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Psychological predispositions and network structure: The relationship between individual predispositions, structural holes and network closure

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Abstract

We examine the effect of individual psychological differences on network structures, proposing several hypotheses about how individual differences might predispose actors to structure their social environment by seeking network closure or by sustaining structural holes. We introduce a new triad census method to examine personal networks of strong and weak ties. For 125 egocentric networks we correlated the triad census results with several extensively researched psychological instruments. The triad census reduced to three principal components, describing central aspects of strength-of-weak-ties and structural holes theories. Psychological predispositions explained a significant proportion of the variance in each of these components. Our results suggest that people who see themselves vulnerable to external forces tend to inhabit closed networks of weak connections. On the other hand, people who seek to keep their strong tie partners apart, and thereby bridge structural holes, tend to be individualists, to believe that they control the events in their lives, and to have higher levels of neuroticism. Finally, people with strong network closure and "weak" structural holes (as with the "strength of weak ties") tend to categorize themselves and others in terms of group memberships. They also tend to be more extraverted and less individualistic.

Keywords: Structural holes; Strong and weak ties; Egocentric networks; Personality; Neuroticism; Extraversion; Self-monitoring; Locus of control

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1. Introduction

As Mehra et al. (2001) note, social network researchers seldom discuss the possible effect of individual psychological differences on network structure. This absence of psychological descriptions of network actors is in contrast to the common use in network studies of directly observable individual attributes, such as gender in a student network or work group in an intra-organizational network. Such (relatively) stable attributes are often examined, for instance, as sources of social selection, perhaps through homophily processes, with the network seen as partly emergent from the distribution of attributes across the actors. There is plenty of evidence for such homophily effects in the right contexts. What is uncommon is the idea that the psychological traits or predispositions of an individual actor may result in a particular structuring of his or her immediate network environment.

Yet there are examples of social network concepts growing from exclusively psychological origins. For instance, Granovetter's (1973) strength of weak ties theory has clear associations with the notion of structural balance (Cartwright and Harary, 1956), which is a network version of Heider's (1946, 1958) balance theory. Reading Heider's (1946) original paper makes clear that this theory is very much about unseen psychological action occurring within the person: individuals seek "balance" in regard to objects in the world (not just social relations) to avoid dissonance-like outcomes.

Kadushin (2002) has provided a theoretical rationale, based on psychodynamic theories relating to safety and self-efficacy motivations, for how actors' psychological predispositions may structure the networks of their social ties. He argues that an individual's object-relations orientation in early childhood creates motivations that lead to network cohesion and low network constraint in adulthood. Kadushin (2002) is concerned, however, about an implicit reductionism in introducing ideas that apply to individuals and not to groups. We are not sure why there should be pressure for the same theoretical explanation to apply across different levels of analysis. Even in most network accounts, it is at the level of the actor that intentionality is usually ascribed (Robins and Pattison, 2001). But we agree that there is a point about reductionism that needs careful consideration. In advancing claims about individual predispositions and social ties, one needs to be careful about reducing what is a relational process (at the least, dyadic) into a solely individualist explanation, viewed from the perspective of one partner only. In other words, an individual's network partners are actors themselves and there needs to be some process of concordance between individual and partner to permit a social tie to form. Nevertheless, assuming that individuals are in a sufficiently unconstrained social environment so that it is possible to choose or reject social partners, the psychological predispositions of actors are likely to influence social choices and to that extent will shape the network (see also Hallinan and Kubitschek, 1988).

Of course, it is also the case that actors' social choices may influence their psychological predispositions. In this paper, however, we focus on several psychological traits that a considerable body of theoretical and empirical evidence suggests may be enduring and relatively stable from infancy onwards. Given this evidence, it is plausible to treat these predispositions as antecedents to network structure. (See Klein et al., 2004; Mehra et al., 2001 for similar approaches). We will discuss this point further when we introduce psychological trait theory in Section 3.1.

The fundamental issue is, of course, whether psychological predispositions add explanatory capacity to network analysis, a question that has both theoretical and empirical implications. In theoretical terms, network analysts are becoming better at conceptualizing and understanding important global properties of networks; we have longstanding traditions in thinking about and investigating local network properties such as reciprocity and transitivity; and we have made some progress in linking such local network structures to global network properties (e.g. through simulation of models based on localized parameter estimates). Yet we still lack a complete theory of how in a given social context, social relationships might emerge between individuals, each exhibiting certain characteristics. Homophily does some work for us here but is arguably insufficient to explain the variety of social relationships that exist. For instance, it is not clear how structured relationships involving hierarchies could emerge if the only theoretical dimension operating is similarity (Robins and Boldero, 2003). At the basic level of a social relationship between two individuals, psychological predispositions of some sort are likely to play a substantial role in a complex theoretical account.

Empirically, we need to uncover what can be gained from the inclusion of psychological variables. To date, only a handful of empirical studies have taken a lead in examining this question. Mehra et al. (2001) collected network data, job performance data and psychological data (self-monitoring, a psychological trait also assessed in the current study) from 116 members of a high-technology firm. Based on self-monitoring theory (Snyder and Gangestad, 1986; Snyder, 1974, 1987), they argued that chameleon-like high self-monitors, relative to low self-monitors, tended to develop relationships across groups because they were able to be more flexible in their presentation to different people. Their findings suggested that high self-monitors were more likely to occupy central positions in the social network (measured by betweenness centrality), especially when they had longer tenure in the firm. They concluded: "the picture we present ... [is] of people taking advantage of their personality to forge different types of network structures" (Mehra et al., 2001, p. 141).

More recently, Klein et al. (2004) collected the friendship, advice and adversarial networks of 900 individuals in 96 teams across two time-points, 5 months apart. They also examined enduring personal characteristics, such as the "big-five" personality traits (described in Section 3.1). Using Hierarchical Linear Modelling, they found that people who were low in Neuroticism tended to have high degree centrality scores in the advice and friendship networks. Unfortunately, their analysis reports only (in)degree centrality, and hence does not allow for a more complete examination of local networks structures surrounding the respondent.

Burt et al. (1998) also found associations between network constraint and personality. They collected egocentric networks from 51 MBA students, and correlated the network constraint score with a scale constructed by an organizational consultancy for professional development purposes. Burt found that 26 of 252 items had medium correlations with network constraint. They found that respondents with networks rich in structural holes endorsed items depicting independent outsiders who were in search of change and authority. In contrast, respondents with highly-constrained networks (few structural holes) tended to endorse items depicting conformity, obedience, security and stability.

These studies suggest that psychological variables may be of some importance to network structure. Yet, since Burt et al. (1998) used a non-standard psychological instrument with

unknown psychometric properties, Klein et al. (2004) only examined indegree centrality, and all three studies limited themselves to a small number of psychological characteristics, further analysis of the relationship between psychological attributes and local network structure is warranted.

In this paper, by following the work of Burt et al. (1998), Mehra et al. (2001) and Klein et al. (2004) but using a wider range of psychological constructs, we examine the notion that individuals with certain predispositions will tend to shape their immediate network environment in particular ways. We use several extensively researched psychological theories and instruments that we argue relate to an individual's social actions. We present a new method of examining personal networks of strong and weak ties through a census of triads of different types. One important empirical result is that the triad census data can be reduced to three principal components, each of which describe central aspects of strength-of-weak-ties and structural holes theories. And, indeed, we find that psychological predispositions predict a small but significant proportion of the variance in each of these components.

The remainder of this introduction has two parts. First, we briefly review the significance of triads in network explanations, and present a notation for describing the triad census used in the current paper. Second, we introduce two major psychological fields of inquiry: psychological trait theory and identity theories, and use them to hypothesize about possible relationships between psychological qualities and network structure.

2. Triads in network structure

From the first, social network analysts have understood the importance of triads as basic building blocks of social network explanations, since "to derive implications for large networks of relations, it is necessary to frame the basic hypothesis more precisely. This can be done by investigating the possible triads consisting of strong, weak or absent ties among A, B, and any arbitrarily chosen friend of either or both" (Granovetter, 1973, p. 1363). Granovetter, for example, relied heavily on Newcomb's (1961, 1968) and Heider's (1958) balance theories to explain the phenomenon of network closure, and why bridges had to be weak-ties. Simmel (1955) introduced the concept of the "tertius gaudens", the "third who wins", and thus provided the basis of Burt's (1992) structural hole theory. Burt (1992, p. 31) described the essence of entrepreneurship in terms of triads as well: "there are two tertius strategies: being the third between two or more players after the same relationship, and being the third between players in two or more relationships with conflicting demands".

