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Asking Social Network Questions: A Quality Assessment of Different Measures

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Abstract

Research findings indicate that different types of social relations have an important influence on the performance of employees in organisations. This paper focuses on a comparison of different methods for acquiring information on advice, cooperation, friendship, adversarial and superficial networks in knowledge organisations.

We investigate the applicability of three distinct measurement methods to acquire different kinds of complete network data by means of the recognition method. Data were collected in a small governmental organisation consisting of knowledge workers. First, employees were presented a short description of a specific situation in which social relations with their colleagues might play a significant role. They had to indicate if (or how often) this specific situation occurred with each of the colleagues. Second, respondents were asked to indicate whether a specific relational concept (in this case 'advice' or 'friendship') applied to each of their relations with their colleagues. Third, we provided respondents with four semantic differentials (e.g. distrust-trust) on which they needed to position their relation with the other employees. Whether these different measurement instruments capture distinct aspects of the relation between employees, or whether they measure the same underlying concepts, is one of the major concerns of this paper. The aim of this paper is twofold. First of all, we want to know to what extent these different measurement instruments overlap. Second, we would like to find out to what degree these different methods as a whole give us conceptually different and complementary information. To the extent that items are correlated within one method and between methods we need to investigate which of these different instruments is best suited for our content related purposes. The criteria used for selecting the most appropriate method are minimal item non-response – i.e. from the viewpoint of measuring complete networks – and maximum relational diversity with a minimum of questions.

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1 Introduction

Formal as well as informal social relations have become important explanatory variables in organisational research. Each individual is surrounded by a specific network of social relations. This structure of relations is referred to as the social network. The structure and the content of these social networks are believed to influence the attitudes and the behaviour of people in many ways. Because of the sensitive and threatening character of the questions measuring complete social networks, special attention is needed for their construction. This paper focuses on acquiring information on different sorts of social networks in a survey context, by using alternative question formulations. We investigate which questions included in our survey measure the same underlying concept and which capture different types of relations between employees. To know whether these different questions are measurement instruments of the same concept (e.g. a friendship relationship), we examine to what extent the answer patterns of these questions overlap. We subsequently evaluate the quality of each of the questions that measure the same underlying concept, by means of the item nonresponse rate. Our findings indicate that three different concepts are measured by the included questions: an advice dimension, a friendship dimension and a social support/social companionship dimension. Moreover, we find that some question formulations provide us with better results regarding the item response rate.

2 Theoretical background

Social networks have become more and more common in social science research. While the importance of social networks has become widely accepted, the problem of which questions are suitable for acquiring information on complete social networks has received little attention[2]. One of the difficulties social network researchers are faced with is the so-called nonresponse, i.e. unit as well as item nonresponse. Especially, when focussing on the measurement of complete social networks –as in our case–, both types of nonresponse need to be minimised. In ordinary survey research, nonresponse is highly problematic, especially when the nonrespondents possess characteristics that are different from these of the respondents (Groves and Couper, 1998). For measuring complete networks unanswered questions are even more problematic because each missing answer

[2] More literature is available concerning the measurement of ego-centric network questions, such as Knipscheer and Antonucci (1990), van der Poel (1993) and Marsden and Campbell (1984).

brings about an additional gap in the social network under study. In order to reduce the item nonresponse, this paper focuses on different strategies that can be adopted when constructing social network questions. In general, well-constructed questions are questions that respondents will interpret in the same way, will be able to answer accurately and will be willing to answer (Dillman, 2000: 32-34). For the current purpose – namely the reduction of the item nonresponse – our focus lays on the problem of the willingness to answer.

Social network questions differ from ordinary survey questions in at least two ways. Firstly, social network questions often are "sensitive" (Tourangeau, Rips and Rasinski, 2000) or "threatening" (Sudman and Bradburn, 1982) questions. These questions invade privacy and people might be afraid that their answers will be disclosed to other people than the contacting agency. The answers on social network questions may be expected to suffer considerably from social desirability. Moreover, people possessing the most sensitive information (e.g. on hindrance networks) may be the least likely to report it (Tourangeau, Smith, 1996: 276). This sensitive nature of social network questions makes us expect higher item nonresponse rates. A second difference from other survey questions concerns the burdensome nature of social network questions. These questions are rather complex and demanding to fill out. Social network questions are designed to obtain specific information about the relations people have with all the other members of a particular group. When measuring a complete network, the researcher knows which people belong to the social group under study by depending on external criteria (such as the structure of the organization) or by questioning a core actor who reports on the composition of the group under study. In either case, i.e. when researchers (nominalistic approach) or respondents (realistic approach) define the social group (Lauman, Marsden and Prensky, 1983), respondents are offered some name interpreters in which a factual (e.g. frequency of informal contact[3]) or an attitudinal (e.g. trust in someone) question is asked for each of the names of the group members. This is a very demanding task on the part of the respondent and imposes a considerable cognitive burden on the respondent. A lot of information needs to be retrieved on a rather short time span. It can be expected that questions containing a high burden are more easily skipped or are more badly completed than questions with a relatively low burden (Tourangeau, Rips and Rasinski, 2000).

The combination of both of these characteristics –i.e. the high sensitivity and the burdensome nature– might increase item nonresponse rates of social network questions. Posing well-constructed questions may lower the nonresponse rate considerable. Especially when dealing with sensitive questions, researchers should pay attention to the construction of the questions itself. As such, the

[3] Responding to a frequency question is troublesome, because once found in the memory, the information needs to be summed, combined or averaged (Tourangeau, Rips and Rasinski, 2000: 136-164).

sensitivity of these questions can be softened by choosing the appropriate wording (Dillman, 2000: 18). Good-written survey questions make it less difficult for the respondents to answer. In this paper different question formats are tested: hypothetical questions, factual questions, direct questions and semantic differentials (Section 3.2). In order to restrict the burden of completing survey questions our challenge is to obtain the greatest amount of information with as few questions as possible. Detecting underlying dimensions gives the opportunity to restrict the total number of questions. When two questions are measuring the same underlying concept, it is unnecessary to include both of them in a questionnaire. That way, the burden of the questionnaire is reduced, because redundant questions –i.e. without any substantive additional information– are avoided.

Little research literature pays attention to nonresponse reduction for complete social network questions. Most research focuses on the accuracy[4] of the acquired information on social networks (e.g. Bernard et al., 1990; Hammer, 1985; Brewer, 1993, Bondonio, 1998, Sudman, 1985, 1988, Feld and Carter, 2002; Huang and Tausig, 1990). The majority of these research articles conclude that individual reports about social interactions differ substantially from the objective observations of these interactions. Moreover, a first research attempt is made to explain variation in the accuracy of social network perception by means of both situational and individual differences (e.g. Casciaro, 1998). Some of this literature concentrates more specific on the problem of forgetting network members (Brewer and Webster, 1999; Brewer, 2000). Our research is more in line with the work of Ferligoj and Hlebec (1999), in which social network survey instruments are evaluated in terms of test-retest reliability.

