SOCIAL NETWORK RESEARCH: CONFUSIONS, CRITICISMS, AND CONTROVERSIES

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ABSTRACT

Is social network analysis just measures and methods with no theory? We attempt to clarify some confusions, address some previous critiques and controversies surrounding the issues of structure, human agency, endogeneity, tie content, network change, and context, and add a few critiques of our own. We use these issues as an opportunity to discuss the fundamental characteristics of network theory and to provide our thoughts on opportunities for future research in social network analysis.

INTRODUCTION

There is little doubt that social network analysis (SNA) has firmly established itself as a major research area across a variety of disciplines. As noted by Borgatti and Halgin (2011), the number of publications referencing "social networks" is exploding. Even the proportion of network papers is rising at an exponential rate (Figure 1). The interest in networks spans all of the social sciences, and is rising even faster in physics and biology. In organizational research, social networks have been used to understand a wide range of outcomes including individual, group, and organizational performance, power, turnover, job satisfaction, promotion, innovation, creativity, and unethical behavior (Borgatti & Foster, 2003; Brass, et al., 2004; Brass, 2012; Kilduff & Brass, 2010).

Insert Figure 1 about here

However, fast growth can be accompanied by a corresponding increase in confusions, criticisms and controversies. Is SNA simply a set of analytic tools and measures (as the "analysis" in the acronym suggests) or a theoretical perspective? Salancik (1995: 348) argued that SNA was descriptive but rarely theoretical. And where there was theory, he contended, it was borrowed from other areas. Another issue, common to many areas of inquiry, is the balance between agency and structure. With its emphasis on the pattern of relationships among actors, some have questioned whether structure has overwhelmed agency in social network analysis. Given that actors may intentionally affect the structure of the network, how can a causal focus on structure be justified? Confusion and controversy also extend to the perception that the field tends to view ties generically, failing to recognize important differences in different kinds of ties and the meanings that ties have for the actors (Harrington & Fine, 2006; Gulati & Westphal, 1999: 499). Does SNA have a "static bias" (Harrington & Fine, 2006) that ignores network change (Watts, 2003) or fails to take into account historical context (Granovetter, 1992). Are actors embedded in stable relationships and recurring interactions or is the network is constantly churning? Do infrequent, occasional ties affect important outcomes?

While we attempt to clear up some confusion, our objective is not to solve all the controversies or defuse the criticisms. Indeed, we will offer critiques of our own. Rather, we will attempt to address the confusions, criticisms and controversies as an organizing framework for discussing the SNA field. For example, we approach the measures/theory confusions as an opportunity to characterize what network theory is, and to identify which elements are unique to the network field. In discussing the controversy surrounding tie content, we present a typology of dyadic phenomena and draw implications for network research. Regarding the agency criticism, we highlight some of the variance within the field in the degree of agency that is conceptualized and point out different dimensions of the agency issue. Finally, we discuss the network change issue, both in terms of the theoretical perspectives used to understand network change, and the role of network change in understanding the consequences of network processes. Of course, each of these topics has connections with the others, and confusions, criticisms and controversies often occur in clusters. As a result, we do not attempt to separate the 'C's nor organize the paper around each. As with any network, the sections are not independent of each other, and should be considered as a whole.

All description, no theory

Many have suggested a "theory gap" in SNA (Granovetter, 1979). Salancik (1995: 348) saw network research as powerfully descriptive, but not theoretical. This was a popular and perhaps valid criticism in earlier times (e.g., Barnes, 1972; Mitchell, 1975; Granovetter, 1979; Burt, 1980; Rogers, 1987), but is surely false today, at least in the social sciences[1]. For example, the body of work developing from Burt's theory of structural holes (1992) is clearly theoretical and wholly network-based (see also Burt & Merluzzi, 2014). Network theorizing has emerged in virtually every area of organizational inquiry, including leadership (Sparrowe & Liden, 1997; Brass & Krackhardt, 1999), power (Brass, 1984; Gargiulo & Ertug, 2014), turnover (Krackhardt & Porter, 1985; 1986), job performance (Mehra, Kilduff & Brass, 2001; Leavitt, 1951; Sparrowe, Liden, Wayne & Kraimer, 2001), affect (Casciaro, 2014), entrepreneurship (Renzulli, Aldrich & Moody, 2000), stakeholder relations (Rowley, 1997), knowledge utilization (Tsai, 2001), innovation (Obstfeld, 2005; Perry-Smith & Shalley, 2003), profit maximization (Burt, 1992), inter-firm collaboration (Jones, Hesterly & Borgatti, 1997), and so on (see also Lizardo & Pirkey, 2014). More generally, social capital theory is largely network theory. Embeddedness theory is network theory. Diffusion theory is network theory. Indeed, in subsequent pages we shall argue that many of the major perspectives in organizational theory, such as resource dependency and institutional theory, have either incorporated or independently invented key elements of network theory.