Granovetter (1973) pointed out that the presence of local triadic configurations has implications for global network structure. Triangles of ties suggest redundancy in that any two actors in the triad are reachable by both a one-path and a two-path; they also suggest "closure", in that the paths "close in" on one another. Ties that are not part of a triangle open the possibility that they may lead to "other", possibly "distant", parts of the network, through longer paths that do not have the feature of closure. (Of course, a series of overlapping triangles may also lead to other parts of the network, but in a more inefficient way, in that they require many more ties to do so.) So for a given network density, high local redundancy in a network threatens longer-range network connectivity, which is exactly why the "small world" is an interesting phenomenon (Watts, 1999).

Granovetter's (1973) theory has distinct structural implications at the local level. Strong ties are expected to exhibit closure (hence the "forbidden triad" of two strong ties from the same actor to untied partners). Weak ties, on the other hand, are not expected to exhibit strong tendencies to closure (unless perhaps one weak tie completes an otherwise forbidden triad); so triangles involving three weak ties are not anticipated.[1] These are seen as the natural implications of strong and weak ties, with the ties operating as a "self-organizing" system to create these local structures (see Breiger and Pattison, 1978; Pattison, 1993, pp. 256–258 for an algebraic formulation of this argument).

By stepping back from the importance of the strong/weak tie distinction, Burt's (1992) structural holes theory permitted weak tie closure and strong tie structural holes (i.e., the forbidden triad). Without the strong/weak tie distinction, there is no compelling structural explanation of how ties come to organize themselves to include bridges across structural holes, and the possibility of individual predispositions (the "entrepreneurial personality") comes into play as a means to explain why some people come to occupy these positions.[2]

These are two rather different theoretical views of the emergence of social structure, one centred on self-organization of ties and the other on individual traits or predispositions. Unfortunately, some of the standard summary-measures of local networks (such as network density as a measure of network closure; network constraint[3] as a measure for the existence of structural holes in a network) are too condensed to differentiate the two viewpoints successfully. There is some debate about the efficacy of these indices in any case (Borgatti, 1997) and, as Burt (1992, 1998) acknowledged, network constraint is correlated with network size, making comparisons across networks difficult.

In contrast, by examining different triad proportions in egocentric networks of strong and weak ties, as explained below, we achieve a more direct picture of local network structure. Moreover, we argue that the various structural possibilities (strong tie closure, weak tie closure, strong structural holes, and weak structural holes) are in effect options available to individuals as they seek to construct their social world. It may be that closure is indeed a self-organizing tendency among strong ties, but some of us may have a greater predisposition to keep more of our strong tie partners separate from one another. Others of us may be predisposed to seek network closure amongst our weak tie partners. In other

[1] Although this point is not usually emphasized, we argue it is implicit in Granovetter's general weak tie argument. If weak ties are those that effectively go beyond an individual's immediate social world (i.e., go "somewhere else"), the efficiency of this process (the "strength of weak ties") is achieved by non-closure. Otherwise, overlapping triangles of primarily weak ties have no particular advantage over overlapping triangles of primarily strong ties in efficiently reaching "other" parts of the network.

[2] Other theoretical accounts such as foci of activity theory (Feld, 1981) have been suggested to explain how ties come to self-organize and why structural holes are observed in networks. For example, Feld (1981) suggests that ties self-organize around settings, or foci of activity. Structural holes are likely to be found between actors who participate in incompatible foci of activities. This paper does not focus on these theoretical accounts, but rather examines whether incorporating psychological predispositions assists in explaining local network structures. Of course, if there is some such association, then it may be that psychological predispositions could also influence the type or structure of foci or settings that individuals engage in. This is a matter for ongoing work.

[3] Network constraint $c_{ij} = (p_{ij} + \sum_q p_{iq} p_{qj})^2$ is an indicator of the extent to which person i's network is directly (p_{ij}) or indirectly ($\sum_q p_{iq} p_{qj}$) invested in a relationship with contact j. See Burt (2000, chapter 2) for complete explanation and examples of network constraint and other network metrics for measuring structural holes.

words, the various structural components of the two theories may be distributed across human egocentric networks in various ways, and that distribution may relate in part to psychological predispositions.

2.1. The triad census for egocentric networks

The standard triad census is for complete networks (see Holland and Leinhardt, 1976; Wasserman and Faust, 1994). Other versions of a triad census include the approach presented by Burt (1990), where he suggests that role equivalence can be identified by utilising a triad census consisting of the proportions of directed one- and two-paths of each actor in a complete network. Both these censuses are for complete networks, and do not include strength of tie. In this article we introduce a new triad census for valued egocentric network data.

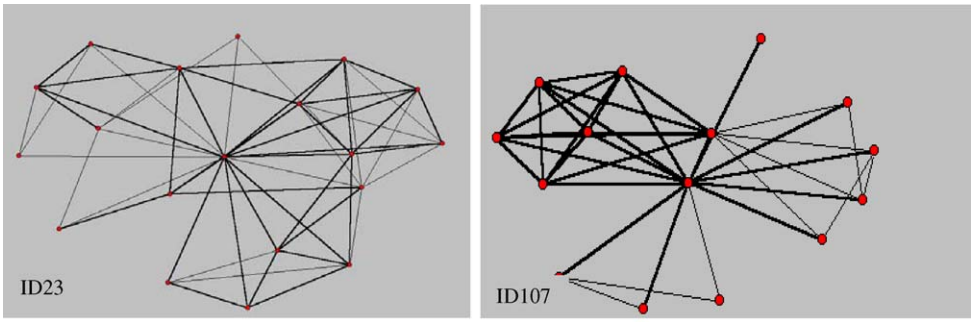
Egocentric networks lend themselves easily to examining triad proportions, since by definition, ego is connected to every other two alters in the network: the name generator elicits only contacts that are related to ego in some way. To create a triad census, one must then ask what is the tie strength between ego and both alters (strong or weak), and what is the tie strength between alters (no tie, weak or strong tie).

Of course, an egocentric approach precludes observation of triads involving individuals with whom ego does not have relationships. This is a problem that afflicts any egocentric data collection. Our assumption is that ego operates principally within a certain "social world" comprising social partners known to ego. So if there are effects relating to ego's personality and local network structure then these will most readily be observed within that social world.

We will now introduce a notation that will enable us to refer to these triads more easily. Given that ego is connected to two alters, alter1 and alter2, we will name the triad that depicts the relationship between these three actors by a three-letter combination. The first letter indicates the strength of tie between ego and alter1 (S or W, for Strong or Weak tie), the second letter the strength of tie between both alters (S, W or N, for Strong, Weak or No tie), and the third letter the strength of tie between alter2 and ego (S or W). Given the symmetry of triads (alter1 and alter2 are interchangeable; SNW and WNS are the same triad), there are nine possible triads that can occur in egocentric networks in which tie strength has three possible values.[4] Our census is not just a count of the various triad types, but rather of the relative proportions of each type against the total number of possible triads given the number of alters in the network. As a result, networks of different sizes can be compared.

Of special interest to us will be the relative proportions of five triads: two triads representing network closure: SSS and WWW (representing strong- and weak-tie network closure, respectively); and three types of structural holes: WNW ("weak" structural holes as implied by Granovetter, 1973); SNS ("strong" structural holes as permitted by Burt, 1992); and SNW, a "mixed" structural hole between a strong and a weak tie. This third structural hole is, of course, permitted by Burt (1992) but is also implied by Granovetter (1973), for if

[4] From now on, these triads will be called by their three-letter combination (SSS, SWS, SNS, WWW, WSW, WNW, SSW, SWW and SNW). The first letter and third letters depict the strength of tie between ego and alters, the second letter depicts the strength of tie between both alters, where S = strong, W = weak, and N = no tie.



