Low reciprocity rates in acquaintance networks of young adults – Fact or artifact?

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January 19, 2014

Abstract

Empirical studies often report low rates of reciprocity in acquaintance networks. These results, however, are not supported by theoretical assumptions according to which full reciprocity should be assured. To investigate this contradiction, we carried out a full network survey in two longitudinal datasets ($N = 213$ and $N = 197$) and identified possible predictors for reciprocity and their development over time. Therefore, we introduce a distinction between active and passive reciprocity. We evaluate indicators for both, perceptional errors and factual directedness of links as possible causes for low rates of reciprocity. Results include the following: Reciprocity does not increase with the strength of the relation. Mutual links are much more stable over time. Personality traits show to influences on active and passive reciprocity. Implications of our findings are discussed. There is evidence that crucial differences exist between mutual and non-reciprocated links and that the network integration of an actor is represented rather by the mutual links than by all of the ties.

Keywords: acquaintanceships; friendships; acquaintance networks; friendship networks; reciprocity

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1 Introduction

While the value of reciprocity of relations for individuals as well as for societies is often identified and discussed in the literature (e.g. Gouldner, 1960; C. N. Alexander and Campbell, 1964; Clark and Ayers, 1993; Buunk and Prins, 1998), quantitative measures of reciprocity are often only byproducts of other research aims. Reported amounts of non-reciprocated links are often remarkable high (e.g. Shulman, 1976; Antonucci and Israel, 1986). This conflicts with theoretical assumptions. According to these, reciprocal relations cannot be a one-way-street since full reciprocity in reciprocal relationships should be assured (e.g. Gouldner, 1960; Molm et al., 2007). This poses the question if these non-reciprocated links should be regarded as artifacts of the data collection or if they are relevant in empirical studies on social relations.

In this paper, we will present results from longitudinal data of acquaintances of students at the Saxon College of Public Administration (University of Applied Science). This setting provided the possibility to determine network boundaries and therefore allowed a full network survey. With the collected data, it is possible to determine the number of links which are reciprocated and to study the character of those which are not. The development of these links over time is also taken into consideration.

2 Reciprocity: Theory and Empirical Evidence

Reciprocity in acquaintances and friendships must be differentiated into the actual reciprocal exchange of resources (e.g. advise, support or information) and the mere reciprocal identification of a relation including a respective commitment to this link (Laumann, 1969; Hammer, 1984). Usually, theoretical discussions focus on the reciprocity of exchange (Gouldner, 1960; Coleman, 1988; Tacke, 2000; Stegbauer, 2010; Axelrod, 2009).

According to Gouldner (1960), reciprocity is necessary to maintain social structures and its absence is only found in relations of exploitation maintained through asymmetries of power. Coleman (1988, p.S102ff) also describes the formation of social capital as a series of exchange processes were the exchange partners do not seek to cancel out the "credit slips" completely. These exchanges do not have to be of the same kind. While arguing from the very different angle of system theory, Tacke (2000) addresses multiplex links explicitly when she concludes that a mutual cancellation of exchanges is difficult since multiplex relations make it impossible to charge an exchange in one functional system against an exchange in another. Also in Game Theoretical considerations (e.g. Axelrod, 2009; Perc and Szolnoki, 2010), repeated exchange processes are discussed and numerous strategies of actors are evaluated. Most successful strategy is TIT FOR TAT which represents reciprocal action and enables actors to establish cliques of cooperators. If an open series of exchanges is assumed, the optimal strategy is to cooperate if the partner does and to defect if the other defects as well.

All these approaches have in common that relations are defined in a way that exchange processes have to go both ways or do not take place at all, at least if the other partner is not able to force exchanges otherwise.

Empirical network studies often identify network links by asking respondents e.g. to name their six best friends (Verbrugge, 1977; Wellman, 1979) or to whom they would turn to ask for help or advice (Mollenhorst et al., 2008). These studies have in common that the identification of a link reflects no factual transaction but rather an address. Even with the use of a somewhat more concrete question like: "[...] with whom you discussed matters important to you" (Burt, 1985, p.119), knowledge about the nature of the relationship is still limited. This example gives information about the addressability of people rather than about actual interactions, making a person addressable in the first place.

An exception is the use of trace data (Hanneman and Shelton, 2011). These data do provide large and exact datasets of single exchange processes like citation and co-authorship (Kas et al., 2012), advice in Online Social Network (Hua and Haughton, 2012) or twitter message exchanges (Fazeen et al., 2011). But while providing a good insight into the structure of exchanges, the contents of these exchanges are very limited. If we assume multiplex networks of interaction to constitute social relations as a more general concept, we still have to consider name generator techniques to cover a larger range of interactions.

However, survey perspectives of asking about an address on the one hand and theoretical considerations on the other hand can be harmonized. It is indeed an address that remains after a series of exchanges which are not accounted for anymore individually. The assumption of series of exchanges is inherent in all theoretical discussions above. Gouldner (1960) includes in his discussion of reciprocity rights and duties against a background of prior actions. While not being claimed, these rights and duties represent an addressability as well. The argument in Coleman (1988) is similar. He aggregates addresses to what he calls social capital. Even what Axelrod (2009, p.150ff) calls "reputation" is an address in this sense. This address is produced by the observation of a player interacting with others as well, but again, it is a series of interactions that make an actor addressable.

However, large differences exist in the strength of reciprocity between empirical results and theoretical assumptions. In empirical results, reciprocity is stronger than expected by chance but still much weaker in comparison to theory where full reciprocity in the exchange of resources is assumed. These discrepancies cannot be reconciled that easily.

Empirical studies are of course obscured by problems in the reliable identification of links regardless if one asks about exchange or addressability (Laumann, 1969; Hammer, 1984). The collection of direct social interaction data usually relies on self reported data. This makes it difficult to distinguish between a lack of mutual commitment by the respondents which makes the link factually directed and perceptional differences as causes if full reciprocity cannot be observed. The study of Antonucci and Israel (1986) illustrates this very well: Two people were asked at a time whether they provided support to or received support from their alters in six dimensions like "sick care" or "talk with when upset". In this type of questions, one would expect high correspondence rates in provider/receiver reports referring again to

addresses rather than direct actions of exchange. Nonetheless, reports of having provided a certain kind of support like "sick care" or "talk with when upset" by one person and to state having received it by the other were consistent in 79% of the cases ranging from 86% for very close relations to 55% among friends. These very close relations consist mainly of spouses and other family members. Therefore, in our analysis we can expect results closer to the 55% among friends since we chose a different setting.

Apparently, rates of reciprocity are stable for different name generator questions. Influential, however, is in case of egocentered studies the limitation of the number of alters which can be named by ego. This is best illustrated by the fact that a poorly connected actor may name a highly connected one who in turn does not name the first one under his or her e.g. six closest friends. Even if a relation is evaluated equally by both actors, if one of the two actors names the other one at sixth position of closeness it is highly probable that the actor does not emerge under the alters of the other ego (cf. Shulman, 1976, p.316). This particular problem does not occur in a complete mapping of a social network as it is done here.

According to Shulman (1976) and Antonucci and Israel (1986), rates of reciprocity decline with the looseness of a contact. In Shulman (1976), reciprocation rates dropped from e.g. 45.7% for the closest ranked alter over 36.7% for the third to 12.5% for the sixth. This decline cannot be explained simply by the limitation of possible alters since – at least for the first named alters – the name list is assumed to be long enough to allow ego to appear in alters list of closest friends even if not at the same position.

Today ergm and SIENA models are widely used to analyze factors of link creation on a actor base directly (see e.g. Moody, 2001; van Duijn et al., 2003; Steglich et al., 2006; de la Haye et al., 2010; Mercken et al., 2010; Schaefer et al., 2010). These studies show that a trend to reciprocate links exists in acquaintance networks. Due to their focus on link creation however, they do not deliver information about the extent to which links are reciprocated and cannot explain the still existing gap between theory and empirical studies.

In this article, we try to identify possible predictors which might explain the low rates of reciprocity in empirical studies and discuss them as indicators for the two most evident explanations for the absence of reciprocity: variances in the perception of a link and lack of commitment on the alters' part and therefore social relations which are indeed asymmetric. Whereas many empirical research is limited to the study of adolescents (e.g. C. N. Alexander and Campbell, 1964; Clark and Ayers, 1993; Vaquera and Kao, 2008) with our sample of young adults we are able to deliver results which go beyond teenage friendship and acquaintance networks.

3 Hypotheses

This study aims to gain further insight into the reasons why empirical studies lack reciprocity in such high amount. Can we find indicators that contradict theoretical conclusions, stating that any continuous exchange – and it's identification via an address – has to be reciprocal?

If in turn theoretical assumptions are correct, expected deviations from full reciprocity could only be explained by the subjective mis-perceptions of a link. An objectively non-existing link identified by only one actor would result in a false positive link and an existing link not identified by one actor a false negative one, respectively.