Besides a focus on the cognitive abilities of people and/or on the accuracy of people's cognitive reports, research should consider the construction of social network measures. This paper concentrates on the 'ordinary' item nonresponse social network questions can suffer from. A missing answer on a social network question does not necessarily imply the absence of a tie. As is often the case, people might simply refuse to answer a particular question. Instead of the assumption that people might forget particular interactions, we should acknowledge the possibility that they refuse to report them. This refusal can be due either to the sensitivity of the questions (i.e. especially because they invade privacy) or to the high burden associated with filling out the questions. When questioning social networks in a small organization –i.e. all network members are known– by means of the recognition method, missing answers cannot be explained by respondents forgetting the presence of alters. Recall problems that are directly related to the subject of the question are the only memory difficulties that can

[4] Accuracy is here defined in a broad sense referring to the extent to which reports about a person's own relations are accurate, as well as to the extent to which people give an accurate picture about the relation existing between other people.

cause nonresponse. When people have difficulties with estimating for example the frequency of contact with a particular network member, they might be less prone to provide an answer to the questions. These memory problems are directly related to the complexity or the burden of the questions.

The purpose of this paper is to understand how social network questions can be constructed in such a way that network relations are measured in an accurate and effective manner within a survey context. As a result, our general research question is twofold:

(a) to what extent are the different measurement instruments indicators of the same underlying concept?
(b) if they are measuring the same concept, which question format is most accurate?

To answer the first question, the principle of trait validity –as part of construct validity– stands central. To check for trait validity different measures of the same trait should be highly correlated (Campbell and Russo, 2001). Questions measuring the same concept are expected to be strongly correlated. Lower, but significant correlations between questions measuring different concepts might exist, since different concepts can also be correlated. Diverse techniques will be used to examine whether the overlap between different questions is due to the fact that these questions are measuring the same concept or that the underlying concepts are correlated. If the constructed questions are measures of the same broader concept, it will be unnecessary to use each of these questions. In that case, it might be advisable to restrict the number of questions needed to get this information in an efficient way. Selecting the appropriate questions constitutes the core of the second part of this paper. The following criteria are used for selecting the most appropriate question for a specific dimension: minimal item non-response and maximum relational diversity with a minimum of questions. In the following part we will describe the questions that were included and the dimensions these questions are suspected to refer to.

3 Measuring social networks

3.1 Types of relations

Social network relations can have very different contents. Various types of networks (also called dimensions) can be important in organisations. A large number of researchers concentrates on different types of networks in an organizational context (Lincoln and Miller, 1979; Krackhardt and Stern, 1988; Hansen, 1999; Burt, Hogarth and Michaud, 2000; Lazega, 2001; Nelson, 2001; Sparrowe et al., 2001). In most studies the general aim of organisational

researchers interested in network relations is not only to measure formal networks (i.e. relations that are mostly a consequence of the organisational structure and of the function of the individuals in that network), but also to pay attention to more informal relational contents, such as support and friendship.

Our research focuses on different relations centred around five different topics: information, support, companionship, hindrance and superficiality. Each of these relations is believed to have an influence on the functioning of employees in companies. A first part of the information relation is the advice network and concerns knowledge sharing and knowledge creation (Cross, Borgatti and Parker, 2001). Initially, we included seven questions related to advice, capturing three different aspects of advice as developed by Cross et al. (2001), namely people tend to exchange "solutions, validation and meta-knowledge". A first type of advice considers those situations in which one turns to colleagues for finding a solution for a specific work related problem, one is not able to solve himself or herself (Q7 and Q8). "Validation" implies that people present their own solutions to colleagues in order to receive confirmation of their work (Q9 and Q10). Obtaining useful information about which experts to contact, where to obtain relevant documents, how to find data, etc., is a third type of advice, called meta-knowledge (Q11). The seventh advice question directly asks with whom one has an advice relation (Q32). Another measure related to the information transfer is the question about cooperation (Q15). Cooperation refers to a situation whereby employees have contact with each other to exchange information on a regular basis. When people cooperate, a stronger and more long-term relation exists than when they are involved in an advice relation (Lazega, 2001: 94-96). In a company context it is expected that relations concerning advice and cooperation have a substantial influence on characteristics of the employee, such as satisfaction and performance. Social support encompasses several dimensions: emotional support, instrumental support and social companionship (van der Poel, 1993). Two questions are included as a measure of emotional support. The first one asks to whom one goes to receive support for important work-related problems (Q12). The second question concerns support in the case of important problems related to their private life (Q13). Social support of co-workers has a strong influence on –for example– job satisfaction (Ducharme, Martin, 2000). Social companionship, as a dimension of social support, is measured by a question regarding the frequency of participation in social activities outside the work context (Q14). Since it is possible that in a work situation some colleagues do not get along with each other, have a row, etc., a negative or adversarial relation is included (Q16). Such conflict situations might be influential on the activities of people, such as individual performance (Baldwin, Bedell and Johnson, 1997; Sparrow et al., 2001). Another question refers to what we call a superficial relation (Q17). It might be the case that in an organisation people simply do not know each other very well or only know others very superficially. It seems unreasonable to suppose that everyone should either be a friend, a co-worker, an adviser, etc. of someone.

Four semantic differentials about the informal – i.e. non-professional – relations between employees were also part of the questionnaire (Q18-Q21). A last question included asks for the colleagues with whom one has a friendship relation (Q31). Friendship is defined as a flexible form of open-ended support that is not related to the tasks themselves (Lazega, 2001: 96). Because of the exploratory nature of this research, we do not a priori assign each of these seventeen questions to a specific dimension. Table 1 shows for each question the relation it is expected to measure and the particular question type it belongs to. This last distinction is explained in the following chapter.

3.2 Measurement instruments

In questionnaires often a description of a certain situation or problem is used to generate the necessary network information. It might be that the often rather long and complex descriptions (e.g. Ferligoj and Hlebec, 1999; Burt, Hogarth and Michaud, 2000; Lazega, 2001) do not provide the researcher with the most high-quality answers. Three different question formats were tested[5]. An example of each of these can be found in Figure 1. First of all, similar to the questions frequently used in literature, a description of a particular situation (or problem) is given to the respondents. Specific for the advice network, two alternative formulations were tested. In the first type of questions respondents were asked to indicate the other employees whom they *think* they *would* go to when confronted with a hypothetical situation or problem. In some sense this is an 'ideal' situation, since no reference is made to what had really happened before. However, this ideal situation might differ from what actually occurs. Therefore, an alternative question formulation was included, in which the respondents are asked to think back in time (i.e. over the last year) and to indicate the number of times a certain problem or situation actually occurred. A potential problem with this kind of question is that it can be more an indication of being confronted with a particular situation, instead of an indication of the availability of support givers in such a situation. In relation to our first research question it might be that there is a great discrepancy between the alters employees get advice from and the alters they would *like* to get advice from. However, it could be that they do not differ greatly. In that case it is better to ask respondents whom they would go to for advice, instead of asking them whom they really went to during the past year (for example to prevent recall errors). We will respectively call these question types: hypothetical (type 1a) and factual (type 1b) questions. The respective answer categories on each of those types are: "yes/no" and a five-point scale of frequency. Only for the advice network a hypothetical formulation makes sense. For all other dimensions only factual questions were developed.