	Global network measures				Triad proportions								
ID	Size	Density	Efficiency	Constraint	SSS	SWS	SNS	SSW	SWW	SNW	WSW	WWW	WNW
23	18	.263	.778	.198	.13	.03	.27	.04	.05	.38	.00	.02	.08
107	14	.267	.789	.203	.16	.09	.60	.00	.01	.13	.00	.00	.00

Fig. 1. Two ego-networks with similar global network measures, and different triad proportions.

all weak ties are involved in completing otherwise forbidden triads (e.g. SWS), then weak ties do not get the opportunity to lead "somewhere else" into the network.[5]

By examining the relative proportions of these triads in each egocentric network, we will be able to obtain a direct measure of the relevance of the different structures for that respondent, including the structural holes in their network. For example, Fig. 1 illustrates two networks with similar network constraint scores (.198 and .203, respectively), similar network density (.26) and almost similar network efficiency (.778 and .789, respectively). The main difference between them is that they differ in network size: ID23 (left) has 18 contacts, where the ID107 (right) has 14. A researcher who relied on the usual measures alone might conclude that they have almost similar network structures. However, examination of the triad proportions in Fig. 1 reveals clear differences between the two networks: ID23 has proportionately more weak and mixed structural holes (SNW and WNW), and thus is behaving according to a Granovetter-like theory of self-organizing ties, whereas ID107 clearly has proportionately more "strong" structural holes ("forbidden" SNS triads).

[5] It is only because we are dealing with egocentric networks that we differentiate between SSW with SWS triads, both of which are versions of the otherwise forbidden triad closed by a weak tie. The justification for treating them separately relies on our argument that individuals seek to structure their social world in certain ways, so that the position of ego in a triad is relevant. We pick up this point further in our discussion.

By correlating the proportion of these structures onto the psychological variables, we will be able to see whether these structures map onto psychological attributes in meaningful ways.

3. Bringing psychological attributes into social network analysis

In this section, we briefly summarize certain psychological trait theories and identity theories, and develop hypotheses relating to local network structure.

3.1. Psychological measurement of personality, trait theory

Psychological personality theory assumes that people's behavior can be explained to some extent in terms of underlying personality constructs. Some of these constructs, called trait characteristics, are assumed to be relatively permanent individual characteristics that are stable over time, whereas others, called state characteristics, are assumed to be more contextual and refer to a temporary adoption of a personality characteristic induced by current circumstances (Allport, 1962). All of the psychological characteristics examined in the current study are considered to be stable trait characteristics. So while we remain open to the possibility that the constructs we use may possibly vary for the one individual dependent on that person's changing social circumstances, the best current theoretical and empirical research suggests that such effects are unlikely to be substantial. To the extent that the personality traits are indeed stable, they cannot be the outcomes of changing social network structures as individuals attempt to shape their social worlds. Accordingly, although we are describing a cross-sectional study, we tend to interpret the traits throughout this paper as potential antecedents of local network structure.

Research on personality has generally concluded that most of the variability across individuals can be measured using five different constructs (the "Big Five"): Neuroticism, Extraversion, Openness to Experience, Conscientiousness and Agreeableness (N, E, O, C, A; see Costa and McCrae, 1992, for full definitions and research findings; and also Goldberg, 1999, 1990; John, 1990). Of these five personality dimensions, two may be especially relevant for hypotheses about network structure: neuroticism and extraversion.

People high in neuroticism tend to experience negative emotions such as anxiety, depression and anger. Neuroticism is often considered to be an overall anxiety ("psychological strain") measure. There is a body of research that links neuroticism with perceptions of social support but without using network methodology. This research tends to use generalized "social interaction" instruments such as the semi-structured interview, the Interview Schedule for Social Interaction. Using this instrument, health psychologists have found that people high in neuroticism tend to have a smaller number of social support alters (e.g., Furukawa et al., 1998; Russell et al., 1997; Stokes, 1985). Henderson (1977) also found that people who were neurotic tended to adopt more negative views of others, and be more negatively viewed by them. This conclusion suggests that neurotic people may view their social partners as more weakly connected to them. We hypothesize that people high in neuroticism will exhibit smaller networks (cf. recent results by Klein et al., 2004) with more weak ties (a higher proportion of WWW and WNW triangles).

Extraverts tend to be energetic, cheerful, gregarious, and sociable. They prefer large groups and gatherings, and are more assertive, active and talkative. Extraverts have larger numbers of social support alters (e.g., Bolger and Eckenrode, 1991; Furukawa et al., 1998; Henderson, 1977) who tend to be more diverse (Cohen and Hoberman, 1983).

There may be two countervailing social processes that affect the personal networks of people high in extraversion. First, it seems likely that people who are high on extraversion may prefer not to keep their close network partners separate, and may actively seek to introduce them to one another at social gatherings. Simply because they are more socially active, they may create more opportunities for such interactions. This process would suggest they would have proportionately more SSS or SWS triads and fewer strong structural holes (SNS triangles). Hallinan and Kubitschek (1988) examined the relationship between tolerance for intransitivity and "friendliness". They found that "friendly" students (defined as students with a high indegree centrality) had a lower tolerance for intransitive triads, and would thus tend to remove the intransitivity over time. Given the empirical results of Hallinan and Kubitschek, we hypothesize that extraverts will tend to be high in SSS and SWS, and low in SNS triad proportions.

Nevertheless, it is important to recognise the possibility of an opposing effect. People higher in extraversion may have a sufficiently large personal network so that it is relatively more difficult to introduce all of their friends to each other. (This would reflect the well-known result that for two networks with same average degree, the larger network has lower density). Moreover, if they have diverse network partners, homophily processes may not be as strong in their personal networks. So it remains an empirical question as to the extent to which these two countervailing tendencies operate.[6]

The Big Five personality traits are usually measured with a reliable and highly-researched questionnaire called the NEO-PI (Costa and McCrae, 1992). Recently, a new instrument called the International Personality Item Pool (IPIP, Goldberg, 1999) has become freely available for research purposes. The IPIP is a pool of items that can be used to reliably construct scales for different psychological constructs, among them the Big Five, and is used in our study.

3.2. Self-monitoring

Snyder (1974, 1987) argued that people differ in the extent to which they self-monitor, or observe and control their expressive behavior and self-presentation. More specifically, "individuals high in self-monitoring are thought to regulate their expressive self-presentation for the sake of desired public appearance, and thus be highly responsive to cues of social and interpersonally-appropriate performances. Individuals low in self-monitoring are thought to lack either the ability or the motivation to functionally reflect their own enduring and momentary inner states, including their attitudes, traits and beliefs" (Snyder and Gangestad, 1986, p. 128).

Self-monitoring theory makes clear predictions about the effects of self-monitoring orientation on how individuals shape their social worlds (Snyder, 1987, pp. 59–84). As Burt

[6] We acknowledge the suggestions of an anonymous reviewer in helping to clarify our arguments here.

(1992) claimed that being a strategic player included regulating one's behavior and attitudes, we hypothesize that having many strong structural holes (SNS triangles) in one's network will be associated with high self-monitoring. The study by Mehra et al. (2001), described earlier, supports this hypothesis. Similarly, Padgett and Ansell's (1993) analysis of Renaissance Florence suggests that Cosimo de Medici's rise into power was in part related to his ambiguity and multivocality when dealing with the other Florentine families – his ability to self-monitor. As Padgett and Ansell showed, the Medici family sat at the centre of a star-like network of families, involving many structural holes.

3.3. Locus of control

Rotter and his colleagues (1966) developed and measured the construct of "locus of control", an individual's generalized belief in internalized (self) versus externalized control of the surrounding environment. People who believe they have an external locus of control (externals) see themselves as relatively passive agents. They see events in their lives as due to uncontrollable external forces, rather than as the result of their own actions. Externals consider success in their goals as dependent upon luck, chance and powerful persons or institutions. On the other hand, those who have an internal locus of control (internals) see themselves as active agents, feel that they are masters of their fates and trust in their capacity to influence their environment. The conclusions of Burt et al. (1998) suggest that individuals with less constrained networks may be people who control their environment and shape their social world in accordance to their needs. We hypothesize that a high proportion of SNS triads in the ego-network will be associated with an internal locus of control.

3.4. Social identity: levels of self-construction

Research in cognitive psychology consistently finds that people categorize natural objects at one of three levels of abstraction (Rosch, 1978; Rosch and Mervis, 1975). The level of abstraction one uses to describe an object depends on the context (what one is comparing the object with).[7] Two social-psychological theories have implemented these insights from cognitive psychology into the social world, more specifically, into the way people construct their identity.