Of course, this discussion begs the question: What is a network theory? Perhaps the most fundamental characteristic of network theory (though not unique to it) is the focus on relationships among actors as an explanation of actor and network outcomes. This is in contrast to traditional dispositional or individualist explanations that focus on attributes of actors that are treated as independent cases or replications (Wellman, 1988). For example, rather than trying to model adoption of innovation solely in terms of characteristics of the adopter (e.g., age and personality type), network theorists posit interpersonal processes in which one person imitates, is influenced by, or is given an opportunity by another. Thus, a person adopts an innovation such as an iPhone not only because she has the right personality and the right set of means and needs, but also because her friend has one. This shift from attributes to relations entails a change in theoretical constructs from monadic variables (attributes of individuals) to dyadic variables (attributes of pairs of individuals), which consist largely of social relations and recurring interactions. The dyadic ties link up through common nodes to form a field or system of interdependencies we call a network. This gives some network theorizing a holistic or contextualist flavor in which explanations are sought not only within actors but in their network environments. Writing in 1857, Karl Marx (1939: 176) puts it nicely: "Society does not consist of individuals, but expresses the sum of interrelations in which individuals stand with respect to one another". Network environments may include quite distal elements unknown to the actor but linked to them through chains of ties, like the butterfly effect in complexity theory (Lorenz, 1963). The effect of the network environment is often phrased in terms of providing benefits and constraints that the actor may, or may not, exploit and manage. At the group level, the structure of a group – the pattern of who is connected to whom -- is as consequential for the group as are the characteristics of its members, just as a bicycle's functioning is determined not only by which parts comprise it, but how they are linked together. For example Bavelas (1950) and Leavitt

[1] In new adopter fields, like physics and biology, purely descriptive studies are considerably more common. It may be that when the idea is new, something as simple as a network diagram seems illuminating.

(1951) identified centralization of a network as a key factor contributing to a group's efficiency in problem-solving for simple tasks. In addition, elegant work has been done clarifying the ways in which network environments can be similar (Lorrain & White, 1971; White & Reitz, 1983).

At a more specific level, network theorizing consists of the interplay of the specific functions or properties of kinds of ties (e.g., acquaintance, kinship, supervisory) with the topology of interconnections. For example, suppose friends within an organization tell each other the latest office gossip. The supposition is a claim about one of the functions of friendship ties (or the kinds of processes they support). Now, it is reasonable to propose that a person with more ties should receive more news (i.e., have greater probability of hearing any specific item) (Borgatti, 1995), just as buying more lottery tickets improves a person's chances of winning. This is a bit of network theory, albeit at the simplest possible level. Now consider that if the person's friends were all friends with each other, the probability of novel information is lower than if the person's friends belonged to separate social circles, each with their own gossip (Burt, 1992). This has added a bit of topological reasoning to the theory – a common and distinctive element of network theorizing. We can go further on the topological side by considering not only ties among the person's friends, but their ties to third parties -- we are now invoking the network notion of structural equivalence (Lorrain & White, 1971). We might predict that persons whose contacts are less structurally equivalent receive more non-redundant information. Or we could return to the ties themselves and add propositions about how the strength of tie affects the probability of transmitting information (Krackhardt, 1992; Hansen, 1999). While we are at it, we can think about whether the strength of ties is independent of the pattern of ties. It seems plausible that if two persons share many close friends, they will very likely become at least acquainted, and may be predisposed to like each other. This implies that people are more likely to hear novel information from those they are not close with, since their social circles overlap less (Granovetter, 1973). And so on. The connections to organizational outcome variables such as job performance, mobility and turnover are obvious. It is equally obvious that we can no longer deny the existence of network theory.

Just Methods and Measures

Hwang (2008) interviewed a sample of researchers on the prospects of the social networks field. Although their comments were intended to assess how successful the field of social networks might be in the future, they are especially interesting for what they reveal about how people perceive the nature of the field. It is clear that many of the respondents regard social network analysis as a statistical method, as shown in Table 1.

Insert Table 1 about here

This view is ironic in that a major concern of social network researchers in the 1970s and 80s was that academics in mainstream disciplines like anthropology and sociology were adopting the theoretical metaphor of a network but not the actual methodology (Wellman, 1988). Moreover, perhaps the best-known paper in the network field is Granovetter's (1973) theory of the strength of weak ties, a paper that is entirely theoretical. This paper is broadly cited across the social

sciences and was for many researchers their introduction to the field of networks. But it did not prevent the development of the networks-as-statistics view displayed in Table 1.

Why would this be? An obvious factor is the term "social network analysis" which calls to mind specific methods such as factor analysis, cluster analysis and analysis of variance. After all, few people confuse "institutional theory" with a statistical technique. Yet, the field does feature some unique methodological contributions. The focus on dyadic relations (as opposed to attributes of individuals) entails more than a conceptual shift. With relational data, the fundamental unit is the pair of actors rather than the individual. Statistical analysis of dyadic data has to be different because classical methods assume independence of observations, which is not the case with network data. These measures and techniques are not available in conventional statistical packages, so specialized computer programs such as UCINET (Borgatti, Everett & Freeman, 2002) are required. All of this tends to make the measures and methodology of network analysis highly salient. By a metonymous semantic process, the methods and measures have come to represent social networks.

Perhaps the most insidious factor may be that many of the concepts in network theory can be and often are expressed as mathematical formulas. To most social scientists, a formula is a measure, and a measure is methodology. However, many formulas are better described as formal and compact expressions of theoretical concepts. For instance, the formula $E = mc^2$ is used to express the equivalence of mass and energy; it is not actually used as a method of measuring the energy in a system. Similarly, in network analysis the concept of closeness centrality (Freeman, 1979) describes an aspect of a node's position in a network as the distance of the node to all others in the network. We could express this concept in words, as we just have, or as a formula, $C_i^{clo} = \sum_j d_{ij}$, but the meaning is the same. Nothing is added by the formula except, when accompanied by appropriate definitions, a reduction of ambiguity. The formula merely defines a theoretical concept using a symbolic language that is more concise than English. We care about the concept because we imagine a process of node-to-node transmissions over time such that the longer the sequence of transmissions, the longer the time or the greater the distortion. But the formula itself does not provide an empirical measure of how long something takes to arrive at a node. To do that, we would have to actually observe something flowing through the network and track its arrival at each node.