[5] The detailed formulations of the questions used can be found in Appendix 1.

A second sort of question used is called a 'direct' question. Instead of giving a description of the concepts measured by a particular question, we mention the relation in the question itself. Respondents are asked in what sense they consider their relation with someone as being of a particular type (in this case advice, friendship or superficial relation). When a question asks explicitly what type of relation one has with each of his colleagues, respondents might be more able to answer accurately. Notwithstanding this potential advantage, it remains problematic and doubtful whether everyone understands a certain concept – such as a type of relation– in the same way. Answers should be given on a seven-point scale.

Finally, we included some semantic differentials of rather straightforward concepts that are directly related to informal relations. Respondents needed to position their answers on a seven-point scale. It might be that respondents find it easier to think in terms of opposite adjectives, than in terms of described situations (as in type 1).

TYPE 1:

1.a.: hypothetical: Suppose that you have found a solution for a work related problem. You are not certain about it and confirmation of others would reassure you. To whom of the members of your research group would you go for confirmation? *(dummy : yes/no)*

1.b.: factual: Consider all situations of the past year in which you think to have found a solution for a work related problem. You are not certain about it and confirmation of others would reassure you. How often have you been looking for confirmation to each of the members of your research group? *(daily – some times a week – some times a month – some times a year – never)*

Type 2:

Consider your relation with each of your colleagues. Can you indicate in what sense you consider that relation as a 'friendship relationship'? *(seven-point scale: not at all(-3)– totally (+3))*

Type 3:

Look at the following contradiction: "distrust – trust". The more left you tick of a box, the more you associate your relation with a particular colleague with "distrust". The more right you pick of a box, the more you associate you relation with that colleague with "trust". *(seven-point scale: distrust (-3)/ trust (+3))*

Figure 1: Type of question.

Table 1: Content, number and type of questions included.

CONTENT	NO.	TYPE
ADVICE	Q7	type 1a
	Q8	type 1b
	Q9	type 1a
	Q10	type 1b
	Q11	type 1b
	Q32	type 2
SOCIAL SUPPORT	Q12	type 1a
	Q13	type 1a
social companionship	Q14	type 1b
COOPERATION	Q15	type 1b
ROW	Q16	type 1a
SUPERFICIALITY	Q17	type 2
SEMANTIC DIFFERENTIALS	Q18	Distrust-type 3
	Q19	Enemie-type 3
	Q20	Superficial-type 3
	Q21	Formal-type 3
DIRECT FRIENDSHIP	Q31	type 2

4 Data collection

4.1 Methodological considerations

Since the sensitivity and the burden are inherent to the social network topic, methodological efforts are needed to minimise nonresponse already at the phase of the data collection. Self-administered surveys are found to increase the item response of sensitive questions relative to other data collection methods (Dillman, 2000: 38; Tourangeau, Rips and Rasinski, 2000: 288-312). A choice should be made between the paper and pencil mode and the more recently developed CASI (i.e. computer-assisted self-administered interview). Often researchers guide their decision in favour of the more or less established paper and pencil method, because of expected higher response rates and the lower data quality. Specific for e-mail surveys (e.g. Couper, Blair and Triplett, 1999) and sometimes for websurveys too (e.g. Crawford, Couper and Lamias, 2001) high nonresponse[6] rates are found. Nevertheless, some research contradicts these findings (Schaeffer and Dillman, 1998; Dayton, 2001). Moreover, Tourangeau and Smith (1996) confirm that using CASI increases the item response rate of sensitive questions. Concerning overall data quality, some hopeful results indicate that CASI and 'paper and pencil' data collection generate comparable data, with a slight advantage concerning criterion validity and test-retest reliability in the case of CASI (Corman, 1990). Besides these nonresponse considerations internet research often suffers from coverage problems (Couper, 2000). While the usage of the phone is widespread, the availability of internet might still be troublesome. This is no real hindrance in this and many other cases, where specific populations with full access to the internet are surveyed. Moreover, when using CASI some major practical advantages accompany the data collection. Time intervals between different stages of the follow-up procedure are much shorter (Tailored design method (Dillman, 2000)) then in ordinary survey research (Total design method (Dillman, 1978)). In this way the duration of the burdensome data collection phase can be shortened. Another advantage of using CASI instead of a paper and pencil procedure is related to the specific cost efficient nature of CASI. The technical development of the CASI questionnaire itself is the financially most exigent part of the surveying process. In contrast with other survey modes, surveying additional respondents by websurvey or e-mail survey does only increase costs to a very small extent. Large scale data collection can be performed at considerably low

[6] E-mail surveys and websurveys both belong to the group of CASI. The only difference between a mail and an e-mail survey is the medium used, i.e. respective mail and e-mail. In the case of an e-mail survey respondents receive a questionnaire in the form of a text message in or attached to an e-mail, that needs to be filled out and send back. This closely resembles the procedure of collecting data by means of a mail survey. Websurveys have a more complex design. A websurvey has in-built facilities to skip questions, to provide help, to send the answers, etc. This provides the respondent with a dynamic survey environment to fill out the questionnaire.

costs. Taking the abovementioned arguments and our research purposes into consideration it was decided to use a CASI procedure as method of data collection.

4.2 Data

This research is the first part of a more extensive research design with as a general aim the study of the relation between an actors' social networks in an organisation and his or her performance. This study is a small pre-test, set up to test the websurvey software and to study the answer patterns on the network questions. The data were collected by means of a websurvey in a small governmental organisation in Belgium (N=28)[7]. We made use of a multiple contact strategy, similar to the one Dillman (1978, 2000) proposed for mail surveys. We contacted each respondent four times by means of different e-mails: a prenotice, an e-mail containing the URL of the questionnaire and two thank you/reminders. Through the prenotice, respondents were asked to participate in the survey and they were informed that they would receive the questionnaire in a few days. Three days later, an e-mail with the URL of the website where the questionnaire could be found, was sent to every employee. Four and eleven days after they received the URL of the websurvey, every member of the organisation was sent a thank you/reminder. In this way, respondents were thanked for their participation and non-respondents were reminded about the presence and the location of the questionnaire.

Because of the use of cookies, every respondent could only participate once. The possibility to fill out the questionnaire in a paper and pencil format was given, but everyone responded by filling out the websurvey. In the end, 25 of the 28 contacted employees completed the questionnaire. This corresponds with a response rate of 89.3%[8]. The questionnaire consisted of some general questions concerning their job, a large network part (25 of the 51 questions), some personal and psychologically oriented characteristics of the respondent and their opinion about the questionnaire. In this paper we focus on the complete network of the respondent in the organisation under study, i.e. only seventeen social network questions are taken into consideration[9]. Every network question was asked by means of the recognition method, i.e. every respondent received (for each question) a list of all other members of the organisation. They were asked to answer the particular question for each of the – in this case – 27 other members of the organisation.

[7] Because of the small number of respondents at our disposal, the conclusions of this paper are more tentative, than decisive.

[8] This high response rate is possibly due to the internal encouragements of the department's director.