Social Identity Theory (Tajfel and Turner, 1979, 1986), and more so its offshoot, Self-Categorization Theory (Turner et al., 1987), claims that Rosch's categorization model also holds for classification of people. People categorize themselves and others at different levels of abstraction (Hogg and McGarty, 1990; Turner, 1999): the superordinate level of humanity (defining one's human identity); the basic level of in-group out-group (defining one's social

[7] For example, one can categorize a pet as a German shepherd (subordinate level of abstraction), as a dog (basic level of abstraction) or as a mammal (superordinate level of abstraction). Since level of abstraction depends on context, one is more likely to refer to the dog as a German shepherd when compared with a Bull terrier (another subordinate level object), rather than when compared to a cat (basic level) or just to another animal (superordinate level).

identity based on group membership); and the subordinate level of self as unique from other group members (defining one's personal identity).[8]

Self-Categorization Theory claims that the level of identity one will utilise in describing oneself depends on context. When context changes so that group (basic level) salience is increased one is more likely to shift from personal-self to social-self descriptions. This shift from personal (subordinate level) to social (basic level) identity entails a depersonalised sense of self, "a shift towards the perception of self as an interchangeable exemplar of some social category and away from the perception of self as a unique person" (Turner et al., 1987, p. 50). These two identities, the personal identity and the social identity, may differ greatly, and Social Identity Theory has devised a reliable psychological instrument, called the collective self-esteem scale (Luhtanen and Crocker, 1992) that measures many related constructs, among them the importance of the social identity to the personal self.

Research has found that when people's social identity becomes salient,[9] they exhibit cognitive biases, selecting for their own group and against other groups. For example, when a social identity becomes salient, people perceive their group members as better than others (ingroup favouritism), as more similar to themselves (ingroup homogeneity) and stereotype against other, "not-us" groups members (outgroup stereotyping; see Hogg and McGarty, 1990; Turner, 1999 for research findings).

We hypothesize that people whose social identity is important to them are more likely to have strong-tie network closure (SSS and SWS triads). Cognitive biases will operate on their partner selection more strongly. They will choose other ingroup members as close friends (because of perceived homophily), and stereotype against "non-group" members, severing relationships with them, leading to strong tie network closure. In contrast, people whose personal identity is more important to them will be less prone to these cognitive biases, and may thus maintain a more diverse network, potentially leading to more "strong" (SNS) structural holes in their network.

Another line of research (e.g., Hui, 1988; Hui and Triandis, 1986, 1989; Triandis et al., 1990) argues that individuals differ in the extent in which they integrate with others and the social environment. This cross-cultural approach suggests that in some cultures people tend to define themselves independently of groups: "They believe that they can stand or fall on their own and survive on their own" (Hui, 1988, p. 18). People who are prototypical of these cultures are called idiocentrics (Triandis, 1994). In other cultures ("collectivist cultures") people see themselves as part of a group, and "value interdependence, even to the extent of submerging the individual in the group. These people consider the group . . .

[8] Hence, one can classify oneself as human (superordinate level); a psychologist, male, Caucasian (basic level) and/or tall, empathic, a risk-taker (subordinate level).

[9] According to Social Identity theory, we have multiple social identities. The social identity that becomes salient at any given moment is dependent on the immediate social context in which one is embedded: if one is a single male in a room of females, the "male" identity may become salient, exhibiting cognitive biases for the ingroup (males) and against the outgroup (females). A different social identity would become salient if one were the only psychologist in a room of medical doctors. Irrespective of what social identity becomes salient, we argue (similarly to Triandis, 1995) that people differ in the overall tendency to endorse their social identities when their social contexts change.

or the collective as the basic unit of survival" (Hui, 1988, p. 18). These people are termed allocentrics[10] (Triandis, 1994).

Almost 15 years of research have been conducted on the characteristics of allocentrics and idiocentrics, using the 29-item Individualism–Collectivism scale (Triandis and Gelfand, 1998). The basic social unit for idiocentrics is the individual (i.e., they categorise people at Rosch's subordinate level of abstraction), whereas allocentrics perceive groups (i.e., Rosch's basic level of abstraction) as the basic social unit. For allocentrics, the self is defined by affiliation with in-groups, whereas idiocentrics view themselves as independent and unique. Idiocentrics prioritize personal goals, but allocentrics prioritize in-group goals (Triandis, 1995).

We hypothesize that people who adopt a "basic-level" view of the social world (i.e., people who are more allocentric and place more importance on their social identity, people who adopt a group focus) will tend to form dense cliques. Thus, they will have many strong, closed triads (SSS, SWS) in their network, and very few "strong" structural-holes (SNS triads).

Burt et al. (1998) found that people with low network constraint tended to be independent people who thrived on change and non-conformity. Such results suggest individuals with idiocentric views. Thus, we hypothesize that people who maintain idiocentric views (i.e., view the world more through their personal identity, through a "subordinate" level of abstraction, adopt an individual focus) are more likely to have more structural holes in their network. We therefore expect a high proportion of strong- and weak-structural-holes (SNS, WNW) triads in their networks.

Table 1 summarises the hypotheses of the current study.

4. Method

4.1. Participants

One hundred and twenty seven first-year psychology students of the university of Melbourne (17 male, M = 19.6 years, S.D. = 2.6 years, 111 females, M = 19.0 years, S.D. = 1.9 years) participated in this study as part of their course requirement. The data was collected during weeks 9–10 of the students' first semester at the University of Melbourne, as it was assumed that people who are transitioning into a new setting are more likely to be proactive in structuring their local network, thus enhancing the link between the individuals' psychological attributes and their social network.

4.2. Materials and procedure

Participants were given a questionnaire booklet containing four psychological questionnaires, a background questionnaire and a network questionnaire. The psychological questionnaires consisted of the following scales:

[10] Although the two levels, cultural and individual, remain connected due to the fact that cultures are made up of individuals, it is important to recognize that within individualistic cultures there exist allocentrics (people with a collectivist orientation), and within collectivistic cultures there exist idiocentrics (people with individualistic orientations).

Table 1
Expected relationship between psychological attributes and triad proportions

Extraversion:
H1a: extraversion will be positively associated with the proportion of SSS triads
H1b: extraversion will be negatively associated with the proportion of WWW triads
H1c: extraversion will be negatively associated with the proportion of SNS triads
Neuroticism:
H2a: neuroticism will be positively associated with the proportion of WWW triads
H2b: neuroticism will be negatively associated with network size
Self monitoring:
H3: self monitoring will be positively associated with the proportion of SNS triads
Locus of control (high score = external locus of control):
H4: locus of control will be negatively associated the proportion of SNS triads
Group focus (allocentrism, strong social identity):
H5a: group focus will be positively associated with the proportion of SSS and SWS triads
H5b: group focus will be negatively associated with the proportion of SNS triads
Individual focus (idiocentrism, strong personal identity):
H6: individual focus will be positively associated with the proportion of SNS and WNW triads

International personality item pool (IPIP50, Goldberg, 1999): This questionnaire measures the Big Five personality dimensions (Neuroticism, Extraversion, Openness to Experience, Agreeableness and Conscientiousness). The version of the IPIP used is similar to the one used by Murray et al. (2004), and endorsed by Goldberg (personal communication).

Self-monitoring scale (Snyder and Gangestad, 1986). This construct was measured by an 18-item, true–false scale. Its validity and reliability are discussed in Snyder and Gangestad (1986) and Kilduff (1992). In the present research, KR reliability coefficient for the scale was .73, similar to the results obtained by Kilduff (1992).

Locus of control questionnaire (Rotter, 1966). This scale consists of 29 forced-choice items, six of which are filler items. Each item consists of a pair of statements. The respondents have to choose between an internal and an external alternative.[11] A total locus of control score is obtained by counting the number of external alternatives chosen (with minimum 0 and maximum 23). A high score indicates external locus of control. Rotter (1966) and others (e.g., Furnham and Steele, 1993) reported adequate to satisfactory reliability and validity for this scale. In the current research, the scale had a KR reliability of .64

Level-of-identity questionnaire. This 11 item Likert-type scale was constructed for the present study, and includes items adapted from Triandis and Gelfand's (1998) Individualism-

[11] The following pair of statements is a clear example: "Many times I feel that I have little influence over the things that happen to me" (external alternative) and "It is impossible for me to believe that chance or luck plays an important role in my life" (internal alternative).

collectivism scale and from Luhtanen and Crocker's (1992) collective self esteem scale (importance of social identity to personal self subscale).[12]

Network measurement. A network questionnaire elicited contacts that were important to each respondent's university life. The name generator elicited significant contacts in up to seven different university-related settings. Four of these settings were predetermined; the three last settings were open-ended. The predetermined settings elicited contacts that were significant for the respondent's: University life (in general); Scholastic achievement; Socializing; and Political activities. The last three settings were unspecified and up to the respondent to complete.