According to Shulman (1976), Antonucci and Israel (1986) and Buunk and Prins (1998), reciprocity rises with levels of closeness in a relation. Hence, we pose as well:

H1 Close relations show higher probabilities of reciprocation than weaker ones.

This is an important connection and would reshape all following results. Therefore it enters here. Unfortunately, it provides no indication to answer our primary question because reciprocity itself but also the perception of a relation may be influenced by the strength of a relation.

As stated above, many authors (Gouldner, 1960; Coleman, 1988; Buunk and Prins, 1998) consider a continuous and mutual give and take to be the basis of a stable relationship and the address that summarizes these exchanges should be reciprocal. The absence of this equity should in turn effect the relation negatively which leads us to our second hypothesis:

H2 Mutual links are more stable than directed ones.

The stability argument is essential for the theoretical argument assuming reciprocity. In case **H2** could not be confirmed the theoretical claim for reciprocity would also be weakened.

This study does not limit the number of possible alters that can be mentioned in the survey. Nevertheless, people's limited resources to maintain relations (Hill and Dunbar, 2003) do of course lead to saturations in the number of personal contacts. This may result in differences in the rates of reciprocity between nodes of different degrees. Wasserman and Faust (1994) interprets the indegree of a node as its popularity. Using single links as subject of research, we prefer to refer to the term attractiveness to describe rather the cause than the effect. The indegree is used as an indicator for that. Such an attractiveness may lead to mis-perceptions by the sending nodes to assume a relation that does not exist. The receiving node may not be aware of these incoming links and hence does not reciprocate.

In turn, less attractive nodes may feel a necessity to provide alteri in the survey be it due to social desirability or be it a mis-perception of relationships in a way that some respondents indeed overestimate their network integration. This leads to two hypotheses:

H3 Nodes with less incoming links are more likely to have outgoing links that are not reciprocated.

and complementary:

H4 Nodes which receive many links may not be aware of all these incoming links and therefore reciprocate to a lesser extent.

If confirmed, both hypotheses would represent indications that the lack of reciprocity can be explained rather by different perceptions of actors than by discrepancies in the theory. Therefore, we could assume that non reciprocated links represent false positives created by one actor when there is in fact no link present between the two respective actors.

While reciprocity is seldom analyzed systematically, studies of influence parameters on reciprocity are even scarcer. Regarding individual actor attributes, influence parameters could be e.g. personal characteristics like socioeconomic background or personality dimensions like Neuroticism or Extraversion. Vaquera and Kao (2008) analyzed predictors like socioeconomic background, race and sex. According to their results reciprocity was higher for Asian Americans' and females' friendships and lower for interracial friendships. However, their egocentered design did not allow an ideal identification of structural determinants of reciprocity.While race is no issue in the small East German college in our study, we incorporated socioeconomic background and sex.

If differences in perception whether a link exists or not influences the observed reciprocity rate, it is most plausible that these differences might be influenced by personality itself. Clark and Ayers (1988) included personality dimensions into their study of reciprocity in a sample of junior high school students with no significant results. However, in our study reciprocity is measured in far greater detail and respondents are older. Therefore, an examination of the effects of personality traits on reciprocity might still be reasonable. The Big Five model (Costa and McCrae, 1985, 1992) is in many studies and in different cultures well replicated as a model of personality research. According to this model the five dimensions Neuroticism, Extraversion, Openness to Experience, Agreeableness and Conscientiousness (each with six sub-facets) are suited to describe the personality of individuals as a whole and in it's structure. Those dimensions with relevance to social behaviors might serve as predictors which are especially suitable to explain differences in the observed rates of reciprocity.

The possible effect of e.g. Neuroticism on reciprocity is ambiguous. On the one hand, one could assume negative effects of Neuroticism on reciprocity: Individuals who score high on Neuroticism are for example often characterized by a low adaptability to the requirements of the situation (Hennig and Netter, 2005). According to this, they might feel insecure in challenging social situations which require fast decisions and correct behavior and could therefore tend not to recognize links due to slow acclimatization which would produce false negative links. Regarding possible positive effects on the other hand, One could also assume that it might be important for individuals who score high on Neuroticism to have someone on their side for support due to their anxiety. Therefore, they might recognize links which are not confirmed by their alters. This in turn would produce false positive links.

Another important dimension could be Extraversion, which, according to Pollet et al. (2011) is related to network size on different network layers (support clique, sympathy group, outer layer). Individuals who scored high on the Extraversion measure also had larger networks on all observed network layers. We expect that these differences are not only caused by differences in the network integration of actors but also by different perceptions. Individuals who score high on Extraversion should be more prone to reciprocate incoming links. Due to their sociable nature, they are be more aware of the people around them and therefore recognize connections to others in contrast to introverted individuals who might tend to overlook existing links (false negatives).

Another well suited model to study a person's personality is the RIASEC model (Holland, 1973, 1996) which focuses on six principal types of interests: Realistic, Investigative, Artistic, Social, Enterprising and Conventional. Individuals with a high interest in social activities (social type: helping others, being together with others; enterprising type: leading others, networking with others) should also be more prone to reciprocate incoming links. They should for example feel connected to others due to their social behaviors which were caused by their social interests in the first place. Individuals with low scores on these dimensions might on the other hand tend to overlook existing links (false negatives).

Consequently we pose:

H5 Reciprocity is influenced by personal characteristics (e.g. socioeconomic background, sex) and those personality traits with a social component (see Big 5 and RIASEC model).

As mentioned above, a confirmed H4 would be an indicator that lack of reciprocity could be explained by different actor perceptions. A confirmed H5 would furthermore deliver possible actor attributes which could be responsible for different actor perceptions.

4 Method

The empirical part of this study is based on full network data of students of a German University of Applied Sciences and data of respective actor attributes. In the following, we will describe the setting and our measures.

4.1 Participants and Procedure

For this study, we use two datasets of full acquaintance networks of students who began studying at the *Fachhochschule der Sächsischen Verwaltung Meißen* (FHSV, College of Saxon Public Administration – University of Applied Sciences) in Germany in September 2009 and 2010. Longitudinal data was collected. Students were asked to fill out a questionnaire after two, six and ten weeks after the start of the semester. The entire survey was realized twice and independently with 213 students (36% male) at the first time in 2009 and 197 students (41% male) at the second time in 2010. In the following, these two datasets will be referred to as Meißen 1 (M_1) and Meißen 2 (M_2). Sociodemographic data was collected, in case of M_1: sex, age, accommodation status (dormitory or not), room in dormitory, zip code of home town. The M_2 dataset furthermore includes information about the relationship status. Descriptive statistics are given in Tab. 1. The vast majority of students is under 25 years old, only a few outliers exist with up to 39 years of age in case of M_1 and 38 years in case of M_2. Medians are 19 years for M_1 and 20 years for M_2. Students at the FHSV are subdivided into seminar groups of about 20 people. The vast majority of courses is organized in these seminar groups.

The FHSV is very attractive to study a full network since the majority of students is accommodated in the university dormitory. The town Meißen with 27.500 inhabitants is rather small

Item	Meißen 1 Mean	SD	Meißen 2 Mean	SD
Sex (male=1)	1.64		1.59	
Age	20.9	4.0	21.8	4.3
Boarding school (yes=1)	1.23		1.46	
Relationship status (single=1)*			1.60	
Indegree t_3Q_1	20.8	8.1	18.9	6.0
Indegree t_3Q_2	16.1	7.8	15.3	6.1
Indegree t_3Q_3	7.0	5.1	5.3	3.5
Indegree t_3Q_4	3.0	2.3	2.6	2.0

Table 1: Descriptive analyses of both Meißen datasets.

* full options: single/divorced $= 1$ and steady relationship/married $= 2$

and student life almost exclusively takes place on the campus. This allows a rather clear definition of network boundaries. The setting allowed furthermore to repeat the data collection to validate results since new students are enrolled each year.

In each survey, we used a network questionnaire which was applied at all three waves. The M_1 dataset was accompanied with general questions regarding personal interests. The M_2 survey additionally contained questionnaires to assess personality traits, and leisure interests. An overview is given in Fig. 1.

The collection of full network data requires high response rates (Marsden, 1990). Response rates at M_1 were high, with 90% at the beginning of the survey (time t_1), with a still decent 81% at time t_2 and 69% at time t_3. In the M_2 survey, these rates could be further improved and we achieved rates of 92%, 86% and 80% at t_1, t_2 and t_3 respectively. Indegrees are in most cases significantly lower for non-respondents and drop-outs in M_1 and M_2. A logistic regression analysis however revealed that only the Big Five Openness to Experience – Imagination sub-scale had a positive impact on not dropping out between t_1 and t_3 if predictors as used in Fig. 11 are included.

