlying structures that are not naturally evident to individuals.

Comparison of spontaneous hand-drawn visualizations with the analytical representation of the personal network

To have an element of comparison, in our study we asked the participants to make a visual representation of their relationships. This request was left open, so as to allow spontaneous drawings and, thus, avoiding inducing a specific layout. For the same reason, the word "network" was intentionally omitted from the instructions. The result indicates to a certain extent how egos perceive their networks.

The representations of the social relations of each individual obtained were highly varied. In Table 3, we summarize the eight most frequent drawings. Most respondents opted to represent their social relations through the use of groups with whom a frequent relationship is maintained. Specifically, the classification into social groupings appears in almost two-thirds of the analyzed drawings (n = 56, 62.9%). In some cases, the groups in which the individual participates are listed directly, while in others the subsets are drawn from the lists of names or nodes that have been previously represented. The most frequent combinations are to identify groups from a list of names (n = 18, 20.2%) or from the Ego's tree of relationships (n = 12, 13.5%), sometimes in the form of a star network. Although less common, there are some cases in which a graph with nodes and relationships is segmented into subgroups after its completion (n = 6, 6.7%).

Two other common strategies were the elaboration of lists of names (n = 27, 30.3%) or the drawing of a star network around ego (n = 20, 22.5%). In both cases, the main strategy consists in reducing the interpersonal environment to the contacts available to the individual. However, the drawing of a relationship tree (or a star network) around the respondent usually entails, even if only partially, a close resemblance to the structure of relations around the respondent. For example, when drawing a star network around ego, some respondents place the most important relationships closer to ego, or point to indirect relationships that emerge from contacts in the first order zone of ego.

Only a small number of respondents drew (partially) graphs (n = 10, 11.2%), composed of a set of nodes and their relations to each other. Such graphs are usually incomplete, because even though relations are drawn between alters, they are not done exhaustively.

Finally, concentric circles, as a way to organize the visualizations according to the relative importance of alters, hierarchical classification diagrams or groupings depending on the geographical location of alters were also used.

In Figure 2, we have selected six examples of graphic representations, to illustrate the combination of the strategies above. The classification into groups, either by the stacking of nodes (i.e. names) or by the use of social categories, is combined with all kinds of visualizations. The most common is to classify alters according to the type of relationship (for example, family, friends and neighbors), or depending on the interaction contexts (for example, "the group with whom I cycle"). We have observed that for the participants in our study, it is far much easier to represent their personal network in terms of social categories, as opposed to an analytical visualization of relationships. Also, the networks correspond to partial representations (such as a star network, node segments according to their relative importance or, at the simplest end, a list of names), rather than a complete graph, given the latter requires an exhaustive compilation of nodes and their relationships with each other.

In this study, we found no evidence that the type of spontaneous visualization is related to the structural properties of the personal network. However, in some cases we observed certain parallelism between the respondent's drawing on the blank page and the subsequent interactive representation with VennMaker. For example, an Erasmus student of German origin distributed his personal contacts between two differentiated socio-geographical spaces, representing the country of origin and the city of Seville (as we can see in Figure 3, left). This same scheme was repeated in the graph that was generated in VennMaker with the help of the interviewee (Figure 3, center). Possibly, the cognitive representation that an individual has of his personal network – although it

Table 3. Common visualization strategies used in the spontaneous representation of the personal network.

Strategy	*n*	%	Description
Groups	56	62.9	The respondent draws a line or a circle in which he/she groups a subset of people belonging to the same category (e.g. "housemates," "family," "friends from work," "flamenco colleagues," etc.)
List of names	27	30.3	The interpersonal environment is summarized through a list of contacts. Names tend to be elicited through association and it is common that contacts with a similar relationship (e.g. siblings) have a close position to each other in the drawing
Ego's star or ego's tree	20	22.5	It consists of representing ego in the center of the graph and drawing around his direct contacts. Links between alters are rare, if there are any. We have called "relationships tree" those cases in which, from the direct relationship with ego, other branches of indirect relationships emerge
Nodes and relationships	10	11.2	A graph is drawn, composed of a set of individual nodes and the relationships they maintain between them
Concentric circles	6	6.7	The most important relationships are drawn in the center of the graph and around them concentric circles of decreasing relative importance are shown successively
Artistic representation	6	6.7	In some cases, respondents opted for creative drawings to represent metaphorically the characteristics of the personal network
Geographical position	4	4.5	Some respondents draw the distribution of their contacts according to the geographical location of alters. For instance, in our study, given it is based on a sample of people who have changed their place of residence, alters were placed between the home country and the host country
Diagram or organization chart	4	4.5	A schema is represented that organizes the personal contacts following some system of hierarchical classification, or imitating the structure of an organizational chart