For each network setting, the respondent was asked three questions: how important this setting was; how much time they spent in this setting; and to nominate up to six significant contacts for this setting (nine contacts for the socializing setting). For the three open-ended settings, the respondents were requested to specify the name of the setting and to nominate up to six significant contacts.[13]

The assumption in utilizing settings as a framework for the name generator was to elicit more bridges. Since both Burt (1992) and Granovetter (1973) agree that bridging is the act of connecting different social circles, we assumed that asking about different social situations would elicit more "bridging" relationships.

The contacts named in each setting were assembled into a single list, and participants had an opportunity to add or delete contacts to the list if they felt that it did not fully capture their university-related network. The final list of contacts included up to 18 names. Respondents were then asked to rate the strength of their relationship to each contact on a four-point scale (later recoded into two levels, "strong" and "weak"). Participants then completed a table that indicated the strength of the relationship between each two contacts (strong, weak or do not know each other).

5. Results

5.1. Data treatment

The data were analyzed using the SPSS v. 10.0 statistical package (Nurosis, 2001) and UCINET v. 6.28 (Borgatti et al., 2002). Graphic representations were elicited through Pajek v. 0.85 (Batagelj and Mrvar, 2002). The network questionnaire was examined for missing values. Two cases were dropped from further analyses because these participants did not complete the alter–alter relationship matrix, resulting in a final N of 125.

Level of identity questionnaire. A Principal Components Analysis with Oblimin rotation was performed on the 11 items that constitute the level of identity questionnaire. Using Kaiser's criterion, three components explaining 56.8% of the shared variance were extracted. The three components were interpreted as "Individual focus", "Group focus" and "Independence". Both the Individual focus and Independence components seem to relate

[12] The full scales were not used here in order to keep the time completion of the questionnaire within reasonable limits.

[13] Overall, we received 340 nominations of settings in the "open-ended" settings. All but three respondents nominated at least one additional setting. The additional settings included family (21% of all settings), social (19%), accommodation (14%), sports (13%), other friends (11%), and work (10%).

Table 2
PCA (rotated) oblimin solution for the level of identity questionnaire and explained variance per extracted component

	Individual focus	Group focus	Independence
Being different to other people in my group is important to me	.833		
I like to distinguish myself from other people in my social groups	.680		
My personal identity independent from others is important to me	.645		
I often do "my own thing"	.586	−.405	
In general, belonging to social groups is an important part of my self-image		.780	
I identify strongly with people because they are in one or more of my social groups		.770	
My membership in social groups is not central to how I feel about myself		−.586	
I rely on myself most of the time; I rarely rely on others			.774
I'd rather depend on myself than others			.753
If the groups I belong to are slowing me down, it is better to work alone			.707
The social groups I belong to are unimportant to my sense of what kind of a person I am		−.460	.469
Shared variance	25.4%	19.1%	12.3%

Note: Loadings < .34 were suppressed from the Table.

to idiocentric-type behavior; while the Group focus items seem clearly related to allocentric behavior. The Individual focus component seems associated with persons specifically distinguishing themselves as different from others in their social groups. The Independence component, on the other hand, seems to relate to people not particularly defining themselves in relation to their social groups at all. Table 2 exhibits the pattern matrix, item loadings, explained variance per (rotated) component and scale name. Component scores were computed for each respondent on each subscale.

International personality item pool. The 50 IPIP items were standardized to eliminate differential use of the scales by respondents (Murray, personal communication). Next, a Principal components analysis with oblimin rotation was performed on the standardized IPIP items. Five components were extracted, explaining 45.9% of the shared variance with a component structure easily interpreted in terms of the Big Five personality constructs. Some items did not load substantially on any of the scales. As a result of a series of reliability analyses, five items were removed, so that each scale comprised nine items, which were then summed to a scale score.

Self-monitoring and locus-of-control: Scale scores were computed by summing the relevant items. For the Locus of control scale, external choices were aggregated, so that higher scores reflect more external locus. To make the present work compatible with previous works using the self-monitoring scale (e.g., Kilduff, 1992; Snyder and Gangestad, 1986), the sample was split so that those with scores of 11 or greater were classified as high self-monitors, who therefore constituted 49.6% of the sample.

Table 3
Descriptive statistics for dependent measures: network size, density, constraint and efficiency

	Minimum	Maximum	Mean	Std. Deviation	Skewness (S.E. = .217)	Kurtosis (S.E. = .43)
Proportion of strong ties to alters	.27	1.00	.79	.15	−.738	.526
Proportion of weak ties to alters	.00	.73	.21	.15	.764	.628
Density of strong ties between alters	.02	.59	.23	.11	.745	.664
Density of weak ties between alters	.00	.68	.25	.14	.856	.192
Density of missing ties between alters	.00	.89	.52	.21	−.939	.178
Network Size	6	18	16.13	3.07	−1.79	2.61
Network Density	.11	1.00	.48	.21	.939	.178
Network Efficiency	.06	.90	.55	.19	−.914	.160
Network Constraint	.018	.320	.048	.038	4.791	27.946

Dependent measures: global network measures and triad proportions: Table 3 (upper panel) exhibits descriptive statistics for the proportion of strong and weak ties to alters, and the density of strong, weak and missing ties between alters. As can be seen from Table 3, the final list included more strong-tie network partners (on average, 79% of contacts, S.D. = 15%). Density of strong and weak ties between alters was similar (.23 and .25, respectively).

Network size, density, constraint and efficiency (Burt, 1992, 2000) were calculated for each of the 125 egocentric networks. Table 3 (lower panel) illustrates the central tendencies for these network measures, and reveals that they have unacceptable skewness and kurtosis. Since the assumption of normality underlies the statistical analyses we wish conduct, these variables were transformed: a square root transformation was performed on network density; network efficiency was reflected and a square root transformation was performed, to create a (normally-distributed) measure of network inefficiency. When transformation was unsuccessful in enhancing normality, variables were dichotomized: network size was dichotomized into maximal network size (18, 61.6% of the sample) and less than maximal network size (17 contacts and less); network constraint was dichotomized at the median (.19).

Next, a triad census was compiled based on the nine possible isomorphic classes of strong/weak tie triads, and transformed into triad proportions to allow comparisons across networks. Table 4 exhibits descriptive statistics for the triad proportions.

An examination of Table 4 reveals that on average, the name generator yielded more strong ties: a mean of 34.9% of the triads related to strong network closure (SSS and SWS). The decision to use different social settings in the name generator in order to elicit structural holes yielded a high proportion of structural holes (over 51% of triads), most of them “strong” structural holes (SNS, 27.9%). We can see here that, on average across the sample, some of the characteristics expected from Granovetter (1973) are present (SSS,

Table 4
Descriptive statistics for the nine triad proportions

	Mean	Std. Deviation	Maximum	Skewness (S.E. = .22)	Kurtosis (S.E. = .43)
SSS	.185	.106	.56	1.16	2.111
SWS	.164	.113	.56	.97	.811
SNS	.279	.181	.82	.43	−.258
SSW	.035	.051	.33	3.01	12.580
SWW	.068	.078	.37	1.71	2.821
SNW	.204	.140	.54	.12	−.839
WSW	.010	.020	.14	3.37	15.443
WWW	.015	.031	.20	3.63	16.305
WNW	.033	.052	.29	2.41	6.626

SWS, SNW, and relative absence of weak network closure, WWW), as are some of the features expected from Burt (1992), such as strong structural holes (SNS).