Even concepts as technical-sounding as structural equivalence (Lorrain & White, 1971) and regular equivalence (White & Reitz, 1983) are purely theoretical. A simplified definition of regular equivalence for symmetric relations is given by Equation 1, which says that two nodes, *a* and *b*, are said to be regularly equivalent if, whenever *a* has a tie to node *c*, *b* also has a tie to a node *d* that is regularly equivalent to *c* (Borgatti & Everett, 1994). Note that the recursive formula, which has equivalence on both sides of the equation, gives no hint how to actually measure regular equivalence, and indeed multiple algorithms and measures have been proposed for empirical use (Everett & Borgatti, 1993). The point here is that sometimes a formula just defines a concept, and is separate from any measure of that concept. The theoretical concepts of structural and regular equivalence were developed in an effort to create formal theory drawing on

the insights on social role of Linton (1936), Nadel (1957), Merton (1959) and others.[2] Their work belongs to a sociological tradition of mathematical formalism exemplified by such figures as Anatol Rapoport and James Coleman. Similarly, the technical notions of clique, n-clique, k-plex and so on that sound so methodological were actually attempts to state with mathematical clarity what was meant by the concept of group which Cooley (1909), Homans (1950) and others had discussed at a more intuitive level. Contrary to what might be imagined, almost all of these mathematical-sounding concepts were proposed in print before methods of measuring them were devised.

$$C(a) = C(b) \rightarrow C\big(N(a)\big) = C(N(b)) \qquad \text{Equation 1}$$

Where N(x) is the set of nodes connected to node x, C(x) is the class of nodes equivalent to x, and C(N(x)) is the union of the classes of nodes connected to x

A final factor in the perception of networks as a method may be that aspects of network thinking have been slowly absorbed (or independently invented) over the last fifty years into the mainstream of social science thought, and therefore are not considered to "belong" to network theory. Many network ideas were absorbed before the network field had sufficient identity and legitimacy to claim or retain ownership. Hence, the homogeneity induced by actors imitating each other is seen in some quarters as the province of institutional theory rather than network theory, even though this notion of diffusion was a core concept of network research long before it entered the institutional theory discourse (Ryan & Gross, 1943).[3] If this explanation has merit, we should increasingly be seeing attributions to "network theory" rather than to, say, "resource-dependency", as network research continues to gain legitimacy.

All Structure, No Content

Although Granovetter's (1973) paper on the strength of weak ties depends crucially on the distinction between strong and weak ties, the rationale behind the theory is not so much about the type of tie as it is about the different network structures surrounding these ties. Indeed, social network research has received criticism for focusing on the structure to the exclusion of the content of ties. The term "content of ties" can mean many things, including type of tie (e.g., the difference between a friendship tie and romantic tie) and what flows through the tie (e.g., whether a tie is a source of information, money, emotional support, etc.). And while it seems clear that reciprocity in a friendship network will be much different than reciprocity in an advice network, the network literature has been remiss in failing to theorize about the differences between different kinds of dyadic phenomena. The type of tie measured is often only discussed in the methods section, as if differences in the type of tie were not of theoretical importance but merely a methodological decision. Yet, research by Podolny and Baron (1997) suggest different outcomes from structural holes and density depending on the type of tie, and Hansen (1999) found search and transfer depended on different types of ties. Kinship, friendship, and

[2] In this line of work, the goal was to redefine the notions of position and role in terms of the characteristic social relations among actors playing these roles, rather than in terms of the culturally defined rights and obligations associated with the roles.

[3] An empirical study of how ideas tend to be attributed exclusively to more central, higher status players is provided by Fine (1979). It is also well-known in feminist communication research (Tannen, 1994).

acquaintance ties have been distinguished on the basis of the norms of reciprocity attached to each type of tie (Casciaro & Lobo, 2008). Centrality in a negative-tie network such as who dislikes whom (Labianca & Brass, 2006) will have different consequences for a node than centrality in a friendship network, and levels of transitivity in a romantic network will be much lower than in a friendship network.

Perhaps the lack of attention to the content of ties is in part due to two reasons. First, network research has largely focused on the flow of information, and information may flow through a variety of different types of ties. Researchers such as Burt (1992) emphasize the importance of non-redundant information and think of many different kinds of ties as sources of information. Although flows are the key ingredient in most network theorizing, it is not flows that are actually measured. In a very real sense, the theoretical machinery of a large portion of network analysis is really about inferring flows from interactions or social relations. Typically, we assume the flow based on the relationship (we return to this point in our discussion of network dynamics).

Second, in his influential discussion of social capital, Coleman (1990) included the concept of appropriability: one type of tie may be appropriated for a different use. For example, friendship ties may be leveraged to serve business ends. Indeed, in his critique of economics, Granovetter's (1985) argued that an essential aspect of economic transactions is that they are embedded in social relationships. If different types of relationships overlap and if one type of tie may be appropriated for another use, we might dismiss the criticism of network researchers failing to address the content of ties.

On the other hand, it might be argued that flows are not the same as relationships and we might be better advised to actually measure the flow network absent the assumption. In the case of appropriability, current language seems to confuse a tie with its function. For instance, securing a loan may not be an appropriation of a friendship tie, but an obligation that is entailed by friendship, as are the airport pick-up, the dog let-out, the let-me-vent, or the give-me-the-benefit-of-the-doubt functions. It may not be appropriate to assume a 1-to-1 relationship between a tie and a function, as in "one type of tie may be appropriated for another use." Rather, we might fruitfully separate relational states (true ties) from other relational phenomena (like flows). So being both a coworker and friend is a case of multiplexity, but writing a report with a coworker is not – it is what happens when you have that kind of tie. In general we find it useful to regard relational states (such as friendship) and relational events (such as going to the movies together) as phenomena that go together rather than being alternatives to each other.