Generally, non response occurred more frequently in certain seminar groups and links are established with higher probabilities towards nodes within the same seminar group (data not shown). Therefore, it is more probable that a student who refused to answer the questionnaire has in turn again contacts who refused to do so as well. It can even be hypothesized that the decision to cooperate or not may be due to mutual understandings between students. Consequently, the influence of non response is effectively smaller than the up to 31% of nodes (M_1, t_3) which are missing. Of course, a link that led to a node that did not take part in the survey was disregarded as well while measuring of reciprocity.

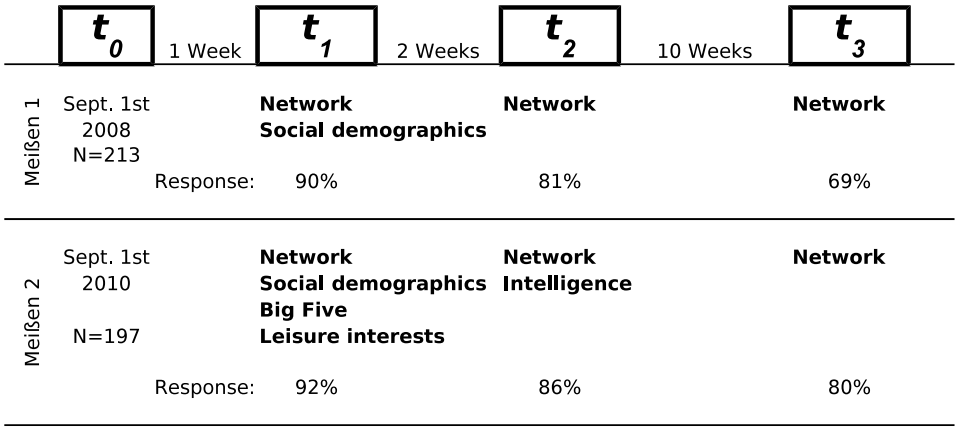

Figure 1: Scheme of data collection.

4.2 Measures

The next sections will give an overview on the three instruments we used: Network properties, Big Five personality traits and Leisure Time Interests.

4.2.1 Network

As stated above, two forms of name generators exist. Both have advantages and disadvantages. If it is asked "Who is your (best) friend?" one refers to a real definition of the term friendship. Another approach is to find indicators for a relation while not being particularly interested in the fact we asked for in the first place. Best example is the question "Who would take care of your house if you went out of town?" (Bernard et al., 1990). The disadvantage of this approach is that we may miss some relations this particular question does not apply to. Therefore different questions have to be posed and still some relations may slip through our fingers. The friendship name generator measures the relation directly but is subject do different interpretations of the term friendship. Moreover, it does not allow for the mapping of different strengths of relations. To do so, we decided to diverge slightly from other sets of relation indicators.

To collect network data, every student was asked the following four questions in respect to every other student in the survey to discover the presence and the strength of personal ties:[1]

Q_1: "Of whom do you know from which place of residence he/she comes from?"

Q_2: "Of whom do you know if he/she is in a permanent relationship or not?"

Q_3: "With whom do you spend your spare time?"

[1]Original questions were: Q_1: Von wem wissen Sie, aus welchem aktuellen Wohnort er/sie kommt?; Q_2: Von wem wissen Sie, ob er/sie in einer festen Beziehung ist oder nicht?; Q_3: Mit wem verbringen Sie Ihre freie Zeit?; Q_4: Mit wem würden Sie über persönliche Probleme reden?

Q_4: "With whom would you talk about personal problems?"

All four questions aim to reflect the dimension of addressability on several levels. However, the quality differs between questions Q_1 and Q_2 on the one hand and questions Q_3 and Q_4 on the other. To answer the first two questions positively the respondent has to be aware and to know the respective person, he or she has to have him or her heard talking about him- or herself and must remember it. It is assumed that in most cases these people did indeed have some face-to-face conversation. To talk about one's personal relationship status assumedly requires a certain level of trust towards the other person.

However, with these two questions we aim not only at the identification of the single exchange of the specific information underlying but at an indicator for an address. In accordance to our initial statement, such an address is a result of some prior multiplex exchange processes even in the case of such weak ties. Both people did not only talk about their places of origin or relationships but repeatedly recognized each other, talked to each other and shared information with each other.

Question Q_3 should produce mutual links since it refers to factual events. Most interesting is certainly question Q_4 because it reflects sources of emotional support. This is combined with self disclosure. Despite of their different character, these four question reflect a broad scope of proximity. Indegrees in Tab. 1 show quite equidistant mean values ranging from 3.0 for question Q_4 to 20.8 for question Q_1.

One might argue that it suffices for answering question Q_2 to have seen the respective person with their partner. This is not very probable because partners the students had before entering the college would seldom be present at the college in the town of Meißen and the share of couples formed during the students stay at the college is probably very low within the first weeks of network creation.

Still, questions Q_1 and Q_2 ask for the availability of knowledge while questions Q_3 and Q_4 ask about interactions. We cannot preclude, that this knowledge does not represent a link. One person i may show some interest in another person j and collects third hand information about j which i is than able to recall. This interest does not have to be reciprocated. In turn, this would lead to much higher rates of non-reciprocated links for questions Q_1 and Q_2. In this case, Q_1 and Q_2 have to be considered with a grain of salt. We will return to this issue later again.

For now, however, lets assume that all four questions reflect different strengths of the same dimension of relationship – which we call *acquaintance* – rather than different dimensions as in multiplex links. This requires those four questions together to constitute a Guttman Scale. To test if this assumption is met, we applied an adjusted version of the Loevinger test: All pairs of items $Q_1 \ldots Q_4$ are compared with each other. A monotonous scale demands that the value of a more difficult item (lets say respondent did not state to spend time with the target person, $Q_3 = 0$) is always smaller or equal as an easier item (but respondent knows if the target person is in a relationship or not, $Q_2 = 1$):

	Meißen 1		Meißen 2	
	Directed	Undirected	Directed	Undirected
t_1	0.95	0.96	0.95	0.96
t_2	0.97	0.97	0.97	0.98
t_3	0.97	0.97	0.98	0.98

Table 2: Loevinger reproduction coefficients R of networks M_1 and M_2 and at times t_1 through t_3 for directed networks and after transformation of the dataset into undirected networks taking only mutually identified links into account

$$Q_i \geq Q_j \text{ if } i < j$$

The Loevinger test consequently counts the number of cases E in which the condition is broken and calculates a reproduction coefficient according to

$$R = 1 - \frac{E}{k} \tag{1}$$

where k is the number of items in the scale. In our case every targeted person m by every respondent n constitutes a scale. For an evaluation of all questions answered by one respondent, the mean can be calculated. We adjusted this test insofar that a targeted persons m is included in the mean only if at least one question $Q_1 \ldots Q_4$ was marked for the respective target. Otherwise the number of consistent scales would become inflated by the large number of target persons who receive not a single link in a single questionnaire and therby always have a Loevinger reproduction rate of one. Tab. 2 shows the results for all times t_1 to t_3. Loevinger reproduction coefficients are always above $R = 0.9$ which is regarded as the threshold value for assuming a Guttman scale. The quality of the Guttman scale becomes even better with time when friendship links are assumed to become more and more consolidated.

To ensure anonymity, a list was handed out with the questionnaires and collected later which provided names of all students of the same year. This technique allowed the students to mark respecting questions in respect to any other student in a matrix of boxes. These surveys led to two longitudinal data sets of four different relational intensities. The fact that students did not know each other at the start of the semester allows to set a first time step at t_0 with no links at all between the 213 and 197 students, respectively. To provide an impression of the the overall connectedness of the network, Fig. 2 depicts the network at time t_3 and question Q_3. The division of students into ten seminar groups had no major influence on the network structure. Only the four specializations students chose separate the network into denser communities.