5.2. Relationship of dependent measures to psychological attributes

Table 5 exhibits a series of Pearson correlations (or Chi square analyses, when appropriate) conducted between the global network measures and the attributes. The Table reveals that the denser and more inefficient the respondents' network, the higher their group orientation ($r = .237$, $p < .01$ and $r = .248$, $p < .01$, respectively). Similarly, the more extraverted the respondent is, the denser ($r = .174$, $p = .054$), larger (point biserial correlation = .185, $p < .05$) and more inefficient ($r = .177$, $p < .05$) their network. Finally, the more constrained the re-

Table 5
Pearson Correlations (and chi square coefficients, when appropriate) between the global network measures and the psychological attributes

	(Square root of) network density	(Square root of) network inefficiency	(Dichotomized) network size[a]	(Dichotomized) network constraint[a]
Background variables				
Gender	.025	.015	$\chi^2_{(1)} = 7.26^{**}$	$\chi^2_{(1)} = 1.804$
Age	−.169	−.178*	−.178*	.036
Time spent on campus	−.140	−.136	.195*	.120
Identity variables				
Individual focus	−.035	−.039	−.023	−.081
Group focus	.237**	.248**	.095	.144
Independence	−.064	−.077	−.070	−.185*
Personality variables				
Extraversion	.174[b]	.177*	.185*	.075
Neuroticism	−.139	−.148	−.132	.005
Self-monitoring[a]	.079	.087	$\chi^2_{(1)} = 1.96$	$\chi^2_{(1)} = 0.72$
Locus of control	.029	.026	−.161	.120

[a] Point biserial correlations or chi-square coefficients when both variables are dichotomized.
[b] Approaches significance ($p < .06$).
* $p < .05$.
** $p < .01$.

Table 6
Pearson correlations between psychological attributes and triad proportions

	SSS	SWS	SNS	SSW	SWW	SNW	WSW	WWW	WNW
Background variables									
Gender[a]	−.059	−.036	−.036	.038	.121	−.002	.003	.077	.020
Age	−.122	−.164	.001	−.096	.017	.210*	.016	.013	.099
Time	.025	−.078	.150	−.060	−.222*	.016	−.055	−.141	−.033
Identity variables									
Individual focus	.038	.036	.211*	−.042	−.064	−.178*	−.149	−.065	−.161
Group focus	.226*	.118	−.078	.023	.136	−.166	−.032	.031	−.140
Independence	−.061	−.102	.097	.033	.060	.025	−.033	.061	−.076
Personality variables									
Extraversion	.240**	.135	−.155	−.010	.013	−.027	.005	−.231**	−.060
Neuroticism	−.265**	−.189*	.043	.101	.106	.102	.055	.223*	.114
Self monitoring[a]	.161	.062	.031	−.007	−.059	−.096	−.066	−.109	−.035
Locus of control	−.017	−.104	−.153	.174[b]	.087	.043	.131	.178*	.212*

[a] Point biserial correlations.
[b] Approaches significance ($p < .06$).
* $p < .05$.
** $p < .01$.

spondents' network, the less independent the respondent (point biserial correlation = −.185, $p < .05$). Interestingly, and in contrast to Burt et al.'s (1998) results, background variables were significantly correlated with the network indices: gender was not independent of network size, with women reporting more contacts ($\chi^2_{(1)} = 7.26, p < .01$);[14] respondents' age was negatively correlated with (dichotomized) network size (point biserial correlation = −.178, $p < .05$) and network inefficiency ($r = -.178$, $p < .05$); time spent on campus was positively correlated with (dichotomized) network size (point biserial correlation = .195, $p < .05$).

If we were only to consider network constraint, the results in Table 5 would lead us to conclude, similarly to Burt et al. (1998), that for the most part psychological attributes were not substantially correlated with network structure. Similarly to Burt, we would conclude that people with networks rich in structural holes (low network constraint) were independent individuals. But examination of the association between the triad proportions and the psychological attributes reveals a more complex pattern of relationships between personality and network structure.

Table 6 and Fig. 2 exhibits the Pearson correlations between the psychological attributes and the different triad proportions in the respondents' network.

Hypothesis 1a stated that extraversion would be positively associated with the proportion of SSS triads. This hypothesis was supported ($r = .240$, $p < .01$). Hypothesis 1b, which suggested that extraversion would be negatively associated with the proportion of WWW triads, was also supported ($r = -.231$, $p < .01$). Hypothesis 1c, suggesting a negative association between extraversion and the proportion of SNS triads, was not supported

[14] However, since the ratio of women to men in this sample was greater than the recommended 5:1, this result should be interpreted with some caution.

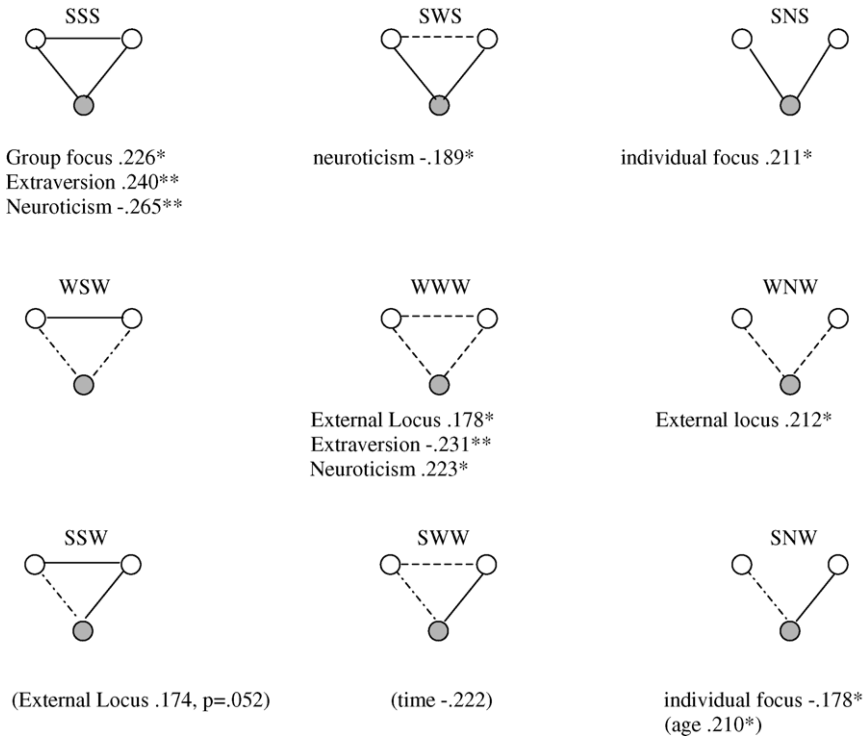


Fig. 2. Psychological attributes associated with each of the triads.

($r = -.155$, ns). However, although the correlation coefficient was not significant, it was in the expected negative direction.

Hypothesis 2a suggested that neuroticism would be positively associated with the proportion of WWW triads. This hypothesis was supported ($r = .223$, $p < .05$). Hypothesis 2b posited a positive association between neuroticism and network size. An examination of Table 5 reveals that this hypothesis was not supported (point biserial correlation = −.132, ns). Table 6 also reveals that the neuroticism is negatively correlated with the proportion of SSS ($r = -.265$, $p < .01$) and SWS ($r = -.189$, $p < .05$) triads.

Hypothesis 3 suggested a positive association between self monitoring and the proportion of SNS triads. This hypothesis was not supported (point biserial correlation = .031, ns).

Hypothesis 4 posited a negative association between locus of control and the proportion of SNS triads. While this hypothesis was not supported ($r = -.153$, ns), the direction of the correlation coefficient was as expected. Surprisingly, locus of control was positively related to the proportion of WWW and WNW triads ($r = .178$, $p < .05$ and $r = .212$, $p < .05$, respectively). A positive trend ($r = .174$, p = .052) was also noted between the proportion of SSW triads and locus of control.

Hypothesis 5a posited that the stronger the respondent's group focus, the higher the proportion of SSS and SWS triads in their network. This hypothesis was partly supported ($r = .226$, $p < .05$ for SSS). A positive, though non-significant trend was observed for the

proportion of SWS triads ($r = .118$, ns). Hypothesis 5b stated that the proportion of SNS triads will be negatively correlated to adopting a group focus, and was not supported ($r = -.078$, ns).

Hypothesis 6 posited that the more of an individual focus a respondent adopts, the higher the proportion of SNS and WNW triads. This hypothesis was partly supported: the correlation between adopting an individual focus and SNS triads was positive ($r = .211$, $p < .05$), but the correlation with the proportion of WNW triads, while non-significant, was negative ($r = -.161$, $p = .073$). Surprisingly, the proportion of SNW triads was negatively correlated with idiocentrism (adopting an individual focus, $r = -.178$, $p < .05$).