[9] The other network questions referred to the social network outside the organisation under study.

We now turn to the analysis itself. First we will outline which questions are measures of the same underlying relational concept. We do so through the use of QAP as a first step and subsequently by factor analysis, cluster analysis and MDS. In a last step we compare the quality of the questions that are measures of the same concept, by looking at the proportion of missing values.

5 Results

5.1 Qap correlation result

A QAP-correlation procedure (Quadratic Assignment Procedure) is used to calculate the overlap in answers given to each pair of questions. QAP is a permutation test that computes the correlation coefficient between the answers for two questions, where each answer that is given forms a separate case. In order to see whether the resulting correlation is significant we have to rely on a simulation test. In this simulation test, values for the correlation coefficient are calculated when the vertices (actor-labels) are reassigned randomly, and the resulting distribution is used to evaluate how extreme this correlation coefficient is.[10] This test procedure is available in UCINET V (developed by Borgatti, Everett and Freeman, 1999). We used a SPSS syntax in order to be certain that missing values would be ignored. The results can be found in appendix 2 (i.e. Tables A, B and C). The majority of the correlation coefficients is highly significant. This would indicate that all the different questions have significant overlap in their answers. However, almost all values of the correlation coefficients are rather low. A low but significant correlation could be an indication of multiplexity of these relations. The results do indicate that employees who give – different types of – advice are also named as cooperation partners and as friends. Moreover, it is shown that for friends, advisers and co-workers the superficial relation is not reported and a positive correlation is present with each of the semantic differentials. Only a high correlation would be an indication that the questions are measuring the same underlying relational dimension. The presence of some high correlation coefficients gives a first indication that separate groups of questions exist. In order to identify these groups we use three different methods: factor analysis, cluster analysis and multi-dimensional scaling. By using factor analysis different dimensions can be distinguished. Furthermore, a cluster analysis is performed in order to confirm or to shed new light on the solution from the factor analyses. Multi-dimensional scaling helps to visualize the results. The application of these techniques is rather explorative when dealing with network related data. Each of these techniques is discussed in the following sections.

[10] For further reading we refer to Krackhardt (1986, 1987).

5.2 Factor analysis

The factor analysis is based on a transformation of the original dataset. Each of the answers of each respondent about his/her relation to a specific other actor is used as a separate case in the factor analysis. We performed a principal axis factor analysis with listwise deletion of missing values. As a result the obtained correlations differ from those calculated by the QAP syntax (Appendix 2). Because of the assignment of Q15, Q16 and Q32 to more than one of the factors these questions are excluded from the analysis. On the basis of the eigenvalue criterion a three factor solution is preferred (Table 2).

Table 2: Factor analytical solution.

		Factor 1	Factor 2	Factor 3
Q7	Advice1-type 1a	**.669**	.116	-.161
Q8	Advice1-type 1b	**-.845**	.075	.076
Q9	Advice2-type 1a	**.724**	.173	-.041
Q10	Advice2-type 1b	**-.860**	.094	-.120
Q11	Advice3-type 1b	**-.681**	.019	-.088
Q12	Support 1-type 1a	.181	.024	**.738**
Q13	Support 2-type 1a	-.037	-.037	**.885**
Q14	Companion-type 1b	.058	-.058	**-.561**
Q17	Superficial-type 2	-.165	**-.540**	-.020
Q18	Distrust-type 3	.132	**.890**	-.215
Q19	Enemie-type 3	.083	**.880**	-.084
Q20	Superficial-type 3	-.140	**.877**	.167
Q21	Formal-type 3	-.112	**.768**	.107
Q31	Friendship-type 3	-.017	**.663**	.269

The first dimension consists of five questions. All of them were initially developed to measure the work related advice network as a broader dimension (Table 1). Contrary to our expectations the direct advice question is not included in this analysis because it could be assigned to more than one dimension (i.e. to the friendship as well as advice the dimension). This might be due to the fact that we did not specify whether we meant advice with respect to work or with respect to more private problems. The second dimension measures the concept "friendship". All semantic differentials[11], the superficial and the direct friendship question are included in this dimension. The third factor is named the social support/social companionship dimension and consists of three items: two measuring social support and one about social companionship. With regard to the different types of questions (i.e. factual, hypothetical, direct and semantic differential), no differences appear. The factor loadings are not systematically

[11] Although their exists a discussion about the inclusion of semantic differentials in factor analysis, we kept them in the analysis.

higher or lower for alternative question formulations. Contrary to what was expected, alternative formulations of the same concept belong to the same factor. Although there are differences in the construction of the questions, they nevertheless measure the same concept.

5.3 Cluster analysis

QAP-correlations can be used as a measure of similarity between the different questions. Questions that are highly correlated are more similar than questions characterised by a low correlation coefficient. We used cluster analysis to assign the questions to different groups. The cluster analysis is performed in UCINET V, i.e. a Johnson's hierarchical clustering[12] with average linkage. The results of the cluster analysis are consistent with the results of the factor analysis. The three clusters are identical to the three different factors found. A first cluster corresponds to the advice dimension in the factor analysis, whereas a second cluster captures the social support/social companionship dimension and the questions measuring friendship can be found in the third cluster.

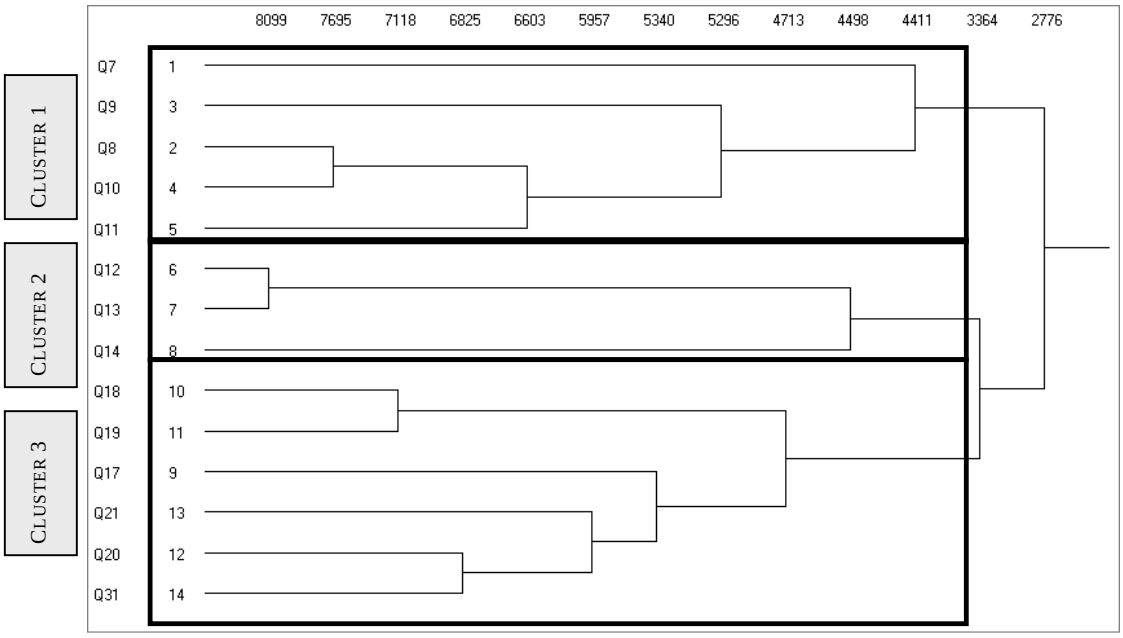

Figure 2: Cluster analysis: dendrogram.