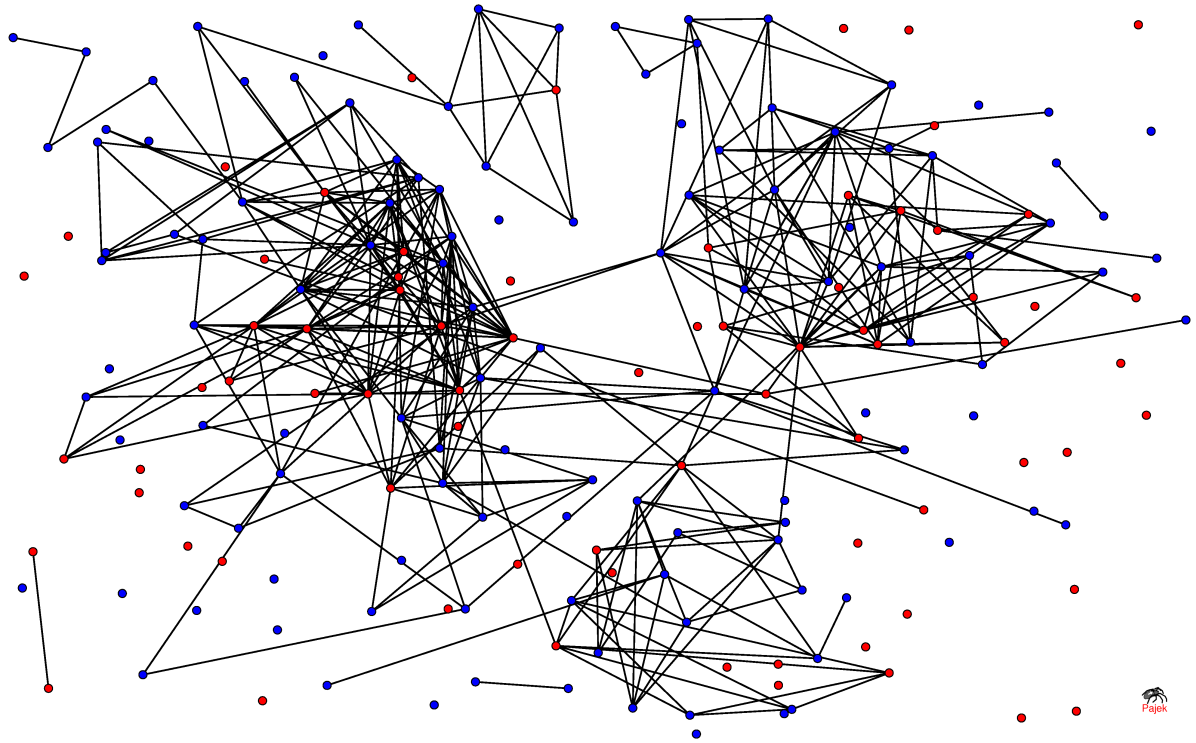

Figure 2: Mapping of the Meißen 1 network at time t_3 and question Q_3. Males are represented by red and females by blue vertices. Edges mark a mutually positive answer to the question: "With whom do you spend your spare time?" 15 unconnected vertices were deleted .

4.2.2 Personality

The short version of the Big Five inventory (BFI-K) (Rammstedt and John, 2005) was administered in M_2. The BFI-K is a 21 item self-report questionnaire measuring the following Big Five domains: Extraversion, containing such characteristics as sociable, enthusiastic and talkative (4 items); Agreeableness, being sympathetic, kind and trustful (4 items); Conscientiousness, being thorough, diligent and reliable (4 items); Neuroticism, being anxious, depressed and worried (4 items); and Openness to experience, having wide interests, being imaginative and profound (5 items). Participants were asked how the 21 statements applied to themselves on a 5 point Likert-scale ranging from *very inappropriate* to *very appropriate*. The reliability and validity of the BFI-K are adequate. Rammstedt and John (2005) showed that Cronbach's αs ranged from .59 to .86 for the different traits, retest reliability ranged from .76 to .93 ($N = 57$, $t = 6$ weeks) and convergent validities ranged from .63 to .82 (to NEO-PI-R domains) for the respective traits. In the present study the αs for the five scales ranged from .60 to .84. To measure the Big Five facets for Neuroticism and Openness to experience, the authors translated the respective twelve sub-scales of the IPIP-NEO-PI-R (Goldberg et al., 2006). Three experts, including the authors, revised the translated items in order to make them as readable as possible. In case of necessity, grammar was simplified. An English teacher who was unfamiliar with the inventory back-translated the items. The back-translated items were reviewed by the authors and some revisions were made. The following Big Five facets of Neuroticism and Openness to experience were assessed. Neuroticism: Anxiety as the level of free floating anxiety, Anger as a tendency to experience anger and related states such as frustration, Depression as the tendency to experience feelings of depression and sadness, Self Consciousness as being shy or experience social anxiety, Immoderation as the tendency to act on ones cravings and urges rather than controlling them and Vulnerability as a general susceptibility to stress. Openness to experience: Imagination as the tendency to turn to the inner world of fantasy, Artistic Interest as the appreciation of art and beauty, Emotionality as the openness to inner feelings and emotions, Adventurousness as the openness to new experiences, Intellect as a curiosity in intellectual questions or materials and Liberalism as the readiness to re-examine ones own values and those of authorities. The items of these twelve sub-scales were mixed to prevent transparency in order to avoid a social desirability answering bias. Participants rated how the statements applied to themselves on a 5 point Likert-scale ranging from *very inappropriate* to *very appropriate*. The αs for the twelve facet scales ranged from .64 to .90.

4.2.3 Leisure Interests

The Leisure Interest Inventory (Stangl, 1991) is a 30 item forced choice questionnaire measuring leisure interests as basic personality traits based on the distinction of occupational interests by Holland (1973). The six measured interest dimensions are: Realistic, encompassing such preferences as manipulation of machines, tools and things; Investigative, interest in trying to understand or predict natural or social phenomena; Artistic, preferring musical or artistic activities; Social, preferring activities which are connected to helping, teaching, counseling,

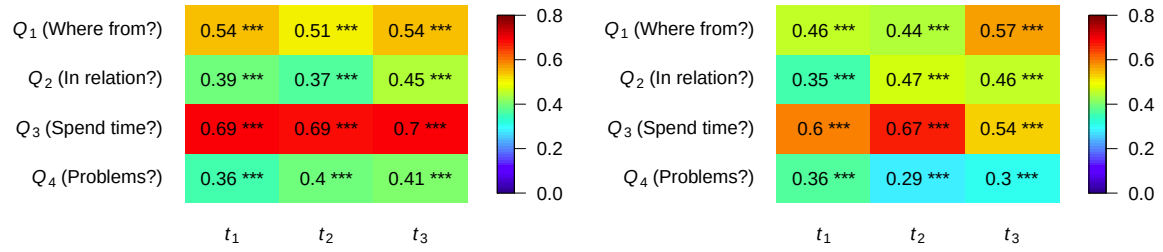

Figure 3: Spearman correlation coefficients between in- and outdegree for all Questions Q_1 – Q_4 and all times t_1 – t_3 (columns) for the Meißen 1 (M_1, *left*) and Meißen 2 (M_2, *right*) dataset. All correlations are highly significant with $p < 0.001$. [2]

treating or serving others through personal interaction; Enterprising, joy in persuading, manipulating or directing others; and Conventional, need to maintain orderly routines or apply standards (Holland, 1996, p.398). Stangl (1991) reported a mean retest reliability of $r_{tt} = .78$ ($N = 14$) and adequate convergent validity coefficients ($r > .30$ to ESV).

5 Results

The difference between the actors' outgoing and incoming links may provide information about the actors' self-perception. Actors who name many targets but do not receive these numbers of links in return probably overestimate their popularity and network integration. On the other hand, some actors name much less targets as they are named by others. These actors apparently posses a certain attractiveness and popularity which is not reflected by their activity. Correlations of in- and outdegrees at all three time steps and both Meißen surveys are shown in Fig. 3 while Fig. 4 presents the distribution of differences between in- and outdegrees.

These correlations indicate large shares of non reciprocated links. As stated earlier, the nature of question Q_3 requires actual mutuality. This might explain the significantly higher correlations for this question. The still slightly higher correlations for question Q_1 are probably caused by saturation effects within the seminar group. Surprisingly low is the agreement of the amount of named and received links at question Q_4. In hypothesis **H1**, we expected that reciprocity increases with further strength of a relationship. Tab. 3 shows that this is not the case. Note, that a high correlation is only a necessary condition for high mutuality but not a

[2] Even though the data used is derived from a full population survey, the respective networks constitute one representation out of a super-population of networks under similar circumstances. Hence, standard statistical measures like standard errors are provided.

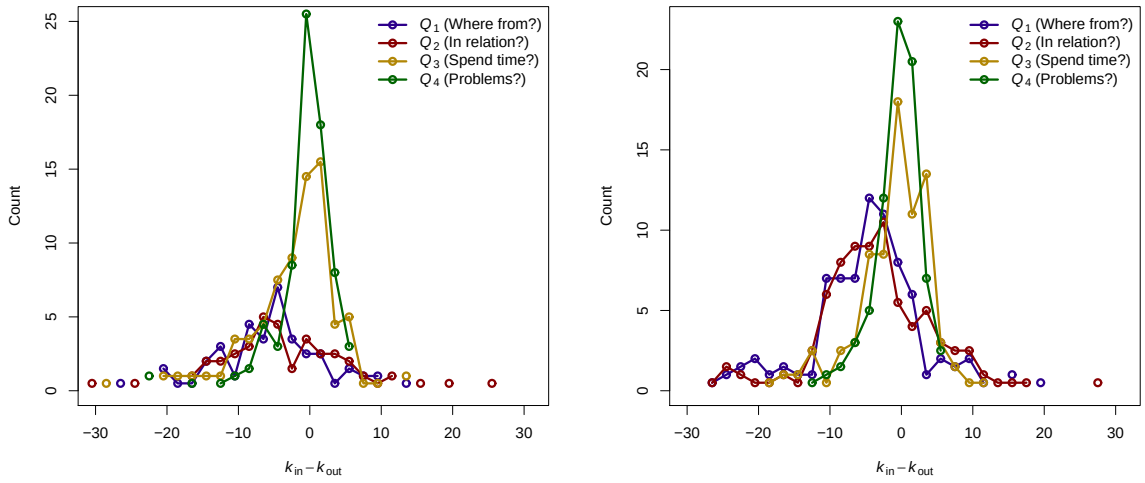

Figure 4: Distribution of gaps between in- and outdegrees at questions Q_1 – Q_4. (M_1 *left*; M_2 *right*)

sufficient one. The concordance of in- and outdegree does show an agreement in a person's attractiveness and activity but does not necessarily mean that these have to be from or to the same person.