5.3. Components of the triad census and their relationship to psychological attributes

An individual cannot set about constructing a social world in which each of the proportions of the triad census is entirely independent of one another: I may opt for a social environment where I have a high proportion of both strong network closure and strong structural holes, but I can only achieve this by having low proportions of weak tie configurations. The previous analysis, examining correlations of each of the triad proportions separately, ignores such necessities. It is important to consider how the nine triad proportions co-vary.

A Principal Components Analysis with oblimin rotation was performed on the nine triad proportions. Three factors, explaining 72.4% of the shared variance were extracted using Kaiser's criterion.[15] Table 7 exhibits the component loadings for the rotated solution, as well as the percentage of the shared variance explained by each component and the component correlation matrix.

Table 7 reveals a clear, three-component structure, which can be readily interpreted in terms of recognized social network structures. The only complex item, loading substantially on all three components, is the SNS triad. The first component, explaining 37.6% of the variance, clearly contrasts weak-tie network closure (SSW, SWW, WWW and WSW) with "strong" structural holes (SNS). Interestingly, these are two features that we do NOT expect to see from Granovetter's (1973) theorization, so this component measures the tendency for different options within a Burt-like, non-Granovetter world. The second component, explaining 23.4% of the shared variance clearly contrasts strong structural holes (SNS) against weak and mixed structural holes (SNW and WNW). Here we have a direct contrast of the forbidden triad against the expected structural aspects (weak and mixed structural holes) in a Granovetter theorization. The third component, explaining 11.5% of the shared variance, contrasts strong-tie network closure (SSS and SWS) against strong structural holes (SNS). This component pits the forbidden triad against a second expected structural feature of a Granovetter theorization (strong tie closure).

Component scores were calculated for each participant. Next, stepwise regressions were conducted, predicting each of the component scores from all psychological and background variables. With 125 cases and 10 independent variables, a forward-selection stepwise regression was chosen to ensure sufficient statistical power for the analyses. Table 8 shows the

[15] Since the triad proportions add to unity, a similar principal component analysis was conducted on the proportion of triads relative to SNS. Results indicated a similar three component structure, suggesting that the structure we found is not a statistical artefact.

Table 7
Component loadings for the (oblimin) rotated three-component solution on triad proportions

Triad	Factor		
	Weak-tie network closure	Strong vs. weak structural holes	Strong-tie network closure
SSW	.915		
SWW	.838		
WWW	.685		
WSW	.487		
SNW		−.893	
WNW		−.755	
SSS			.741
SWS			.717
SNS	−.432	.654	−.662
Percent variance explained	37.60	23.37	11.45
Component correlation matrix	1. weak tie network closure	2. Strong vs. weak structural holes	
2. Strong versus weak structural holes	−.275		
3. Strong-tie network closure	.01	.270	

Note: loadings under .34 are suppressed from this pattern matrix.

standardized regression coefficients for the predictors in the final models and the explained variance for final models of the three stepwise regressions.

5.4. Predictors of weak network closure (component 1)

The only significant predictor of component one ("weak network closure", pitting SWS, SWW, WWW and WSW against SNS) was locus of control ($F_{(1,123)} = 4.5$, $p < .05$). The selected model, predicting only a small proportion (3.6%) of the variance, suggested that external locus of control was positively associated with an increase in weak network closure compared to SNS triads (standardized coefficient = .118). In other words, people who believe that they themselves do not have a strong effect on what happens to them in life are more

Table 8
Results of final stepwise regression models predicting the components from the psychological attributes.

	Standardized regression coefficient	t	R^2
Predictors of weak-tie closure			
Locus of control	.118	2.12*	.036
Predictors of strong-versus weak structural holes			
Individual focus	.227	2.58*	.044
Predictors of strong-tie network closure			
Group focus	.229	2.72**	.148
Extraversion	.191	2.10*	
Neuroticism	−.192	−2.10*	

* $p < .05$.
** $p < .01$.

likely to find themselves in cliques of many weak ties, and not have lots of "separated" strong tie partners. It takes a belief in one's own agentic capacity to keep strong partners apart and to have weak ties going to parts of the social world distinct from one's own personal network.

5.5. Predictors of strong- versus weak-structural holes (component 2)

The only significant predictor, explaining (a small, but statistically significant) 4.4% of the variance in component two ("strong- versus weak-structural holes", SNW and WNW against SNS) was adopting an individual focus (idiocentric, $F_{(1,123)} = 6.8$, $p < .01$). An increase in individual focus was associated with an increase in strong (SNS) structural holes (standardized coefficient = .227). People who focus on being different from others, including others in their own "social group", are more likely to have separated strong tie partners. People who do not focus on being different from others are more likely to behave as Granovetter expected, with fewer forbidden triads and weak ties leading to other parts of the social world.

5.6. Predictors of strong-tie network closure (component 3)

Three significant predictors, explaining 14.8% of the variance in component three ("strong-tie network closure", pitting SSS and SWS against SNS) were group focus, extraversion and neuroticism ($F_{(3,121)} = 7.0$, $p < .01$). Group-focus was associated with an increase in strong-tie network closure (SSS and SWS, standardized coefficient = .229). Extraversion was associated with an increase in the probability of strong-tie network closure (SSS and SWS, standardized coefficient = .191). Surprisingly, neuroticism was associated with a decrease in strong tie network closure (standardized coefficient = −.192). People who see their "social groups" as important to them are more likely to behave as Granovetter expected, with strong tie network closure and without forbidden triads. Extraverts seem to live in networks with fewer strong tie structural holes, and neurotics with more.

6. Discussion

This paper argues that using triad proportions rather than global network measures provides a more accurate and informative depiction of egocentric network structure, and that psychological attributes are associated with these network structures. In contrast to previous studies (e.g., Burt et al., 1998; Mehra et al., 2001), we introduced a way of breaking down egocentric networks into triads, and used a more complete and reliable mapping of psychological attributes, while ensuring sufficient statistical power for the analyses.

This discussion has two parts. First we consider the use of triad proportions and the resulting three components in relation to previous studies and theories. Second, we discuss methodological issues pertaining to egocentric networks and the measurement of structural holes.

The main strength of using triad proportions rather than global network measures in strong- and weak-tie egocentric networks is that triads provide a direct and unbiased measure of the proportion of different network structures. Since global network measures sum

over the different ties to arrive at a single index, they do not allow for a differentiation between three types of structural holes (WNW, SNS and SNW), which are essential to theories of bridging (Burt, 1992; Granovetter, 1973). For the purposes of this article, we have used our triad proportions as variables in regression and other analyses. As a reviewer has suggested to us, a further step would be to develop statistical techniques to assess the significance of various triad proportions within an egocentric network, akin to the work of Holland and Leinhardt (1976). For the moment, these procedures have not been developed for our egocentric triad census.

Both Granovetter's and Burt's theories received empirical support: on average almost 60% of the triads that were found were in accordance with Granovetter's theorizing: about a third of the triads involved "network closure" (SSS and SWS), and a fifth were "mixed" (SNW) structural holes. Surprisingly, we found very few "weak" (WNW) structural holes (see Table 4). Burt's theory received strong empirical support as well, with almost 28% of the triads (on average) being "forbidden triads", or "strong" structural holes. What is clear is that these different characterizations of local network structure can co-exist (and usually do) within the one network. Individuals have a degree of choice in structuring their social worlds and that choice may be partially shaped by individual differences.

The importance of these triads to theories of bridging is revealed by examining the clear three-component structure that was obtained from reducing the triad proportions (see Table 7). The first component we found comprised many closed, weakly connected triads as compared to triads with separated strong ties. This component incorporates all of the configurations that Granovetter (1973) described as unlikely (weak tie network closure and forbidden triads). Its sole predictor, explaining less than 4% of the variance, was locus of control. People who believe that they control the events in their lives are more likely to keep their strong ties separated, whereas people who believe that things "just happen", because of influential others or due to luck (see Kaufmann et al., 1995), live in networks in which every person is weakly connected to everyone else. They may not have the motivation (or believe in their ability) to withdraw from these weak ties or strengthen them.