[12] To be able to perform the analysis a transformation of the correlation matrix was necessary. The correlations needed to be positive and could not consist out of decimals.

5.4 Multi-dimensional scaling (MDS)

A third technique used is multi-dimensional scaling (more specific PROXSCAL). This method has the property of visualizing results according to a number of dimensions. The different factors are combined resulting in three figures. Dimension 1 represents the type of relation (more advice and more friendship). Figure 3 represents factor 1 (the advice dimension) and factor 2 (the friendship dimension). Figure 4 shows the distinction between factor 1 (the advice dimension) and factor 3 (the social support/social companionship dimension). Finally, Figure 5, visualizes factor 2 (the friendship dimension) and factor 3 (the social support/social companionship dimension). In each figure both of the factors are represented by two distinct groups. The overall results of the multi-dimensional scaling procedure are confirming the factor analytical solution.

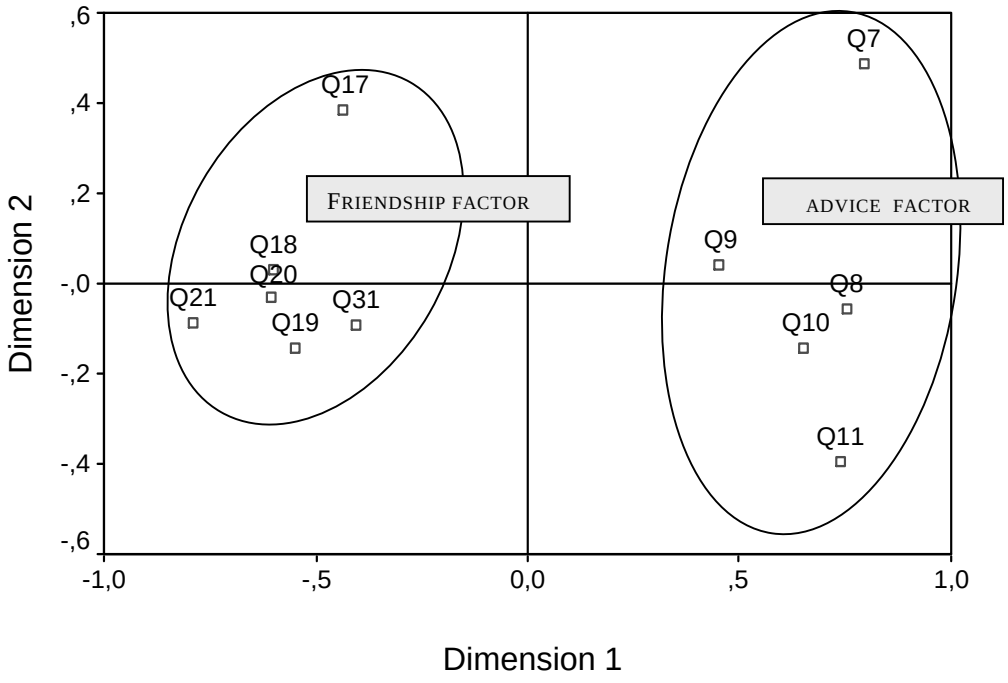

Figure 3: Multi-dimensional scaling: factor 1 and factor 2 (stress < .005).

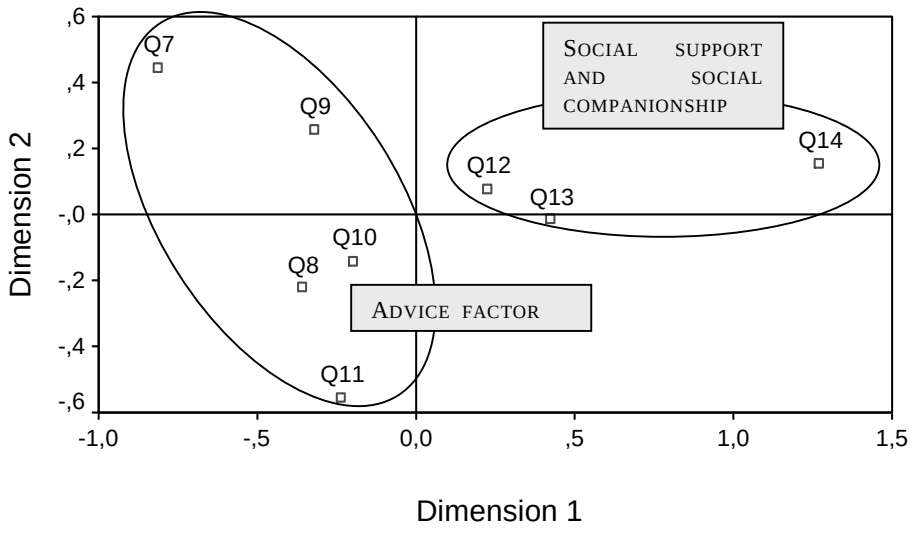

Figure 4: Multi-dimensional scaling 2: Factor 1 and Factor 3 (stress < 0.005).

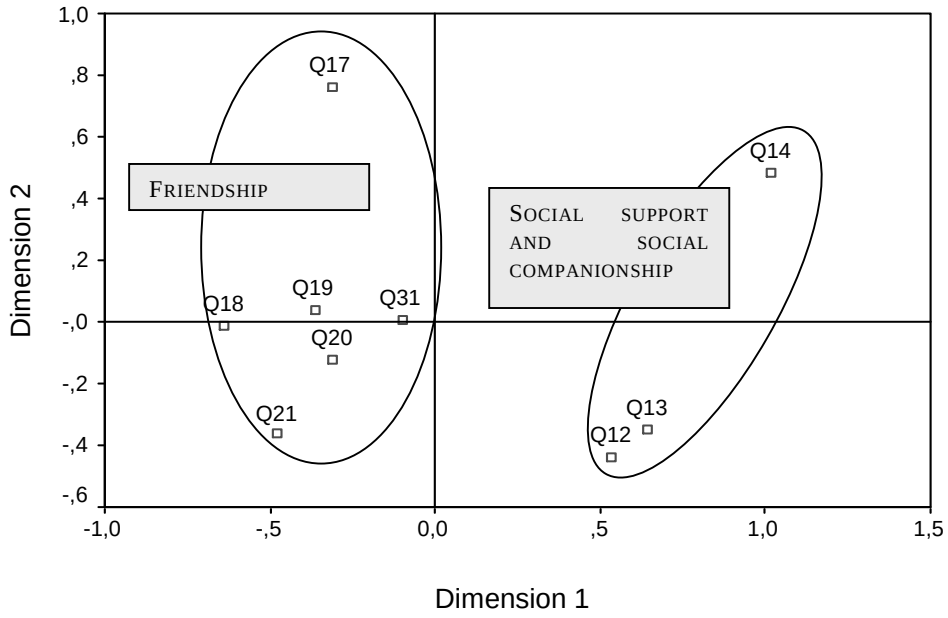

Figure 5: Multi-dimensional scaling 3: Factor 2 and Factor 3 (stress < 0.005).