The share of outgoing ego links which are in fact returned by the alter is therefore shown in Fig. 5. The probability that a link is returned does not increase with the strength of the relation. The fraction of not returned links rather increases from e.g. 25% (M_1) and 21.5% (M_2) at question Q_1 (t_3) to 49% and 53.3% at question Q_4 (t_3). The smaller number of not returned links at question Q_1 may be (partly) explained by almost fully connectedness within the seminar groups of about 20 persons. If cliques (or groups) would be larger, maybe the rate of non reciprocity would be larger for this question as well.

The fact that reciprocity rates for questions Q_1 and Q_2 are not smaller than for questions Q_3 and Q_4 eases the fear that a large number of directed links at questions Q_1 and Q_2 is only produced by gossip and not by actual interactions.

As the network evolves from a state of complete disconnectedness, it may be argued that rates of not returned links result from fluctuating interpersonal ties. In this period, these rates do not represent the rates of a stable network. Later processes of convergence should lead to a stable network. Such convergences towards reciprocated links can be observed applying dynamic actor-oriented models (SIENA) to the network data (Snijders et al., 2010). We defined a basic model using common effects in such analyses including reciprocity but also structural effects and ego, alter and similarity effects for sociodemographic data. For a full list

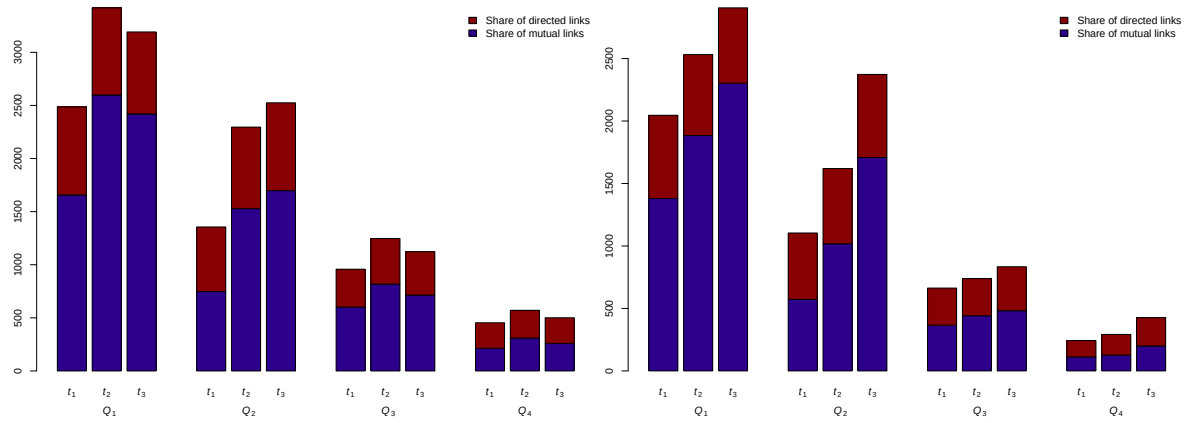

Figure 5: Total number of outgoing links and share of returned ones. (M_1 *left*; M_2 *right*; Rates and standard errors are given in Tab. 3)

		t_1	(SE)	t_2	(SE)	t_3	(SE)
Meißen 1	Q_1	.67	(.01)	.76	(.01)	.76	(.01)
	Q_2	.55	(.01)	.67	(.01)	.67	(.01)
	Q_3	.63	(.02)	.66	(.01)	.64	(.01)
	Q_4	.47	(.02)	.54	(.02)	.52	(.02)
Meißen 2	Q_1	.67	(.01)	.74	(.01)	.79	(.01)
	Q_2	.52	(.01)	.63	(.01)	.72	(.01)
	Q_3	.55	(.02)	.60	(.02)	.58	(.02)
	Q_4	.46	(.03)	.43	(.03)	.47	(.02)

Table 3: Rates of reciprocated links for Meißen 1 and Meißen 2 data. Respective standard errors are calculated by bootstrapping.

			M→						NM→					
			M	(SE)	NM	(SE)	0	(SE)	M	(SE)	NM	(SE)	0	(SE)
Meißen 1	Q_1	$t_{1\to2}$	.89	(.04)	.03	(.01)	.08	(.03)	.58	(.05)	.22	(.04)	.20	(.04)
		$t_{2\to3}$	.93	(.02)	.05	(.01)	.01	(.01)	.37	(.04)	.45	(.04)	.18	(.03)
	Q_2	$t_{1\to2}$	.86	(.05)	.04	(.02)	.10	(.04)	.45	(.06)	.28	(.05)	.27	(.06)
		$t_{2\to3}$	.90	(.03)	.08	(.02)	.02	(.01)	.41	(.05)	.43	(.05)	.16	(.03)
	Q_3	$t_{1\to2}$	.81	(.06)	.06	(.02)	.13	(.06)	.33	(.08)	.27	(.06)	.39	(.08)
		$t_{2\to3}$	.76	(.05)	.15	(.03)	.09	(.04)	.29	(.05)	.34	(.05)	.37	(.05)
	Q_4	$t_{1\to2}$	.78	(.10)	.08	(.05)	.14	(.09)	.26	(.08)	.26	(.08)	.48	(.10)
		$t_{2\to3}$	.69	(.07)	.15	(.05)	.16	(.06)	.15	(.05)	.45	(.07)	.40	(.08)
Meißen 2	Q_1	$t_{1\to2}$	.95	(.01)	.04	(.01)	.01	(.01)	.47	(.05)	.41	(.05)	.12	(.03)
		$t_{2\to3}$	.96	(.01)	.03	(.01)	.00	(.00)	.47	(.05)	.43	(.05)	.10	(.03)
	Q_2	$t_{1\to2}$	.93	(.03)	.05	(.02)	.02	(.02)	.42	(.06)	.44	(.05)	.15	(.04)
		$t_{2\to3}$	.92	(.02)	.06	(.02)	.02	(.01)	.47	(.05)	.40	(.05)	.13	(.03)
	Q_3	$t_{1\to2}$	.86	(.05)	.10	(.03)	.04	(.03)	.28	(.07)	.42	(.06)	.30	(.07)
		$t_{2\to3}$	.74	(.07)	.12	(.03)	.14	(.05)	.25	(.06)	.36	(.06)	.39	(.06)
	Q_4	$t_{1\to2}$	.83	(.09)	.15	(.08)	.03	(.05)	.18	(.07)	.51	(.09)	.31	(.08)
		$t_{2\to3}$	.74	(.10)	.17	(.08)	.09	(.07)	.24	(.08)	.45	(.09)	.32	(.10)

Table 4: Development of mutual (M) and non mutual (NM) links between two time steps ($t_{1\to2}$ and $t_{2\to3}$) into mutual (M), non mutual (NM) or non existent (0) links. Respective standard errors are calculated by bootstrapping.

see Fig. 6. As shown in this figure, reciprocity is indeed one of the strongest effects during new link creation.

Therefore rates of not returned links should decrease over time. Observing the network structure directly reveals that this cannot be confirmed for question Q_4 (see Fig. 5). This surprises insofar that for question Q_4 the SIENA models produced the highest estimates for reciprocity. Only for question Q_1 and Q_2 non-return drops remarkably. Again, this is probably caused by a beginning emergence of fully connectedness within seminar groups. Rates of Q_3 lie between those two cases.