To resolve the controversy concerning the content of ties, we endorse a systematic attempt to distinguish different types of dyadic phenomena. As suggested by Borgatti, Mehra, Brass, and Labianca (2009), we consider four basic kinds of dyadic phenomena evidenced in network research (see Figure 2). The first, similarities, consists of co-memberships in groups, co-participation in events, and the sharing of attributes, such as having the same political orientation. Although often used as proxies for social ties, similarities are not social ties, though we might think of similarities as providing the relational conditions (Borgatti & Cross, 2003) for ties to form. The second type consists of social relations, which are the prototypical kinds of ties studied in social network research. Social relations include such things as kinship relations (e.g., brother of, in-laws of), other role-based relations (e.g., friend of, boss of, or student of), affective relations (e.g., likes or dislikes), and perceptual relations (e.g., knows). A characteristic of social

relations, shared with similarities, is their continuity over the lifetime of the tie. They are states rather than a series of recurring events.

Insert Figure 2 about here

Interactions represent a third type of dyadic phenomena that includes transactions and exchanges. Interactions include talking with, sending email to, collaborating on a project, having lunch with, and so on. In contrast to social relations, interactions consist of discrete events that occur and then are gone, until they occur again. It is often assumed that frequent interactions imply some kind of underlying, ongoing social relationship. Furthermore, social relations tend to imply certain kinds of interactions, so that, for examples, friends can be expected to talk more than non-friends. In turn, interactions provide the conditions for the fourth kind dyadic phenomena, flows. For example, when friends (social relation) talk (interaction), there is a strong possibility of exchanging information (flow). As organized in Figure 2, dyadic phenomena to the left can provide the conditions or opportunities for the phenomena to their right, although we cannot always assume that these opportunities will be realized. Conversely, phenomena on the right can cause changes in the phenomena to their left. For example, if two people share intimate details (flow) they may well develop a different, deeper relationship (social relation), which in turn could result in them attending more events together (similarity).

Our comments should not be taken to say that all network theory should be articulated at the level of a specific tie type, such as friendship. To do so would make network theory extraordinarily and unnecessarily complex. In our view, network theory should be phrased at the level of the abstract function of a tie. For example, if the theory (such as structural holes theory) depends on deriving the amount of flow to each node based on its structural position, then it should specify the tie as any tie that enables the appropriate kinds of flows. This keeps the theory uncluttered, and allows us to use a specific type of tie that embodies the requisite theoretical quality in a given setting. For example, in certain cultures, it may be kinship relations that serve as conduits for a certain kind of information. In other cultures, friendship relations may be more appropriate.

We advocate a separation between the abstract model of the network, such as the flow model, from the particular properties and consequences of the model that are specific to a given setting. Hence, we write theory at the level of the function of enabling something to flow from one node to another, not at the level of, say, liking ties. For example, a closer look at Granovetter's theory of the strength of weak ties shows that a specific definition of strong ties is unnecessary: any type of tie that has the property of generating transitivity will do. The rest of the theory does not make use of the definition of strong ties in terms of time, emotional intensity, intimacy, and reciprocity. The only property of strong ties that is needed by the theory is the transitivity property.

The work of Labianca and Brass (2006) on the "social ledger" is consistent with this orientation (see also Labianca, 2014). Developing the notion of net social capital, they note that individuals have both positive ties, which contribute to their social capital, and negative ties, which reduce their social capital. Like Granovetter, they provide a specific definition of negative ties. But we suggest that such a definition is probably unnecessary; in most cases, we can simply define a negative tie as one that reduces social capital.

An additional issue related to tie content is the little-noted fact that, for the most part, ties in network research are theoretically and empirically binary. The term "binary" here refers to the fact that all ties are between two nodes, as opposed to, say, trinary, a 3-way tie, or more generally, n-ary. In most network analyses, a conversation among three people cannot be distinguished from three separate pair-wise conversations, even though sociologically there is a big difference between those two situations (Zuckerman, 2008). To address these differences, the field has seen a recent, rapid increase in a type of analysis known as 2-mode network analysis (see Borgatti & Halgin, 2011 for a review).

All Structure, No Agency

The structure/agency debate is complex for many reasons, not the least of which is that people define it differently. For some, agency is about motivation, will and individual choice, while structure is about opportunities and constraints, and the debate is about the relative importance of agency versus structure (McAdam, 1992). This is reflected in the old saying, which Granovetter (1985) attributes to Duesenberry (1960): Economics is about how people make choices while sociology is about how people have no choices to make. For others, this debate is the same but the requirements of agency are satisfied by any individual differences – including putatively fixed and passively acquired characteristics like personality, gender and race. For still others, the debate is about the relative importance of the collective versus the individual, where the collective could be concrete (as in other individuals) or abstract (as in cultural institutions). In some cases, the structure/agency issue is part of the network change issue: An agency perspective concerns itself with how actors change the network to meet their needs, while a structure perspective limits itself to studying the consequences of structure, irrespective of its origin. As Emirbayer and Goodwin (1994: 1413) argue, social network analysis "fails to show exactly how it is that intentional, creative human action serves in part to constitute those very social networks that so powerfully constrain actors in turn."