5.5 Qualitative considerations

Up until now, the second research question is left unanswered. Besides knowing which questions measure which underlying factor, it is important to examine which questions of a particular concept are best suited to be used in further research. In network analysis, more than in other research, restricting the number of questions is essential. As said before, the 'sensitive' and 'threatening' social network questions are supposed to generate more item missing values. This requires a well-considered decision about the number and the type of questions included.

An important criterion in order to select certain types of questions is the proportion of missing values for each of the questions (Table 3). We can distinguish three groups: one with a lot of missing values (Q13 and Q16), a medium amount of missing values (Q8, Q10, Q11, Q14 and Q15) and the rest of the questions with a small number of missing values. Questions having a binary scale (i.e. the type 1a) cannot be compared with questions having an ordinal scale as an answer category (i.e. type 1b, type 2 and type 3 questions). In the case of the dummy variables an answer "zero" might indicate either the absence of a relation or a missing answer. This makes it impossible to calculate the percentage of item missing values in the same way as it can be done for scale questions. Therefore, both groups of questions cannot be compared. Notwithstanding, comparisons within each group and between different groups with scaled answer categories can be made.

A substantial percentage of missing values is found for Q13 (talking about important private problems) and Q16 (people whom one has a row with) vis-à-vis the other dummy variables. Because of the highly sensitive nature of these questions, respondents are less prone to answer it. In comparing the factual questions (type 1b) with the direct questions (type 2) and the semantic differentials (type 3) it is clear that the last two types of questions generate the least amount of missing values. Moreover, within the type 1b group the questions on social companionship and on cooperation have a smaller amount of missing values, than is the case for the other factual questions.

When a choice needs to be made between two questions measuring the same trait, it is advisable to choose the one that provide the researcher with the most high quality data (i.e. with the least number of missing values and generating the largest amount of information). Concerning the advice factor, this means that the factual questions and the direct question need to be preferred above the hypothetical ones. Factual and direct questions generate a lot of information and make it possible to distinguish missing answers from the absence of a relation (by means of a 'never' answer). However, the direct advice question was excluded from the analysis, which makes the current advice factor consisting only of factual questions. None of the questions measuring factor 2, i.e. the friendship dimension, has a large amount of missing values. For future applications, a choice should be

made, depending on content-related criteria, between the different items, except for Q17 (i.e. a dummy scale). Factor 3 consists of three questions, one hypothetical question (Q12) and two scale questions (Q13 and Q14) from which one has a large amount of missing values. It seems necessary to improve the questions to measure this factor.

Table 3: percentage missing values, mean and standard deviation per question.

		percentage missings	mean	std. dev.
Q7	Factor 1-type 1a	4.00	0.256	0.437
Q8	Factor 1-type 1b	20.44	4.210	0.877
Q9	Factor 1-type 1a	0.00	0.150	0.358
Q10	Factor 1-type 1b	20.44	4.500	0.785
Q11	Factor 1-type 1b	18.37	4.400	0.722
Q12	Factor 3-type 1a	4.00	0.120	0.327
Q13	Factor 3-type 1a	32.00	0.096	0.295
Q14	Factor 3-type 1b	12.59	4.710	0.568
Q15	……..-type 1b	13.78	4.330	0.980
Q16	……..-type 1a	60.00	0.096	0.296
Q17	Factor 2-type 2	4.00	0.470	0.500
Q18	Factor 2-type 3	0.15	5.170	1.353
Q19	Factor 2-type 3	1.63	5.090	1.138
Q20	Factor 2-type 3	1.19	3.680	1.545
Q21	Factor 2-type 3	1.19	4.250	1.618
Q31	Factor 2-type 2	0.44	3.880	1.650
Q32	……..-type 2	1.63	4.180	1.349

6 Conclusion

Interest in formal and informal relations as explanatory factors in the organisational research context has been growing steadily. However, little research has yet been devoted to the construction of questions measuring social relations in complete networks. Because of their specific character, social network questions should be developed very carefully. They are perceived as sensitive or threatening questions, that are very burdensome to fill out. Consequently, social network researchers are often faced with severe nonresponse problems. Especially, when estimating complete networks limiting the number of missing values is of major importance. In order to reduce the nonresponse, researcher may interfere at two different moments, i.e. at the data collection phase and/or at the questionnaire construction phase. Concerning the first phase, we made use of a self-administered data collection method – i.e. a websurvey – which makes people more prone to answer sensitive questions. With respect to the construction of the social network

questions, seventeen questions of three different question formats – hypothetical and factual questions, direct questions and semantic differentials – were proposed. Fourteen of these questions are found to measure three different types of relations. Besides on estimating which question measures which underlying concept, our focus is also on the quality of the questions. Notwithstanding the exploratory nature of this research, some interesting results were found.

The first step consisted of ascribing these questions to a particular underlying dimension. One method to detect the overlap between different questions is the QAP correlation procedure. The obtained results indicated that some underlying dimensions might be present. To discriminate between questions we made use of factor analysis, cluster analysis and multi-dimensional scaling. Three different factors were found, representing respectively the advice network (five questions), the friendship network (six questions) and the social support/social companionship dimension (three questions). These findings are confirmed by the cluster analysis and the multi-dimensional scaling procedure. The question about the adversarial relation was omitted from the analysis due to a high number of missing values. Nevertheless, further research is needed on the measurement of negative social network relations. Two questions (the direct advice question and the cooperation question) were found to be measures of more than one underlying concept.

In a second stage, a quality estimation is made for each of the questions belonging to one dimension by means of the item nonresponse rate. Our findings show that semantic differentials and direct questions generate the least number of missing values. On the other hand, factual questions should be preferred above hypothetical questions. They generate more information and have the possibility to distinguish item nonresponse from absent relations. With respect to the advice network a selection should be made from one of the following factual questions: solutions, validation and meta-knowledge (Cross et al., 2001). Further research should focus on the improvement of the item response rate for factual questions. For measuring the friendship network one can choose a question from the four semantic differentials or the direct friendship question. The measurement of the social support/social companionship dimension needs to be improved, since only one question generates a small amount of missing values. More research on this dimension is necessary. In general, this paper improved the measurement of social network relations in two ways. First, by defining different network dimensions that are measured by a limited set of questions. And second, by identifying question formats that produce more high quality data than others.