In any case, the hypothesis that mutuality increases with strength of a relationship (**H1**) cannot be confirmed. Mutuality is not lower but higher for weak relationships which are reflected by the question about knowing where a person comes from. This holds even at t_1 where networks within the seminar groups were far from being saturated. Generally, mutuality is low in contrast to results from theoretical considerations of e.g. Gouldner (1960) or Coleman (1988). However, these studies deduct mutuality from mutual processes in friendships. These mutual processes are in turn responsible for the stability of these relations. Nonmutual relations are indeed not stable (**H2**) as shown in Fig. 7. The majority of links which were directed at on time step turn into mutual links or vanish in the following. At questions Q_1 and Q_2, a majority of not returned links changes into mutual at the next time step. At questions Q_3 and Q_4 however, non reciprocated links rather vanish at the next time step. This is plausible because the amount

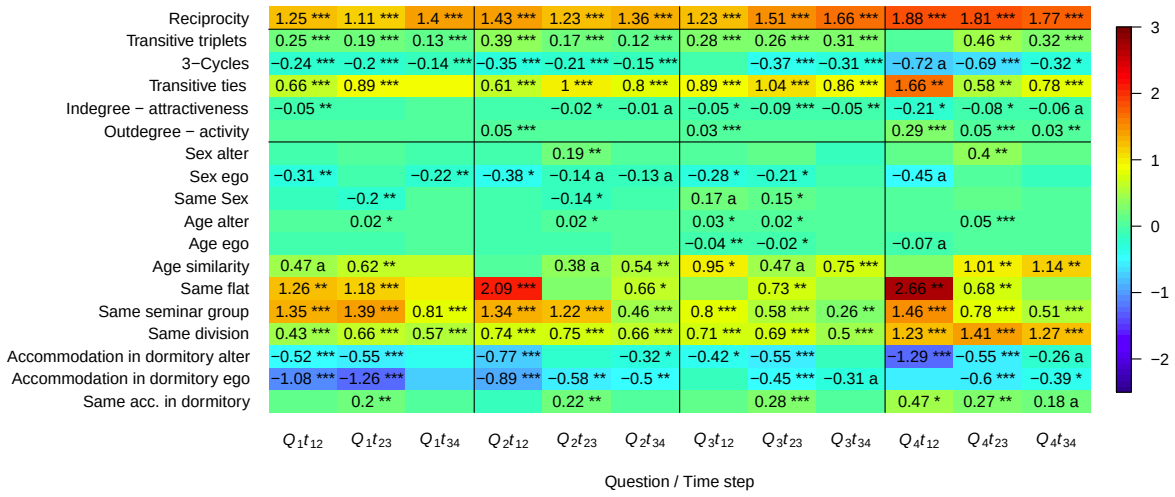

Figure 6: Dynamic actor-oriented models (SIENA) applied to the M_2 data. Parameter estimates with significance levels above $p = 0.1$ are excluded in the depiction. Significance levels are: $^a p < 0.1$, $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$)

of people one can be aware of (Q_1 and Q_2) does not saturate as much as the amount of others one can frequently interact with (Q_3 and Q_4). The total number of links increases during all time steps (compare Fig. 5). Furthermore, saturation of links in seminar groups plays a further role towards fully connected cliques at Q_1 and Q_2. On the other hand, the total number of links in the network does not increase strongly at questions Q_3 and Q_4. Consequently, the establishment of new links is only possible if old links are dropped simultaneously.

This instability of links is not a general effect in acquaintance networks as shown in Fig. 8. Mutual links clearly turn out to be very stable. Hence, social relations are not as volatile as they appear in Fig. 7.

To explain the causes of different strengths of reciprocity (**H3 – H5**), we define active reciprocity as the probability of a specific node to reciprocate an incoming link and passive reciprocity as the share of a node's outgoing links that is reciprocated by all neighbors. This passive reciprocity then represents the probability of an outgoing link from that node to be reciprocated.

In a first step, the analysis is based on degrees as indicators for the activity (outdegree) and attractiveness (indegree) of a node. To test our hypotheses, we focus on links instead of nodes as units of examination. In order to test for example the influence of the indegree of a node on the probability that the nodes links are reciprocated (**H3**), we analyze the dependence between the indegree at the start of a directed link and its probability to be mutual (Fig. 9, first

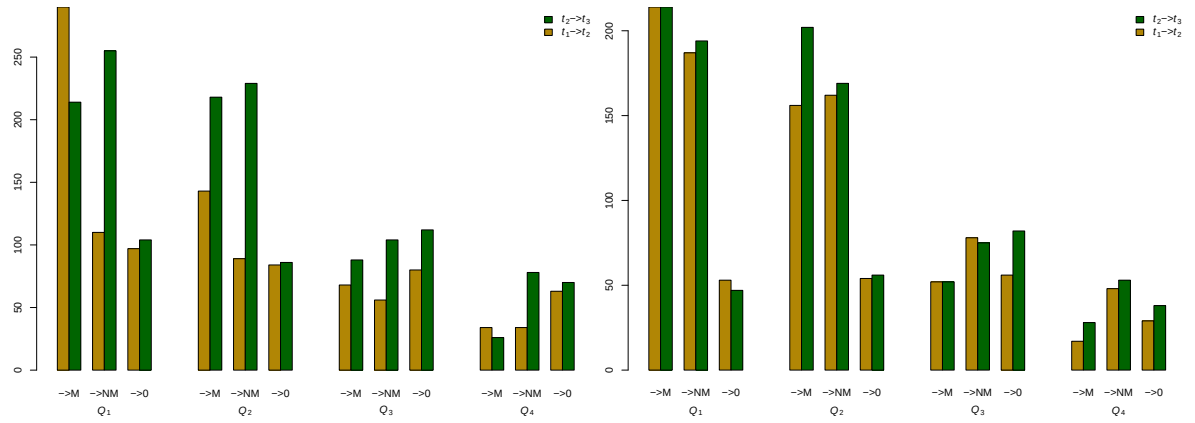

Figure 7: Development of links that were not returned at t_1/t_2 analyzed at the following time step t_2/t_3. Links switch to mutual (M) remain non mutual (NM) or vanish (0). (M_1 *left*; M_2 *right*; Rates and standard errors are given in Tab. 4)

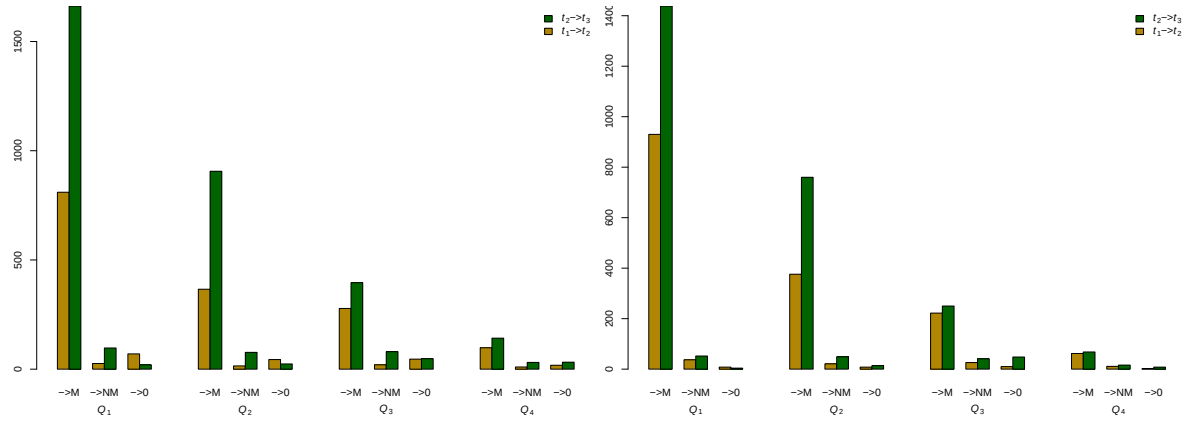

Figure 8: Development of mutual links between t_1/t_2 and the following time step t_2/t_3 respectively. Links remain mutual (M) change to non mutual (NM) or vanish (0). (M_1 *left*; M_2 *right*; Rates and standard errors are given in Tab. 4)

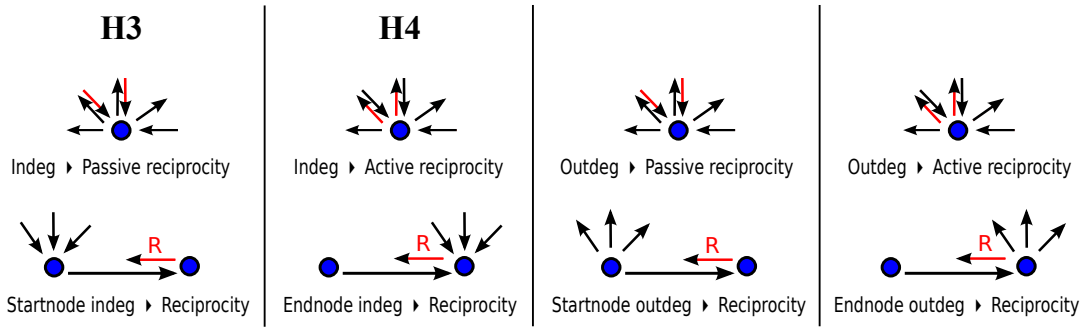

Figure 9: Link versus node reciprocity. Instead of a dependence between indegree and passive reciprocity (first row) the influence of the indegree on the link reciprocity is calculated (second row) to test **H3**. The three other combinations are shown in the following columns. Schematics in the first row show clearly the autocorrelations in this analyses.

column). Equivalent measures based on links and on nodes are shown in the other columns of Fig. 9. The analysis of links instead of nodes inhibits the effect that a node with a low indegree per se faces low reciprocities even in networks were links are distributed randomly between nodes (data not shown). The same applies for the outdegree and the active reciprocity of this node. Both correlate positively in random networks. These effects are therefore considered as artifacts.