Note: In each strategy, we indicate the number and percentage of respondents who used this form of graphic representation. The same respondent can use several visualization strategies in the same graph.

is a global perception, without attention to detail – , conditions the way in which information is stored and recovered from memory. Therefore, it can influence in some way the collection of relational data.

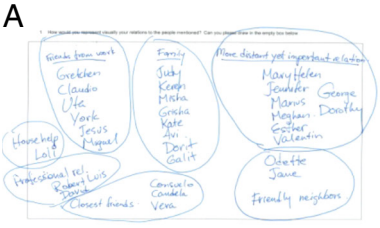
It is precisely the collection of systematic and exhaustive information that allows us to capture relational patterns that are not intuitively perceived by the interviewees, generating novel structural information even for them.

Some participants resorted to artistic representations. For example, an Erasmus student drew a tree, whereby the central trunk containing the core alters sustains the branches that have emerged through her biographical itinerary (Figure 4, Left). In another case, a Flamenco artist distinguishes between the closest strong relationships that she meets frequently and alters distributed in the different geographical locations in which she has resided (Figure 4, Right). In comparison with these graphs, the analytical visualization is not based on the symbolic value of the representation. However, what is lost in imagery is gained in structure: revealing the underlying structure can have a similar effect, giving the observer a deep insight, the feeling of being able to observe and apprehend the whole picture.

Identifying groups and communities through personal networks

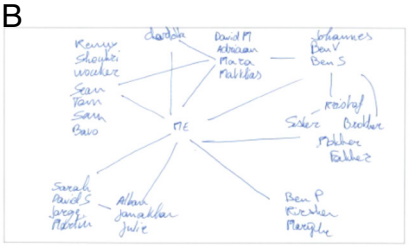
In a previous study (Cachia and Maya Jariego, 2010), which served as a pretest of the instruments we used in the present investigation, we verified that the visualization of personal networks facilitates the detection of social groups and communities in which respondents participates. Specifically, we compared the spontaneous enumeration of significant groups

A



List of names, with classification in groups.

B



Ego's star network, with classification in groups.

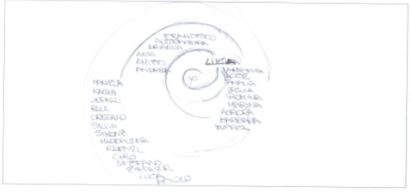
C

Artistic representation, with classification in groups.

D

Artistic representation, with classification in groups and geographical position.

E



Concentric circles, in three segments of relative importance.

F

Graph (nodes and relationships), with classification in groups.

Figure 2: Six examples of hand-drawn visualization of personal networks. (A) the respondent has listed names in groups (family, neighbors, etc.). (B) the representation is a star network of ego, in which groups of names have been connected instead of individual nodes. (C) it is a symbolic representation, in which the individual has classified her contacts in three categories. (D) the sun represents the strongest and most significant ties for the respondent, whose light nourishes other relationships that have developed in Holland (the tulips) and in Spain (the daisy flowers). (E) the spiral allows the recognition of three segments of alters, depending on their proximity to ego, which correspond to three levels of relative importance. (F) a network of relationships between individual nodes is divided in ten different groups.

and communities by the respondent with the identification of groups and communities based on the visualization of their personal network. We found that the participants identified 3 times more communities and 1.5 more groups from the analytical visualizations than from the spontaneous drawing.