The preliminary nature of this research makes it necessary to devote attention to the limitations of this research and to the possible ways for future research. One of these limitations concerns the small number of respondents to draw conclusions from. Only 25 employees actually responded to the questionnaire. A large scale research should be developed to retest our main research questions. Moreover, in future research, a comparison between the reported and the actual social network should be made. Knowing how accurate respondents answer on questions of a

particular type, is an important field of research. The fact that people were contacted by means of a websurvey might have an influence as well. Experiments with different self-administered data collection methods – such as paper and pencil and other types of websurveys – might shed new light on the results. Another important restriction of this paper, is the fact that the techniques used to establish the different conceptual dimensions are statistical tools that are developed for data drawn from an independent sample. These methods are not especially developed to deal with network data. Being aware of this, we found it necessary to compare the results of three different techniques. In our case no differences between the techniques are found, but this does not imply that no better suited techniques are available or might be possible. In addition, the reliability of the present findings should be tested (e.g. by means of a test-retest design) in order to make the results more conclusive. Another recommendation for further research is that efforts should be done to integrate these questions into an MTMM design. This complex technique might solve some remaining questions in relation to the construction of appropriate social network questions. Future research should concentrate more on nonresponse reduction, especially in the case of complete networks. It might be possible that certain imputation techniques can solve the most important nonresponse issues. Though the results of this paper are hopeful, a lot of work still remains to be done

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Appendix

Appendix 1: Network question used in the questionaire

Q7: Suppose that you are confronted with a work-related problem, for which you couldn't find a solution yourself. To whom of the members of your research group would you go for advice?
[multiple choice question: dummy]

Q8: Consider all work related problems you had during the past year and for which you couldn't find a solution yourself. How often have you been for advice to each of the members of your research group?
[Five-point scale: daily – some times a week – some times a month – some times a year – never]

Q9: Suppose that you have found a solution for a work related problem. You are not certain about it and confirmation of others would reassure you. To whom of the members of your research group would you go for confirmation?
[multiple choice question: dummy]

Q10: Consider all situations of the past year in which you think to have found a solution for a work related problem. You are not certain about it and confirmation of others would reassure you. How often have you been looking for confirmation to each of the members of your research group?
[daily – some times a week – some times a month – some times a year – never]

Q11: Consider all situations of the past year in which you needed crucial information/data/software, etc. for your work, but you didn't possess it yourself. How often did you obtain this information with the help of each of the members of your research group?
[daily – some times a week – some times a month – some times a year – never]

Q12: Suppose that you are confronted with serious problems at work (e.g. lack of motivation, problematic relation with a colleague). With whom of the members of your research group would you discuss these problems?
[multiple choice question: dummy]

Q13: Suppose that you are confronted with serious problems in your private life (e.g. relational problems, death of a beloved one) lack of motivation, problematic relation with a colleague). With whom of the members of your research group would you discuss these problems?
[multiple choice question: members of research group: dummy]

Q14: How often does it happen that you do a social activity outside the work context with the members of your research group(e.g. going for diner, doing sport, going to the movies, etc.)? [attention: activities that are organised by the university itself, such as following courses or participating in a conference do not belong to this type of social activities!]
(daily – some times a week – some times a month – some times a year – never)

Q15: Consider all situation of <u>the past year</u> in which you cooperated with some members of your research group. With cooperation we mean: working together on the same project, solving problems together, etc.. Occasional advice does not belong to this type of cooperation. How often have you cooperated with each of the members of your research group during the past year?
*[*daily – some times a week – some times a month – some times a year – never]

Q16: In a work situation it can happen that members of a research group do not get along with each other. It could be that you have a row with some members of the research group, it could be that you try to avoid contact with particular colleagues, that you can't get on with someone, etc. With whom of the members of the research group can't you get along?
[multiple choice question: dummy]

Q17: In an organisation it often happens that people have only superficial contacts with particular colleagues, such as doing a meaningless talk about the weather, etc. With whom of the members of your research group do you have a rather superficial relation?
[multiple choice question: members of research group: dummy]

Q18: Look at the following opposite adjectives: "distrust – trust". The more left you tick of a box, the more you associate your relation with a particular colleague with "distrust". The more right you pick of a box, the more you associate you relation with that colleague with "trust".
[distrust (-3)/ trust (+3)]

Q19: Look at the following opposite adjectives: "hostile – friendly". The more left you tick of a box, the more you consider your relation with a particular colleague as "hostile". The more right you pick of a box, the more you consider your relation with that colleague as "friendly".
[hostile (-3)/ friendly (+3)]

Q20: Look at the following opposite adjectives: "superficial – profound". The more left you tick of a box, the more you consider your relation with a particular colleague as "superficial". The more right you pick of a box, the more you consider your relation with that colleague as "profound".
[superficial (-3)/ profound (+3)]

Q21: Look at the following opposite adjectives: "formal – informal". The more left you tick of a box, the more you consider your relation with a particular colleague as "formal". The more right you pick of a box, the more you consider your relation with that colleague as "informal".
[formal (-3)/ informal (+3)]

Q31: Consider your relation with each of your colleagues. Can you indicate in what sense you consider that relation as a 'friendship relationship'?
[not at all– totally]

Q32: Consider your relation with each of your colleagues. Can you indicate in what sense you consider that relation as an 'advice relation'?
[not at all– totally]

Appendix 2: QAP-correlation tables

Table A: Qap-correlations: Q7-Q13.

		Q7	Q8	Q9	Q10	Q11	Q12	Q13
		Advice 1-type 1a	Advice 1-type 1b	Advice 2- type 1a	Advice 2-type 1b	Advice 3-type 1b	Support1 type 1a	Support2 type 1a
Q7	Advice1-type 1a	1,000						0,315 (0,000)
Q8	Advice1-type 1b	-0,512 (0,000)	1,000					-0,483 (0,000)
Q9	Advice2-type 1a	0,522 (0,000)	-0,518 (0,000)	1,000				0,479 (0,000)
Q10	Advice2-type 1b	-0,434 (0,000)	0,770 (0,000)	-0,630 (0,000)	1,000			-0,516 (0,000)
Q11	Advice3-type 1b	-0,395 (0,000)	0,625 (0,000)	-0,488 (0,000)	0,678 (0,000)	1,000		-0,397 (0,000)
Q12	Support 1-type 1a	0,331 (0,000)	-0,433 (0,000)	0,518 (0,000)	-0,484 (0,000)	-0,341 (0,000)	1,000	0,810 (0,000)
Q13	Support 2-type 1a	0,315 (0,000)	-0,483 (0,000)	0,479 (0,000)	-0,516 (0,000)	-0,397 (0,000)	0,810 (0,000)	1,000
Q14	Companion-type 1b	-0,189 (0,006)	0,290 (0,000)	-0,148 (0,006)	0,262 (0,001)	0,278 (0,001)	-0,353 (0,000)	-,498 (0,000)
Q15	Coop-type 1b	-0,253 (0,000)	0,493 (0,000)	-0,408 (0,000)	0,457 (0,000)	0,427 (0,000)	-0,294 (0,000)	-,241 (0,000)
Q16	Row-type 1a	-0,052 (0,475)	0,008 (0,353)	-0,089 (0,202)	0,0987 (0,223)	0,191 (0,018)	-0,115 (0,088)	-0,084 (0,332)
Q17	Superficial-type 2	-0,146 (0,027)	0,315 (0,000)	-0,246 (0,000)	0,301 (0,000)	0,311 (0,000)	-0,267 (0,000)	-0,302 (0,000)
Q18	Distrust-type 3	0,231 (0,000)	-0,266 (0,000)	0,307 (0,000)	-0,296 (0,000)	-0,303 (0,000)	0,276 (0,000)	0,293 (0,000)
Q19	Enemie-type 3	0,223 (0,000)	-0,306 (0,000)	0,286 (0,000)	-0,325 (0,000)	-0,316 (0,000)	0,319 (0,000)	0,348 (0,000)
Q20	Superficial-type 3	0,158 (0,031)	-0,276 (0,000)	0,276 (0,000)	-0,351 (0,000)	-0,304 (0,000)	0,373 (0,000)	0,441 (0,000)
Q21	Formal-type 3	0,215 (0,002)	-0,246 (0,000)	0,259 (0,000)	-0,219 (0,002)	-0,263 (0,001)	0,355 (0,000)	0,365 (0,000)
Q31	Friendship-type 2	0,0689 (0,368)	-0,289 (0,000)	0,222 (0,000)	-0,330 (0,000)	-0,281 (0,000)	0,322 (0,000)	0,423 (0,000)
Q32	Advice4-type 2	0,266 (0,000)	-0,363 (0,000)	0,346 (0,000)	-0,371 (0,000)	-0,307 (0,000)	0,242 (0,000)	0,247 (0,000)