In the early days of SNA, much of the theoretical and rhetorical emphasis was a reaction against essentialist and dispositional explanations of behavior and outcomes. Explanations of behavior that came too close to "because she wanted to" were seen as unsatisfying because they didn't so much explain the mystery in the dependent variable (behavior) as shift the mystery to the independent variable (desire). To behaviorist psychologists like B. F. Skinner, cultural materialists like Marvin Harris, and structuralist sociologists like Peter Blau, it made more sense to stay out of the black box of the individual psyche for as long as possible. Only when more mundane factors were accounted for would they dip into more ineffable factors which themselves needed explanations, and were also harder to falsify. Indeed, structuralist sociologists argued that when chance (essentially, the opportunity structure) was sufficient to explain observed outcomes, no further explanation was needed. For Mayhew and Schollaert (1980), there was no need to explain why societies have inequality: There are so many more ways of distributing wealth unequally than equally that it is the expected result. For Blau (1977), there was no need to explain why members of a small group have so many ties to members of a large group: It is the expected result given the opportunities each person has. Only when the observed numbers exceeded expectations based on group sizes would we consider a dispositional argument. This sounds like a statistics lesson, but as Mayhew and Blau explain, it is a much bigger statement about how things work.

At the time, the debate was phrased in terms of attributes versus relations (Wellman, 1988; Beiger & Melammed, 2014) and is roughly equivalent to the current distinction between human versus social capital. For example, in explaining status attainment, sociologists traditionally looked at other attributes of the individual, such as intelligence and education. In contrast, network analysts were more interested in who the individual was connected to. Granovetter (1973, 1974) argued that success in the job-search market was a function of the number of weak ties one had. Social resource theory (Lin, 1982) held that even if an individual did not have certain resources themselves, they could use their social ties to obtain or control the resources of others. The focus on relational mechanisms was fueled by the rise of diffusion and adoption-of-innovation studies. For example, in Coleman, Katz and Menzel (1957), physicians were seen to adopt a new medicine not just because of their independent rational decision-making processes but also because they were influenced by the choices of their peers.

However, it is not that agency was thought unimportant. The unstated premise of the opportunities-and-constraints perspective is that an actor has to do something to exploit the opportunities and mitigate the constraints. We can see this clearly in classic pieces such as Nancy Howell Lee's (1969) book "The Search for an Abortionist", Kadushin's (1969) "Why People go to Psychiatrists", and Granovetter's (1974) "Getting a Job". Likewise, the knowledge management literature often describes an active search for information in the network (Hansen, 1999; Borgatti & Cross, 2003). Similarly, the Dutch rational actor school of network research (e.g., Stokman, Ziegler & Scott, 1985; Zeggelink, 1994; Stokman, van Assen, van der Knoop, & van Oosten, 2000) has a decision-making agent as the focus of analysis. Even the embeddedness literature, which in Granovetter's hands (1985) was carefully balanced, has acquired a decidedly instrumental cast. For example, Jones, Hesterly and Borgatti (1997) see embeddedness as a rational choice of governance mechanisms that minimizes transaction costs.

If the balance of network research was once decidedly structural, the scale is much more balanced today, especially in organizational network research. Although Burt (1992) focuses on the consequences of structural holes without dwelling on whether actors seek to maximize structural holes, it is usually assumed that they do (e.g., Buskens & Van de Rijt 2008). This perspective has advantages and disadvantages. The advantage is that agency-based theorizing tends to be simpler and more intuitive, enhancing acceptance of network theorizing. Thinking in agentic terms is quite universal in human explanations of everything, from the cosmological accounts of the ancient Greeks to contemporary social scientists. The disadvantage is that, taken to the extreme, it brings us back to the essentialist, individualist explanations of a century ago. In the end, it seems clear that the fundamental tenet of network theorizing – that network structure and position provide agents with opportunities and constraints – contains the seeds of both over and under-socialized views of network actors. The dominant view depends more on larger intellectual currents than it does on the network enterprise itself. Gulati and Srivastava (2014) propose "constrained agency" and provide a deeper discussion of how actors are both constrained by their network and individually motivated to alter their network.

We see promise in work that recognizes the interplay between individual differences and network constraints. This is not to say that individual differences are necessary for network actors to have agency. For instance, consider a network in which all actors share identical motivations and capabilities. Clearly, they could all still have agency, such as seeking to maximize structural holes or the closing of transitive triples. Similarly, some individual

differences don't imply agency in terms of network behaviors. All network actors may react differently to adults versus children, regardless of what these targets do. Instead, we see opportunities for work that theorizes how specific individual differences affect how individuals alter the networks that constrain attitudes and behaviors. For instance, Mehra, Kilduff and Brass (2001) and Sasovova, Mehra, Borgatti and Schippers (2010) suggests that individual differences in self-monitoring personality provide a richer explanation of how and why brokerage structures emerge and change over time. As pointed out by Burt (1992) and Sasovova et al. (2010), this is an advancement over previous work that recognized agency but treated all actors as generalized individuals, resembling the homo-economicus of neo-classical economics.

We also see opportunities to investigate various types of network alterations related to individually motivated behavior (Baker, 2014). For instance, researchers rarely recognize that individuals can have the ability to drop certain ties. As discussed by Gulati and Srivastava, individuals can acquire, activate, alter, and adjust relationships. Related to our discussion of tie content, most ties are not everlasting so there are opportunities to explain variation in success (i.e., performance or reward) as a function of intentional tie alterations. Mehra and colleagues, in this volume, argue that such behaviors are likely motivated by individual differences. Other work in this area includes Parker and colleagues' (Parker, Halgin & Borgatti 2013) finding that top performers form more information seeking ties over time than others. We also see opportunities to untangle the agency issue by investigating tie aspirations, strategies, and ensuing changes. Halgin and colleagues (Halgin, Gopalakrishan & Borgatti 2013) examine relational aspirations and find that individuals in geographically distributed work seek to form ties with highly engaged alters and those located in different locations. Follow-up work can determine who is successful in implementing such desirable changes.