Therefore, a more exhaustive evaluation of the personal network not only reflects its structure in greater detail, but also allows researchers to capture unconscious structural properties, that is, those that the individual would be unable to describe spontaneously and intuitively. Returning to the study with the four immigrant collectives in Seville, it can be easier for the respondents to explain how their relations are distributed in the transnational space by placing the nodes in the different areas that represent the place of habit-

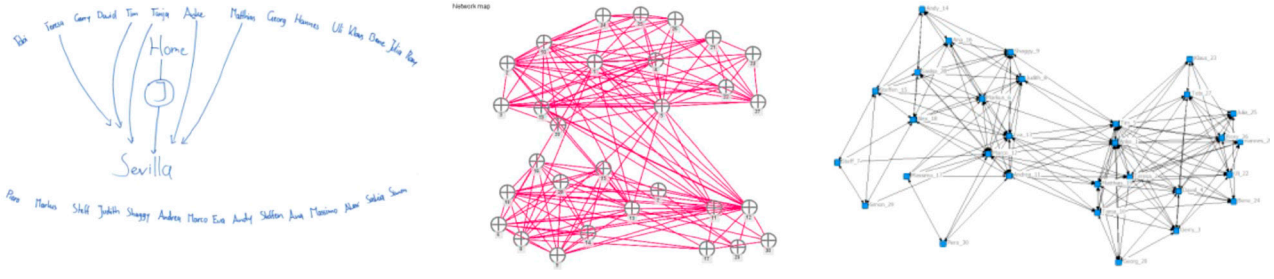


Figure 3: Spontaneous visualization and graphic representations with VennMaker and Ucinet of the personal network of an Erasmus student.

Figure 4: Symbolic representations of the personal network.

ual residence of the alters. However, the systematic, analytical and exhaustive collection of relationships not only reduces social desirability but also reveals novel processes for the informants themselves. Indeed, the analytical visualization contributes to the understanding of social structures, notwithstanding that its application as a technique consumes a great deal of time and effort. In this study, we have refrained from asking respondents to enumerate the groups and communities in their visualizations and what we have noted is that intuitively respondents tried to represent alters in different groups. Interestingly, this was more visible in the hand-drawn visualizations. Respondents used various techniques to group people together, varying from drawing people together in one space, using squares and lists and using circles, amongst others. A major advantage of using a blank paper for visualizations is that respondents are free to represent their networks as they like, without any restriction. In this respect, this type of visualization seems to correspond better to how respondents perceive their networks and the structural features of the network are simplified.

The richness of the structural data of the automated visualizations was a novel aspect in respondents' network. Many were pleasantly surprised to see their automated visualization prompting them to comment on different aspects of the relations. For instance, they would comment that they were not aware that a particular group in their network was so closely-knit or that some alters hardly knew anyone in their network. There were instances, were the detection of groups became clearly visible when the relations were added to the network (see Figure 5). If we look at the two visualizations, we observe how in the automated visualization (on the right), four groups clearly emerge from the visualization, something which was not easily detectable in the spontaneous drawing. Moreover, the respondent could also observe how one of the groups is very densely connected, a characteristic which is not visible at all in the free-hand drawing.

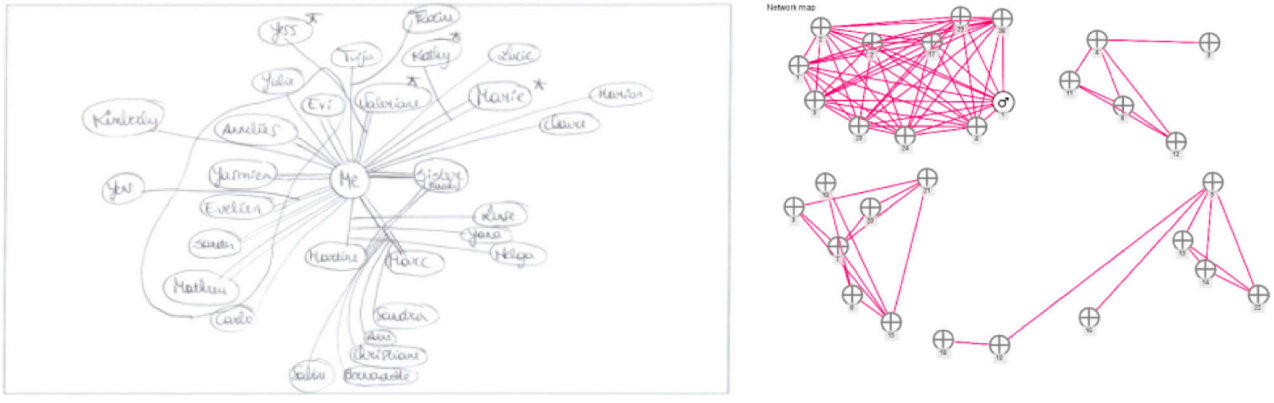


Figure 5: Spontaneous drawing and the automated visualization by an Erasmus student.