Table B: Qap-correlations: Q14-Q20.

		Q14 Compa-nion type 1b	**Q15** Coope-ration type 1b	**Q16** Row type 1a	**Q17** Super-ficial type 2	**Q18** Distrust type 3	**Q19** Ennemie type 3	**Q20** Super-ficial type 3
Q7	Advice1-type 1a	-0,189 (0,006)	-0,253 (0,000)	-0,052 (0,475)	-0,146 (0,027)	0,231 (0,000)	0,223 (0,000)	0,158 (0,031)
Q8	Advice1-type 1b	0,290 (0,000)	0,493 (0,000)	0,0076 (0,353)	0,315 (0,000)	-0,266 (0,000)	-0,306 (0,000)	-0,276 (0,000)
Q9	Advice2-type 1a	-0,148 (0,006)	-0,408 (0,000)	-0,089 (0,202)	-0,246 (0,000)	0,307 (0,000)	0,286 (0,000)	0,276 (0,000)
Q10	Advice2-type 1b	0,262 (0,001)	0,457 (0,000)	0,099 (0,223)	0,301 (0,000)	-0,296 (0,000)	-0,325 (0,000)	-0,351 (0,000)
Q11	Advice3-type 1b	0,278 (0,001)	0,427 (0,000)	0,191 (0,018)	0,311 (0,000)	-0,303 (0,000)	-0,316 (0,000)	-0,304 (0,000)
Q12	Support 1-ty 1a	-0,353 (0,000)	-0,294 (0,000)	-0,115 (0,088)	-0,267 (0,000)	0,276 (0,000)	0,319 (0,000)	0,373 (0,000)
Q13	Support 2-ty 1a	-,498 (0,000)	-0,241 (0,000)	-0,084 (0,332)	-0,302 (0,000)	0,293 (0,000)	0,348 (0,000)	0,441 (0,000)
Q14	Companion-type 1b	1,000	0,104 (0,242)	0,075 (0,408)	0,274 (0,000)	-0,092 (0,245)	-0,267 (0,000)	-0,380 (0,000)
Q15	Coop-type 1b	0,104 (0,242)	1,000	0,126 (0,119)	0,361 (0,000)	-0,157 (0,04)	-0,246 (0,001)	-0,342 (0,000)
Q16	Row-type 1a	0,075 (0,408)	0,126 (0,119)	1,000	0,348 (0,000)	-0,496 (0,000)	-0,427 (0,000)	-0,283 (0,000)
Q17	Superficial-type 2	0,274 (0,000)	0,361 (0,000)	0,348 (0,000)	1,000	-0,306 (0,000)	-0,428 (0,000)	-0,541 (0,000)
Q18	Distrust-type 3	-0,092 (0,245)	-0,157 (0,04)	-0,496 (0,000)	-0,306 (0,000)	1,000	0,712 (0,000)	0,536 (0,000)
Q19	Enemie-type 3	-0,267 (0,000)	-0,246 (0,001)	-0,427 (0,000)	-0,428 (0,000)	0,712 (0,000)	1,000	0,670 (0,000)
Q20	Superficial-type 3	-0,380 (0,000)	-0,342 (0,000)	-0,283 (0,000)	-0,541 (0,000)	0,536 (0,000)	0,670 (0,000)	1,000
Q21	Formal-type 3	-0,329 (0,000)	-0,270 (0,001)	-0,333 (0,000)	-0,420 (0,000)	0,396 (0,000)	0,531 (0,000)	0,663 (0,000)
Q31	Friendship-type 2	-0,410 (0,000)	-0,298 (0,001)	-0,361 (0,000)	-0,588 (0,000)	0,340 (0,000)	0,473 (0,000)	0,683 (0,000)
Q32	Advice4-type 2	-0,135 (0,074)	-0,245 (0,001)	-0,145 (0,052)	-0,349 (0,000)	0,288 (0,000)	0,296 (0,000)	0,447 (0,000)

Table C: Qap-correlations: Q21-Q32.

		Q 21 Informal type3	**Q31** Friendship type 2	**Q32** Advice 4 type2
Q7	Advice1-type 1a	0,215 (0,002)	0,069 (0,368)	0,266 (0,000)
Q8	Advice1-type 1b	-0,246 (0,000)	-0,289 (0,000)	-0,363 (0,000)
Q9	Advice2-type 1a	0,259 (0,000)	0,222 (0,000)	0,346 (0,000)
Q10	Advice2-type 1b	-0,219 (0,002)	-0,330 (0,000)	-0,371 (0,000)
Q11	Advice3-type 1b	-0,263 (0,001)	-0,281 (0,000)	-0,307 (0,000)
Q12	Support 1-type 1a	0,355 (0,000)	0,322 (0,000)	0,242 (0,000)
Q13	Support 2-type 1a	0,365 (0,000)	0,423 (0,000)	0,247 (0,000)
Q14	Companion-type 1b	-0,329 (0,000)	-0,410 (0,000)	-0,135 (0,074)
Q15	Coop-type 1b	-0,270 (0,001)	-0,298 (0,001)	-0,245 (0,001)
Q16	Row-type 1a	-0,333 (0,000)	-0,361 (0,000)	-0,145 (0,052)
Q17	Superficial-type 2	-0,420 (0,000)	-0,588 (0,000)	-0,349 (0,000)
Q18	Distrust-type 3	0,396 (0,000)	0,340 (0,000)	0,288 (0,000)
Q19	Enemie-type 3	0,531 (0,000)	0,473 (0,000)	0,296 (0,000)
Q20	Superficial-type 3	0,663 (0,000)	0,683 (0,000)	0,447 (0,000)
Q21	Formal-type 3	1,000	0,562 (0,000)	0,214 (0,003)
Q31	Friendship-type 2	0,562 (0,000)	1,000	0,304 (0,000)
Q32	Advice4-type 2	0,214 (0,003)	0,304 (0,000)	1,000