However, there are limits to agency that traditional accounts of isolated, independent actors fail to recognize. Even simple dyadic relationships such as friendships are subject to acceptance by both parties. Each has agentic veto power, while neither has total control of establishing the relationship. Triadic relationships further diminish ego's agentic control; structural holes may open and close regardless of, or in spite of, ego's efforts. Centrality within the larger network is a function of many complex relationships among actors that ego may not even be aware of. The complexity of agentic effects is illustrated in Hummon and Doreian's (2003) attempt to apply Heider's balance theory to entire networks and Buskens and van de Rijt's (2008) paper considering what would happen if everyone tried to build structural holes.

As Brass (2012: 676) notes, "the effects of agency become inversely related to the path distance of alters whose relationships may affect ego." Path distance, like tie content, has been virtually ignored by organizational network researchers. Decisions to collect ego or complete network data have been relegated to the methods section with little justification beyond convenience or opportunity. However, recent analyses by Burt (2007) showing that complete network measures of structural holes add little explained variance to direct-tie, ego-network measures can be contrasted with results from Fowler and Christakis (2008) indicating the effects of ties as far as three links removed from ego. While the Fowler and Christakis data is limited in its ability to justify this popular three-step claim, other organizational research has shown third-party (two-step) effects (Bian, 1997; Bowler & Brass, 2006; Gargiulo, 1993; Labianca, Brass & Gray, 1998). The issue is further complicated by debate over whether ego can accurately describe links

between direct-tie alters (Krackhardt, 2014; McEvily, 2014). We doubt whether the local-versus-global issue can be addressed in the abstract, absent the content and context of specific research questions. But there is little doubt that organizational network researchers have failed to theoretically justify their choices.

All Static, No Change

An often-voiced criticism of network research is that it is "static" or "ignores dynamics" (Watts, 2003). Underlying these criticisms are a number of different ideas, such as (a) network research focuses too much on the consequences of network properties and too little on the antecedents; (b) network data is often cross-sectional rather than longitudinal; (c) what flows through links is understudied; (d) by measuring properties like centrality and using them to predict outcomes, we implicitly assume that networks are static; and (e) when studying the consequences of network properties we fail to take into account that actors have agency and are constantly changing their ties and positions -- a process of structuration or co-evolution that requires modeling, thereby invalidating our conclusions. We discuss each in turn.

Antecedents. Does network research focus too much on the consequences and ignore how network properties come about in the first place? If so, this is perhaps the result of a logical progression as the field matures. The first order of business is to show that its constructs and mechanisms matter – that they have an effect on important outcomes. Otherwise, why study them? Once it is established that networks matter, it makes sense to investigate how they originate, how they can be manipulated, and how they might change over time.

Although the work is distributed across many fields, and is not labeled in consistent ways, there is a considerable amount of research on network antecedents, whether they be preference based or opportunity based. For example, social psychologists have published masses of research on friendship (Fehr, 1996) and acquaintance ties (Newcomb, 1961). One of the most studied phenomena in all of networks is homophily – the tendency or preference of individuals to interact with and form certain kinds of positive ties with people similar to themselves on socially significant attributes such as gender, race, religion, values, beliefs, etc. (Brass, 1985, Ibarra, 1993, McPherson, Smith-Lovin & Cook, 2001). Homophily has been studied from both a preference perspective (ease of communication) and an opportunity perspective (available contacts) and at the organizational level as well as the individual level (Fernandez & Galperin, 2014). In classical cultural anthropology, there is a wealth of research devoted to understanding the rules governing one particular social tie – who marries whom. Another well-studied opportunity-based antecedent is the effect of propinquity on human relations, particularly communication (Allen, 1977; Festinger, Schachter & Bach, 1950, Krackhardt, 1994). Inter-organizational network research has focused on the antecedents of alliance formation (Gulati & Gargiulo, 1999). Considerable network research in the public health context is concerned with network formation and stability (Moody, 2002). In addition, recent articles on networks in the physics literature have focused on the evolution of such social networks as the world-wide web, co-authorship among scientists, and collaboration on movie projects (see Newman, 2002, for a review). Predicting which ties will form, whether in alliances, friendships, or the web, is clearly about network change, even if authors do not label it as such.

Most work on antecedents is at the dyadic level of analysis, predicting the presence/absence (or strength, frequency, duration, etc.) of a tie between pairs of nodes. Based on dyadic probabilities, it is then possible to make predictions about higher level constructs, such as centrality (at the node level of analysis) or cohesion (at the whole network level of analysis). For example, homophily implies a tendency for members of the largest group to be the most central in the network. Mehra, Kilduff and Brass (2001) argued that high self-monitors (a personality trait) were more likely to develop higher betweenness centrality and more structural holes. Thus, these are direct explanations of node-level network properties. At the whole network level, governance scholars have long argued that institutions like rule of law affect the overall density (i.e., number of ties) of business transactions, by reducing risk.