The second component obtained from reducing the triad proportions (named "strong- versus weak-structural holes") contrasted the structural holes permitted by Granovetter (namely, SNW and WNW triads) against structural holes permitted by Burt's theorising (namely, SNS triads). Only one psychological predictor for this component was significant, explaining about 4% of the variance. In line with Burt et al. (1998) findings, people who had a high proportion of SNS triads ("entrepreneurs" in Burt's language) were individualists. They have their own, unique view of the world, based on idiocentric values such as autonomy, freedom and competition (Triandis, 1995). They view their group membership as less important and view themselves as dissimilar to other group members. Compared with these people, people who have many weak or mixed structural holes (i.e. behaving according to Granovetter's theorizing) have less of an individual focus and are more group oriented. Since they see the social world through their group membership, their only ties that may lead to other social circles would have to be weak ties, just as Granovetter (1973) has argued.

The third component ("strong-tie network closure") contrasted the proportion of SSS and SWS triads against the proportion of SNS triads, and related directly to Granovetter's (1973) "network closure versus forbidden triad" argument. By showing that SSS and SWS

triads "go together" and oppose SNS triads, this component provides empirical evidence for the importance of Granovetter's (1973) network closure argument. This result also provides support to Kadushin's (2002) analysis that the two types of network motivations (reflected by network closure versus "entrepreneurial" networks) co-occur. However, and contrary to Kadushin's (2002) analysis, our results suggest that while network closure and structural holes co-occur, the likelihood of one structure reduces the likelihood of the other. Furthermore, the two structures are associated with different psychological profiles, with our regression model explaining 15% of the variance in this component. People who opt for network closure are more social, energetic and skilled in handling social situations. They enjoy social situations more and are more at ease with themselves. They hold allocentric values, such as obedience, security and duty (Triandis, 1995). More importantly, they view the world as "us versus them", and their social identity is important to the way they see themselves and the world. These findings may explain the tendency for network closure; after all, these people may sever relationships with people who are not part of "us".

The finding that people with many "strong" structural holes tend to be more neurotic is an interesting one. Since neuroticism is an index of general psychological strain, this result suggests that there is something stressful in keeping your close friends separated, exactly as Granovetter (1973) would have predicted. It might also be that neurotic people, who trust other people less (see Henderson, 1977), would opt for a "divide and rule" strategy in constructing their network.

Interestingly, we could not replicate the findings by Mehra et al. (2001) linking self-monitoring with structural holes (measured by betweeness centrality). Compared to their organizational sample, bridging between different social circles at university may not require as much self-monitoring. It seems plausible that transitioning into a new institution such as a university requires a different set of skills compared to maintaining relationships in a workplace over an extended period of time. Of course, in a relatively unconstrained university environment many relationships are freely chosen, which may not be the case in a workplace. Self-monitoring may be an important skill in situations when it is not easy to opt out of problematic relationships.

One of our main research questions was to examine the explanatory advantage to be gained from the inclusion of psychological variables into social network explanations. When examining the global network indices (network constraint), we found few relationships. Yet the results pertaining to the triad census suggested that psychological attributes are, in fact, related to local network structures in meaningful ways. While the correlation coefficients were not large, (the largest correlation in Table 6 was −.265, between neuroticism and the proportion of SSS triads), indicating small to medium sized effects, they were theoretically meaningful.

These results became clearer when we examined the relationship between the psychological predispositions and the three components. While the psychological predictors explained only a small, albeit significant, percentage of the variance (3–5%) in the non-Granovetter components (component 1, "weak tie closure" and component 2, "strong"- versus "weak"-structural holes) they explained 15% in component three ("forbidden triads" versus "strong network closure"). It seems that in a social world that behaves according to Granovetter's (1973) theorizing, psychological attributes may play more of a role in shaping an individual's local network.

Recently there has been a trend in psychology to move from broad psychological traits (such as the Big Five) to more specific, behaviorally-oriented ones. A growing body of knowledge suggests that the Big Five may be too diffuse to capture specific behavioral outcomes, such as tendency to bridge (Block, 1995; Briggs, 1989). The use of more specific psychological constructs, especially ones that are theoretically relevant to bridging (e.g., self-efficacy, political skills) may be worth investigating in future studies.

Using an egocentric network methodology raises some concerns about interpretation. Egocentric network design, for instance, does not allow an examination of 4-cycles (Lazega and Pattison, 1999): the structures we called strong (SNS), weak (WNW) and mixed (SNW) structural holes may actually be part of a larger cycles (for example, a 4-cycle), which egocentric methods have no way of measuring. Of course, a 4-cycle indicates that structural holes are not present. A second, related, concern is that the triad census obtained for ego is different to the census that (could have been) obtained for the alters: for example, an SWS triad ("strong network closure") obtained for ego is an SSW triad ("weak-tie closure") for ego's alters.

Moreover, biases operate in the way individuals perceive networks. Research by Casciaro and her colleagues (1998, Casciaro et al., 1999) found that people's perceptions of their local networks are influenced by personality factors. For example, Casciaro (1998) compared the perceived friendship and advice networks to the actual networks in three research centers in an Italian university. She found that extraverts had slightly better accuracy scores in the friendship network and that self-monitoring was not related to network accuracy in either friendship or advice networks. Similarly, Casciaro et al. (1999) found that positive affectivity (a psychological construct positively correlated with extraversion) was related to global, but not local, accuracy in a 24-node network. They conclude: "positive affectivity enhances people's perceptions of the broader pattern of social relationships in their environment, while it hampers the accuracy of judgments in their own direct social connections" (p. 300). In this light, a possible interpretation of our results linking extraverts to "strong tie network closure" is that extraverts tend to perceive their local network as more closed than it actually may be. This interpretation is strengthened by Hallinan and Kubitschek's (1988) finding that "friendly" students had a lower tolerance for intransitive triads, and would thus tend to remove the intransitivity over time, and results by Kumbasasr et al. (1994) that suggest that overall, individuals tend to perceive more reciprocity and transitivity in their local network than is actually observed. Only an extensive examination of complete networks will help to resolve the balance between actual structure and perception.[16]

Longitudinal analysis of complete networks is what is ultimately required. Our argument in this article is that individual predispositions lead actors to attempt to structure their local social environment in certain ways. For instance, extraverts may be more inclined to

[16] One reviewer suggested that respondents who adopt an individual focus may be less prone to this transitivity bias, thus viewing their contacts as less likely to form transitive triads. Recently, we have analyzed results for a small pilot study of a complete network of Jewish- and Arab-Israelis. Results provide partial support for the conclusions in this article, in that adopting an individual focus is associated with a higher prevalence of structural holes between different religious groups in complete networks, and that neuroticism may be involved in bridging structural holes within religious groups. This suggests that the results may not simply be the result of biases in perception. But further work is needed, with larger complete networks.

introduce their friends to each other, thereby increasing tendencies for network closure. But in acting to achieve such outcomes, people may also come to believe they have been more successful than they actually are. Only an understanding of the simultaneous changes in perceptions and in actual structure will permit a proper differentiation of such processes.

Furthermore, implicit to Granovetter's (1973) theorization is the assumption that strong ties are self-organizing over time, with networks exhibiting more closure and fewer "forbidden triads". Similarly, Burt (2001) found that most bridging ties tend to decay over time. The difference between a person who is a "network entrepreneur" and a person who predominantly behaves according to Granovetter's (1973) theory is that over time the entrepreneur will try to keep strong ties separated, while people who do not show these entrepreneurial tendencies will bring the two friends together to achieve network closure.[17] A clearer picture of the psychological differences between network entrepreneurs and people who prefer to bring closure to "forbidden triads" will only be obtained by examining the development of these network structures longitudinally. A fuller understanding of the association between psychological variables and network structure requires an examination of network evolution.

Finally, our sample of 125 university students is small, and comes from a highly homogenous population (psychology undergraduates). Similarly, our data collection technique of using a setting-generator is novel. As a result, generalisability of these results is uncertain. Future research should examine whether the three-component structure that we found when reducing the triad census is observed in other samples and in other methods of collecting egocentric networks, and whether similar psychological predispositions are observed in relation to the triad census and the resulting components in egocentric, and complete, networks.

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[17] Of course, people may show both tendencies simultaneously, and be entrepreneurial in some instances and prefer network closure in others. We argue that longitudinally, an actors' motivation (entrepreneurial or other) may influence the balance between structural holes and network closure in their network. We thank an anonymous reviewer for refining this argument.

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