It was also interesting to observe that the transnational dimension was often depicted in a great variety of the networks. The transnational spaces can be easily identifiable in the way the network is drawn or constructed. In this respect, we have often observed similarities in terms of network structure in the way networks are drawn and the automated version. The major difference between the two types of visualizations lies in the relations. In the spontaneous drawing, respondents tend to simplify the connections, using various techniques.

In this respect, in this study we have observed that while some structural features of the network are often visible in the hand-drawn visualization, the global structure of the network remains concealed and only becomes visible through an automated visualization. In Figure 6, we can note how the automated visualization (right) illustrates a highly dense group, which would have not been detected through the spontaneous drawing. In contrast, the clear division of the groups is more visible in the hand-drawn visualizations. The analytical representation helps to become aware of the general structural properties.

Discussion

In this paper, we have shown two ways how to use network visualization in data collection. On the one hand, as a generator of names and relationships, the graphic representation acts as a facilitator that reduces the perceived load in the information collection process. On the other hand, as a device for requesting qualitative interpretations, visualization allows obtaining biographical information and the identification of natural interaction contexts. In both cases, it works efficiently in the description of transnational spaces and organizing relationships by socio-geographical areas. As found by Ryan and D'Angelo (2018) when using sociograms in their longitudinal research on migrants, visualizations prompted respondents to discuss issues related to identity and their changing self through time, instead of simply checking how many ties have changed or remained.

The advantages of using computer-based network visualization in the data collection are numerous. A depiction of complex structures is easily made comprehensible, helping both respondent and interviewer (Gamper et al., 2012). Through digital network visualizations it is much easier for the interviewee to identify errors in their network. These advantages are confirmed when compared to the spontaneous representations of the personal network (McCarty et al., 2007). Computer-based network visualizations rendered important details that were different from respondents' perceptions of what they had originally drawn, for example, allowing respondents to compartmentalize alters of different ethnicities.

However, visualization strategies have some limitations in the systematic collection of information of the dyad relations. While name generators with a matrix of alters force the interviewee to be disciplined in the evaluation of the dyads one by one, with graphic devices there is a tendency to focus on the overall vision of the relationships. We have seen this when comparing hand drawings of personal networks with the elaboration of traditional graphs. This is consistent with the value attributed to the technique of name generators when a valid and reliable measure of the size of an individual's personal network is sought (Hogan et al., 2007).

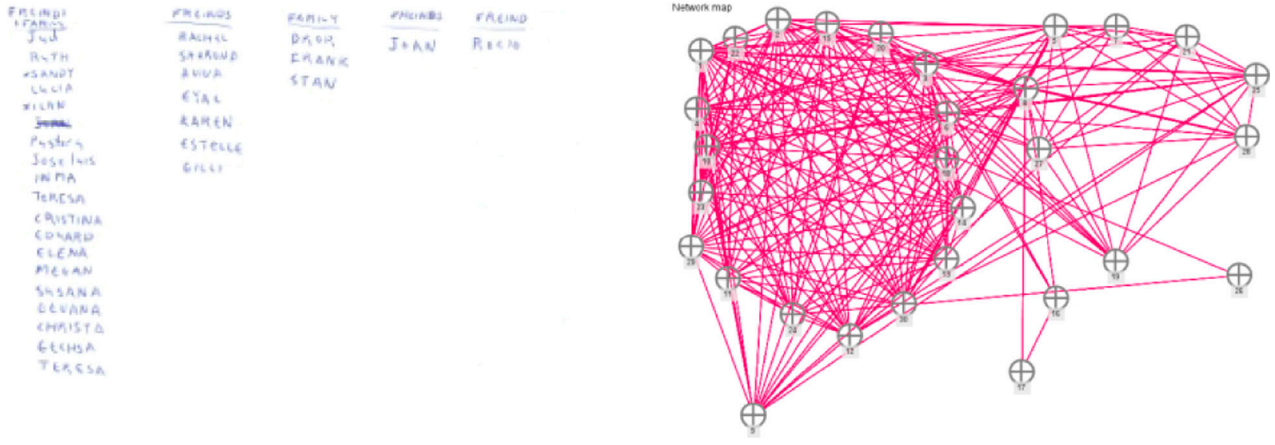


Figure 6: Spontaneous drawing and the automated visualization by a partner of a worker of the European Commission.