In preparation for our analysis, the indegree and the outdegree are calculated at both start and end node of every link in the network. Furthermore, we check if this link is returned (if it is mutual). Every reciprocation of a link leads to an increment of one to the indegree at the start node and to the outdegree at the end node. This causes a slight correlation between both. To suppress this small artifact, these increments are omitted.

With these calculated vectors (cf. row three in Fig. 9), we performed a logistic regression analysis with the emergence of mutuality as the dependent dichotomous variable and four parameters to be estimated: *start node indegree*, *end node indegree*, *start node outdegree*, and *end node outdegree* (cf. columns in Fig. 9). To test the hypotheses **H3** and **H4**, only the first two vectors are necessary. For reasons of completeness and symmetry, we included start node outdegree and end node outdegree as well.

The influence of the start node indegree serves to prove hypothesis **H3** arguing that links that start from nodes with high indegrees (attractive nodes) have higher probabilities to be mutual. The results of the logistic regression are shown in Fig. 10. The first row shows that in fact all dependencies are positive and significant. For closer relationships ("spend time together" – Q_3), odds ratios reach values of up to 1.2 (M_2) and for talking about personal problems (Q_4) 1.35 (M_2). Note, that with the closeness of the relationship in- and outdegrees drop strongly. Therefore we did not make use of a standardization of degrees. But another

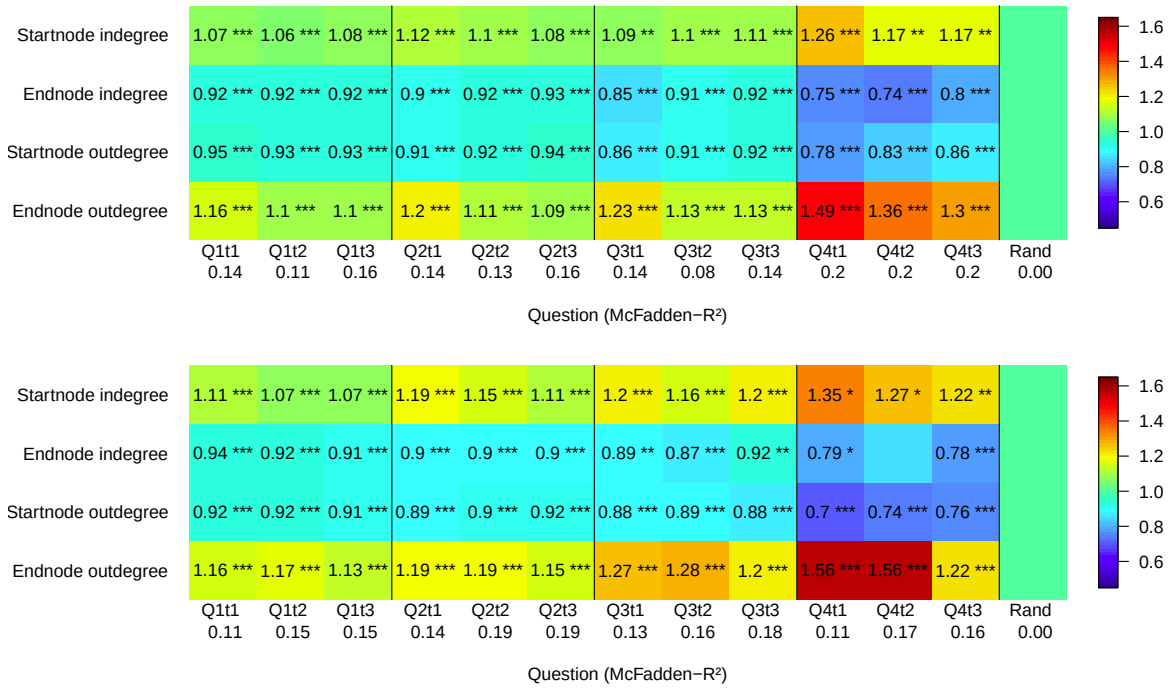

Figure 10: Logistic regression results for the probability of a link being returned for all four questions Q_1–Q_4 at all three time waves t_1–t_3 (columns). Estimated were the influences of the indegree at start and end node and the outdegree at start and end node as well. Parameter estimates are given in Odds Ratios and values with significance levels above $p = 0.1$ are excluded in the depiction. Significance levels are: $^a p < 0.1$, $^* p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$ (M_1 *top*; M_2 *bottom*)

effect becomes obvious if this hypothesis is tested at different times of network establishment: Estimates clearly drop in most cases while students get to know each other better.

Hypothesis four **H4** may be seen as the counterpart of **H3**: Attractive nodes receive per definition lots of links but may be unaware of these and not be able to respond to all incoming links due to saturation effects. This is tested using the indegree of the end node and link reciprocity which corresponds on a node level to the indegree of this node and its active reciprocity (Fig. 9, second column). The second row in Fig. 10 shows that almost all parameters are significant and negative which supports the hypothesis. In most cases, this effect does not diminish over time. Again, the influence of a degree increment of one on the probabilities of link reciprocity increase with decreasing total degrees considering we did not standardize degrees.

But not only the effects we tested turned out to be highly significant. Also the two other related degree effects are significant and in parts very strong: First, the influence of the start node outdegree which corresponds to the impact of the outdegree on passive reciprocity at a

node level, and second, the outdegree of the end node which corresponds to the impact of the outdegree on active reciprocity at node level. Both effects are stable and show no clear change over time.

Actors who name many other students of the FHSV tend to have lower rates of reciprocity (Fig. 9, third column and Fig. 10 row three). This can be explained in the cases of Q_3 and Q_4: respondents apply different thresholds in order to characterize a relationship as existing. However, no differences exist in perceptions of the intensity of the actual relationship. Both actors may agree in their perception of the relation but when asked apply different standards. Weak interpretations of a friendship by these egos are apparently not shared by the alteri. These standards are probably correlated with attractiveness which is obvious if we turn our focus to questions Q_1 and Q_2. Some actors remember more facts about others but alters do not remember facts about them probably due to a lack of awareness or interest. This is plausible since in the Meißen 1 (M_1) dataset passive reciprocities correlate significantly not only between Q_1 and Q_2 ($r = 0.61$***) as well as between Q_3 and Q_4 ($r = 0.45$***) but also in all other cases e.g. between Q_2 and Q_3 ($r = 0.28$**) and Q_2 or between Q_4 ($r = 0.18$*). In the case of the Meißen 2 (M_2) dataset former correlations are somewhat lower: between Q_1 and Q_2: $r = 0.4$*** or between Q_3 and Q_4: $r = 0.37$*** but even higher between Q_2 and Q_3 ($r = 0.36$***) or between Q_2 and Q_4 ($r = 0.19$*).

The next row in Fig. 10 (row four and Fig. 9, fourth column) illustrates the symmetric effect (impact of outdegree on active reciprocity). Nodes that distribute denominations of acquaintances with lower levels of discrimination show higher levels of active reciprocation.

The first two effects rely on the number of links that are indicated by alteri and therefore provide a rather objective measure. The last two effects rely on subjective statements of the respective egos and are therefor more vulnerable to perceptional errors.

For a further characterization of nodes with high or low active and passive reciprocity as hypothesized in **H5**, we turn back to the node level and apply linear regression models where sociodemographic characteristics and personality traits are included. This analysis is limited to the M_2 survey. In- and outdegree have to be included considering they influence reciprocity in two ways: First, as artifacts causing indegrees having a strong impact on passive reciprocity and of outdegrees having the same effect on active reciprocity. Second, all in- and outdegrees affect both passive and active reciprocities as social effects as shown above.

Results of a series of linear regressions analyses for all questions Q_1–Q_4 and both passive and active reciprocity are shown in Fig. 11. The strong influence of degrees in all models is obvious. These models are probably disturbed by high correlations between in- and outdegree (compare Tab. 3). However, variance inflation factors did not exceed values of 1.9. In this analysis both serve as control variables and therefore they are kept.