Longitudinal. If network data is harder and more time-consuming to collect than other social science data, we would expect longitudinal data would to be comparatively rarer in network research than in other fields. This does not seem to be the case. Some of the oldest data in the network literature are longitudinal, including the well-known Sampson monastery data and Newcomb fraternity data. In addition, a bibliometric study by Hummon and Carley (1993) showed the percentage of empirical papers employing longitudinal data was about the same in network analysis as in sociology in general. Today, longitudinal network data is very popular, to the point that some reviewers seem to regard it as mandatory. This trend is likely to continue as longitudinal electronic archival data becomes increasingly easy to obtain (Groenewegen & Moser, 2014). In addition, the development of Siena actor-oriented change models (Snijders, Steglich, Schweinberger, & Huisman, 2008) makes it particularly attractive to study tie-level network change.

Flows. Social network research often conceives of networks as pipes or roads and implicitly or explicitly constructs a model of expected flows through the network. Measures of centrality, for example, provide estimates for each node of the times until arrival, or frequency of arrival, of something flowing through the network (Borgatti, 2005). Measures of centrality are measures of the outputs of an implicit model of network flow As a result, it is true that many network studies do not collect flow data, but it is not true that the studies neglect the concept of flows, as flows are in fact the main theoretical concern.

Having said that, it is worth pointing out that some studies do collect flow data. A great deal of research has studied purely dyadic flows, such as the flow of goods between countries, personnel between organizations, passengers between stations, phone calls between locations, and so on. We call this purely dyadic because the data don't track the trajectories of a given item as it moves from node to node. An example of trajectory flow data is the classic study of Milgram (1967), which tracked a package as it was sent from person to person in an effort to get it to a particular individual unknown to all but the last person. As another example, Brass (1981) tracked the workflow through an organization, and Stevenson and Gilly (1991) studied the flow of customer complaints through an organization. Today, with the advent of social media like Twitter, it is becoming easier to watch a particular idea or video move from person to person (e.g., through retweeting or reposting). We expect this will be a major growth area for social network analysis in the coming years, and is likely to be accompanied by new conceptual tools that are based on the actual flows rather than the underlying roads (Borgatti & Halgin, 2010).

Static Assumption. One way to criticize a study that, say, relates centrality of employees to their performance, is to argue that this somehow assumes (inappropriately) that centrality remains fixed. Indeed, at the data level, this is true: the centrality values are based on a now-frozen snapshot of the network at one point in time. There are many things to say about this argument. First, the simple fact that independent variables change does not invalidate a study of their consequences. A study of how mood affects risk-aversion in investing does not assume that moods stay constant; rather it ask how changes in mood correspond to changes in investment style. Second, it is a matter of research design to get the time scales right so that the dependent variable is, so to speak, reacting to the value of the independent variable that you have measured, and not to a more recent (or prior) value. It may be that national revolutions around the world tend to depress prices in the US stock market, but we would not test this by relating today's stock prices to the presence or absence of a revolution thirty years ago. Note that none of these issues – time-variant variables and appropriate lag times – is in any way specific to networks, although it may be that the widespread practice of displaying network data graphically – i.e., drawing a network diagram – makes the (supposed) assumption of stasis more salient in network research than other research.

Co-evolution. The structuration or co-evolution perspective notes that even as an actor's position affects the actor's opportunities and constraints, the actor is using these opportunities and getting around these constraints in ways that, consciously or not, change the actor's position. This is the substantive manifestation of this view; the methodological one is that network research suffers from a massive endogeneity problem. Actors are not randomly assigned to positions, and it could be that something like wealth enables actors to buy their positions, which they then use to obtain greater wealth. The statistical problem is just that, and there are ways of handling endogeneity issues, such as fixed effects models and instrumental variables. But in the end, field data will never be the equal of experimental data, which itself falls significantly short of a God's-eye view of the world. This is not a problem we are likely to solve, whether in network analysis or any other field of human inquiry.

Statistical issues aside, it is an open question whether, in the presence of co-evolution, we are required to take a co-evolutionary perspective. Suppose we have long known the mechanisms such that X causes Y, and now take it as a given. Recently, however, we have come to wonder about whether Y can cause X, and through what mechanism. Aside from issues of statistical estimation, do we need to rehash what we know about X causing Y, or can we just deal with the part that is novel? In general, our view is that treating the problems separately can be fine, as the mechanisms by which Y causes X may be substantially different from and unrelated to those enabling X to cause Y.

In light of the view that the network field is all methodology, it is ironic that studying network change has been handicapped by a lack of methodological tools and statistical models for modeling network change. This situation has changed significantly with the development of new statistical models and accompanying computer programs specific to dynamic data (e.g., Snijders, 2001; Robins & Pattison, 2001; Banks & Carley, 1996), the growth of simulation approaches to studying network change (Skvoretz, 1985; Zeggelink, 1994), the use of complex adaptive agents to simulate organizational systems (e.g., Carley, 1991, 2002), and increased access to "big data". In addition, the development of new data collection techniques such as location badges provide opportunities to capture data on transient relationships that a respondent might not identify in

more traditional data collection techniques such as surveys. These developments provide us with opportunities to test existing theories as well as develop new ones.

Many of these opportunities are also related to issues of agency. As previously mentioned, when theorizing about the dynamic effects of network structures, researchers seem to ignore the possibility of new ties being added or existing ties being dropped. Consider studies of brokerage in which an actor derives power from the absence of a tie between two alters (e.g., Freeman, 1979; Gould & Fernandez, 1989; Burt, 1992). The theories make sense only to the extent that alters are unable to form a direct tie and bypass the broker that joins them (Aldrich & Whetten, 1981), which, according to dependency theory (Emerson, 1962), they would surely do if they could (but see Brass, 2009). Thus, an implicit scope condition of all such structural theories must be that they apply only to relations of a type that are not easily or quickly created, such as state-based ties of trust or friendship. Technological advancements now allow us to turn attention towards dynamic interactions to consider other theories of brokerage. We might also theorize about how the benefits of certain network structures vary as the global network is becoming more or less centralized over time.