In the spontaneous representation (through free-hand drawing), participants frequently resort to the identification of social groups (which sometimes reflect the main contexts of interaction in which the individual participates, or significant subsets of their personal network, for example in function of the type of relationship). In our case study, referring to the transnational space, the groups are usually organized in two or more geographical areas. Some drawings also recognize partial approaches to a network, either with a list of names, with a graph in the form of a star around ego, or with nodes and relations drawn in a non-systematic way. The preference for the use of group categories had previously been observed with samples of university students and immigrants (Maya Jariego and Holgado, 2005; McCarty et al., 2007). In the context of transnational mobility, becoming aware and understanding the structure of the social support network may be highly significant and is clearly associated with psychological adaptation during relocation.

In contrast, analytical visualizations generate a more detailed representation, which reveals structural patterns that are not intuitively evident to the participants. That is, it serves to identify unconscious relational phenomena, such as belonging to communities or participation in social circles. This highlights the beneficial use of network analysis in the study of the psychological sense of community, social cohesion and community integration processes (Maya-Jariego, 2004). In our study, it was interesting to verify that the groups with which the individual has a direct relationship (which are usually represented in the personal network), are an efficient means to detect the communities of indirect relationships of which they are a part.

Resorting to visualization during data collection has great advantages in terms of reducing participant burden and time. On the other hand, the versatile nature of visualizations provides an enormous potential to integrate it with the objectives of each specific investigation. It is a strategy that seems to coincide with the mechanisms of perception of the social world (Brands and Mehra, 2019; Mehra et al., 2014): for participants it is natural to represent their relationships on a map or “read“ the graphic representation of their personal network. In addition, it allows them to concentrate on the fundamental properties of their interpersonal space, considering the entire configuration (which entails certain degree of simplification). In some cases, “Gestalt” has been identified as a subjective approach followed by individuals in the description of their networks (Von der Lippe and Gamper, 2017). This shows that completing a matrix in a traditional name generator requires a different type of cognitive processing from the visual representation of relationships during the interview process. The analytical approach is less intuitive and more expensive, both for the interviewer and for the interviewee. However, within this limitation lies its virtue, since the unconscious ways of obtaining ties and relationships not only reduce the social desirability of the information obtained but also may eventually generate structures that are a surprise even for informants. The analytical approach sometimes makes visible what the eye does not see.

Conclusions

In this paper we have reviewed different strategies of visual representation of the networks, together with the contributions and limitations that each of them entails. The visualization can be based on a spontaneous drawing, without restrictions; in a computer-assisted interactive interview, or in analytical data collection through a name generator and an adjacency matrix. Each approach has its advantages and disadvantages. Depending on the objective of the study, the researcher should choose what type of visualization to use, keeping in mind, that the type of visualization could mean obliterating some data. For instance, in this study we have shown that an automated visualization is a better tool if the researcher is interested in the global structural features of the network. On the other hand, a hand-drawn visualization would be more apt if the researcher is trying to understand how interviewees perceive their network, given the unstructured approach allows them to depict their network freely, without any template of automated visualizations. In fact, the combination of strategies can help to counteract some of the limitations and generate new types of data.

Through the study of the transnational relations of four groups of foreigners living in Seville, we have verified the natural tendency to simplify the social world in social categories (referred to as groups of belonging), as well as the specific value of analytical displays, which allow to go beyond the cognitive capacity of the individual on his space of relations:

- The description of interpersonal space through social groups is an intuitive strategy, which the respondents use both when they draw their personal network spontaneously and when they are asked to give meaning to a sociogram. The categories are a central element in the processes of social perception.
- However, analytical graphs detect structural patterns that are not intuitively evident, facilitating the description of social circles and communities of belonging.

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