Despite the fundamental differences between the chance of receiving a reciprocation to a link and the willingness of actors to reciprocate, some symmetry emerges in a comparison while respective reciprocities only slightly correlate. We observe a small but stable influence of the age of students for both passive and active reciprocity. Older students generally show smaller rates of reciprocity. This effect decreases in case of passive reciprocity with

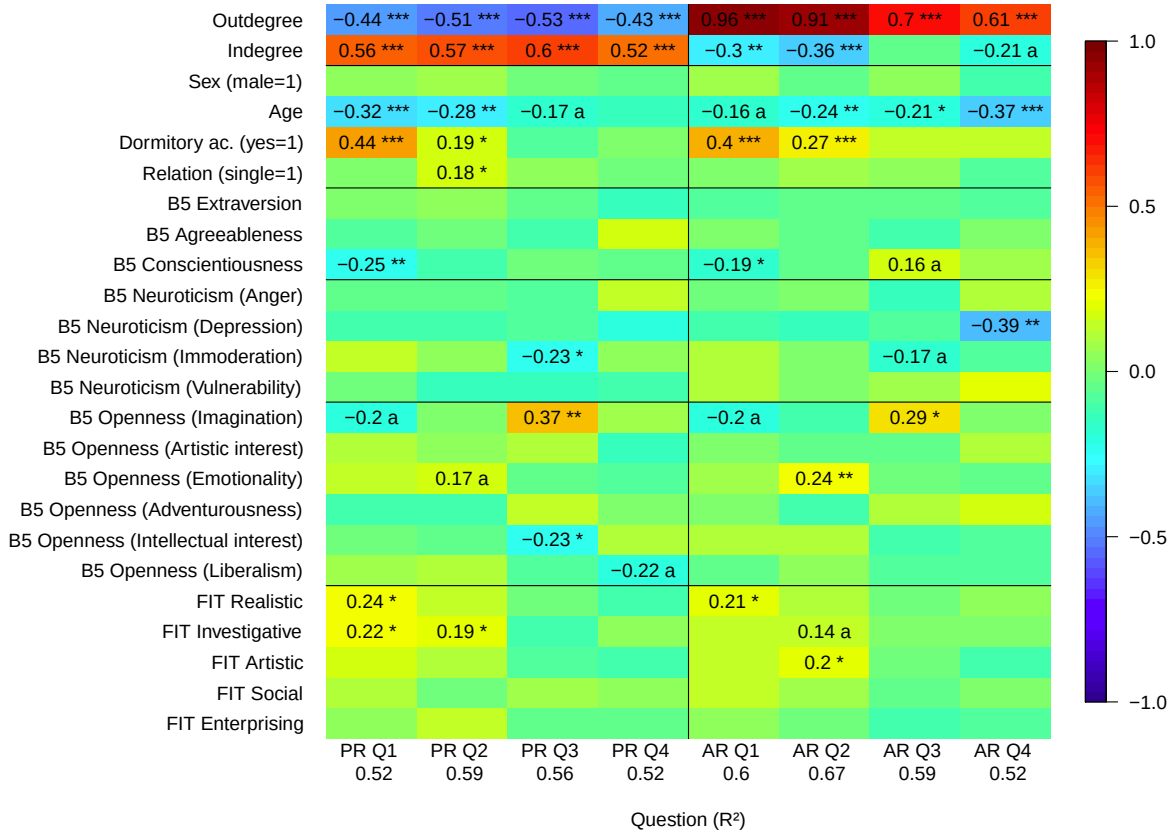

Figure 11: Linear regression models for active (AR) and passive reciprocity (PR) and all four subnetworks Q_1–Q_4 in the M_2 dataset at time t_3. Besides sociodemographic details Big Five traits (B5) and Leisure Time Interests (FIT) served as predictors. Big Five traits Neuroticism and Openness are fanned out into sub-scales. All predictors are kept regardless if significant or not to maintain comparability of all regressions. Exceptions are Big Five Neuroticism sub-scales Anxiety and Self Consciousness and FIT sub-scale Conventional which were removed while not significant to avoid collinearity. Parameters are standardized. Parameter estimates with significance levels above $p = 0.1$ are excluded in the depiction. Significance levels are: $^a p < 0.1$, $^* p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$

the closeness of a link but increases in case of active reciprocity with closeness. University dormitory accommodation has a large impact on the – so to speak – reciprocal awareness of students. Students who are not accommodated in the dormitory have far lower degrees than their fellow students but knowing about each other seems to be a less ambiguous effect. A slight dependence can be observed between being in a romantic relationship and the reciprocated knowledge about it. Students relationship status is known better if they are indeed in a relationship.

Extraversion surprisingly fails to provide an explanation for variations in reciprocation. Hypothesis **H5** can therefore not be confirmed. Conscientiousness influences both reciprocities slightly negative for loose acquaintances of a person and positively to the question of spending time together combined with active reciprocation. Depression is strongly significant in its influence on active reciprocity regarding Q_4, talking about personal problems. Imagination is remarkable for its influence on both active and passive reciprocity on spending time together. Also the influence of emotionality is symmetric again in the question about relationship status. Leisure time interests only have smaller influences on the reciprocation of loose links in the network. This is counter-intuitive again if we look e.g. at the social or the enterprising type.

6 Conclusion

As expected, we found indicators for both, absence of a mutual commitment to a relation and differences in the perception of actors. With regard to the discussion of reciprocity in the literature, links identified by questions Q_3 and Q_4 are of course most interesting but also relations reflected by questions Q_1 and Q_2 implicate some awareness of the other actor and serve for a comparison with closer relations.

The fact that rates of reciprocity do not depend on the closeness of a relation is surprising since other studies showed that closeness has an influence on the rate of reciprocity (Shulman (1976), Antonucci and Israel (1986) and Buunk and Prins (1998) – **H1**). This casts doubts on the assumption that complete reciprocity exists in close relations. It could be on the other hand an indicator for the appearance of mis-perceptions regarding the existence of a link – no matter how strong the relationship seems to be. Results on the stability of non reciprocated and mutual links support theoretical assumptions (**H2**). As stated earlier, theory defines stable relationships by their reciprocity. Our results indicate that this definition is not arbitrarily chosen: Reciprocated relations differ strongly from non-reciprocated ones in their stability. This could legitimize further research to focus only on links which are reciprocated.

Non reciprocated links may in turn be qualified as less important for social networks when seen – in a strict definition – as means to provide stable and reliable access to resources. However, these links still describe certain social roles as results to hypotheses **H3** – **H5** show. Our results show evidence that – in terms of attachment – unattractive nodes indeed seek relations but are satisfied to a much smaller probability than highly attractive nodes. The indirect measure of attractiveness by indegrees and its application in regression analyses may

be worth discussing but it has the great advantage that it cannot be influenced by respondents. Also the counterpart to hypothesis **H3** could be interpreted in a way that it describes roles in social networks: Some nodes in the network attract lots of links but do not respond to them. The same analysis revealed two other possible roles of active nodes as well: Highly active nodes have smaller probabilities to receive a reciprocation but the same nodes also tend to reciprocate links with larger probabilities.

This analysis realized by indirect measures is accompanied by measures of sociodemographic characteristics and personality traits and their influence on reciprocity (**H5**). In this case, we differentiated between active and passive reciprocity as foundations to a description of different roles in networks. Most interesting are again results for questions Q_3 and Q_4. Conscientious students tend to reciprocate links to the question with whom they spend time. Individuals with low scores on the Conscientiousness scale might have a less systematic nature and therefore tend to overlook existing links (false negatives). Immoderate students get these links reciprocated to a lesser extend. Their immoderate nature might lead others to avoid them and to neglect existing links to them. Actors with high values of imagination, on the other hand, do respond strongly and get reciprocated as well. Their positive, creative nature might lead others to like them and increase their visibility, while individuals with low scores on this measure may have a higher chance to get ignored by others. Actors with a characteristic value of depression reciprocate significantly less incoming links to the question with whom to talk about problems. Due to their nature they might tend to overlook existing links and therefore might have the impression not to have any support. Most of these results are plausible and serve as possible explanations why people take up specific positions in the network.

Our study has several limitations. First, the results to the linear regressions in order to examine the influence of socioeconomic variables and personality on reciprocity rates (**H5**) are not very consistent regarding the four different questions Q_1 to Q_4. Further research will have to specify these results in order to achieve a better understanding of the different influential factors of personal actor characteristics on reciprocity.

Second, for our analysis we chose two different entry years of students to improve the degree to which these results can be generalized and to encounter the limitations caused by small datasets. But the strength of our setting is also its weakness: As a first approach to these tests of reciprocity, we chose a setting where intervening variables are limited. Our groups are fairly homogeneous with no larger structural subdivisions. This made such an analysis possible in the first place. However, for further research, it would be desirable to analyze a somewhat more complex network setting in a larger population in order to control for influences such as power or information hierarchies. Such further influences may indeed change our results significantly.

However, results concerning actor differences (see **H3** and **H4**) are very clear and differences in the stability of directed and mutual links are remarkable. These differences appear to justify a differentiation between directed and mutual links.

Conclusively, the answer to our initial question is twofold: We observe a strong distinction between directed and undirected links. While mutual links provide stable relations following

a theoretically deducted definition of a link, directed links are no artifacts but might in turn describe rather actor attributes – roles – in a network but not – at least not directly – the actors network integration.

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