All Networks, No Context

Just as Granovetter (1985) noted that economic transactions occur within the context of social relationships, organizational network research has typically implied that the network is the context within which behavior occurs and outcomes are affected. Little attention has been given to the context within which the networks themselves exist. Emirbayer and Goodwin (1994) refer to this criticism as a lack of attention to culture and Pachucki and Breiger (2010) refer to "cultural holes" to label the divide between network analysis and cultural thinking in sociology. We do not intend to delve into the myriad definitions and classifications of culture, whether they be simple notions of national culture (Xiao & Tsui, 2007) or more nuanced constructions of inter-subjective meanings, local practices, discourse, repertoires, and norms (see Pachucki & Brieger for an extensive review). Yet, we know that networks occur within larger contexts and similar configurations may produce different outcomes depending on, for example, whether they occur within a cooperative or competitive environment (Kilduff & Brass, 2010). Of particular importance may be the historical context as exemplified by Padgett & Ansell's (1993) historical analysis of the Medici networks (see also Mizruchi, 2014, for an historical analysis). Despite considerable interest in organizational culture in the 1970s and 1980s and more recent efforts to introduce cognition into network analysis (e.g., Kilduff & Krackhardt, 2008), we find few examples of consideration of the context within which network occur (see Barley 1990; Bian & Zhang, 2014; Lazega, 2014). Despite noting this failure, we simultaneously recognize network context as a growth area.

Conclusion

Our goal in this article has been to address common confusions, criticisms, and controversies surrounding social network analysis. In doing so, we have also added a few critiques of our own. We have reviewed foundational aspects of network theory often attributed to other disciplines; we have presented a typology of ties to clarify issues of tie content; we have highlighted the multiple perspectives of agency and provided guidelines for future work in this area; and we have presented both methodological and theoretical perspectives used to understand network change. We end with three additional Cs - Content, Change, and Context – which we believe represent opportunities for considerable growth in social network theory and analysis. We hope

that our discussion of these issues will help clarify existing network scholarship as well as guide and facilitate the generation of new network theory.

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- I think that SNA will eventually be subsumed by the stats crowd and eventually be regarded as just another statistics tool (like Bayesian stats).
- In my discipline I expect SNA will be acknowledged as a mature analytical technique.
- Ubiquitous research method
- It will stand beside traditional regression approaches in the way we analyze research questions
- It will be a method used with greater sensitivity but in association with much more qualitative methods as well as observational methods
- Probably become an accepted and well-known method of analysis
- If it has not pretty much faded away, it will be a small part of another discipline like statistics or computational simulation.

Table 1. Quotations from interviews about social network analysis (Hwang, 2008)

Figure 1. Proportion of all articles indexed in Google Scholar with "social network" in the title, by year.

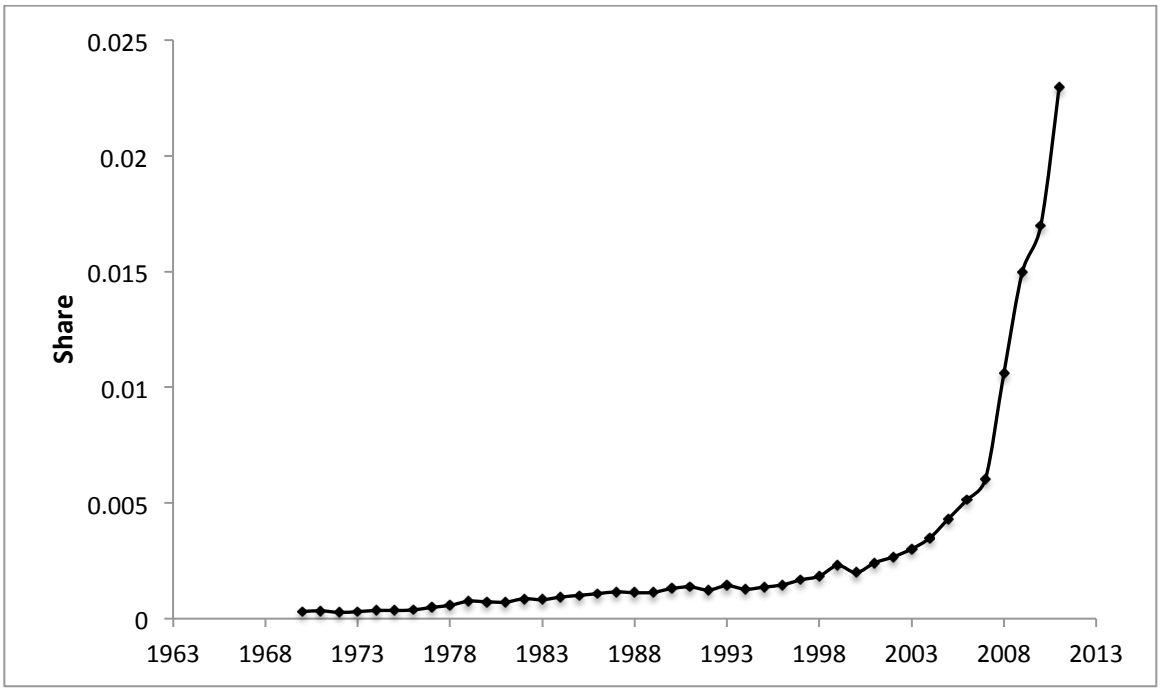

Figure 2. Types of Ties.