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Focalization of Network Contents

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Abstract

Do social networks lead clustering or divergence? Research has found that actors use social networks to access diverse sources of information on one hand, but on the other hand, social networks have also been connected with mimicry in choices leading to cascades. We examine this question in a longitudinal network setting with actors making choices and find that uncertainty has a strong moderating effect. In more uncertain conditions, actors tend to use networks to make choices more similar to others than in conditions of less uncertainty.

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The Focalization of Networks Contents in Conditions of Uncertainty

8 January 2012

Abstract: Do social networks lead clustering or divergence? Research has found that actors use social networks to access diverse sources of information on one hand, but on the other hand, social networks have also been connected with mimicry in choices leading to cascades. We examine this question in a longitudinal network setting with actors making choices and find that uncertainty has a strong moderating effect. In more uncertain conditions, actors tend to use networks to make choices more similar to others than in conditions of less uncertainty.

Social networks have been found to both enrich the diversity of information available to one individual (Granovetter 1973, Burt 1992, Lin 2001) and to produce global cascades, where large numbers of people make similar choices (Granovetter 1978, Macy 1991, Watts 1999, Centola 2010). Thus they are associated with both with both increasing and decreasing diversity of outcomes. There are several reasons why this apparent contradiction may exist, including differences across individual and global levels of observation and differences in network structure. Here we explore the idea that differences in the way network connections are used play a role in producing this observed variance. We find that individuals use social networks differently in different environmental contexts. Specifically, in stable situations, the information transmitted via social networks is more diverse, whereas in uncertain situations, there is a greater concentration on a smaller number of outcomes.

External Effects on Networks

Social network research has been closely allied with a theoretical position that relationships are the fundamental building blocks of society. A large body of research has evolved that documents the effects of networks and network structure on a variety of social and individual outcomes, including health, community organization, collective action, individual and corporate success, and many others. Recent research has however challenged the perspective that networks (i.e. social relationships) are always the primary explanatory factor behind social processes by showing how things like culture, organization, and even individual dispositions can affect the construction of networks. Omar Lizardo, for example, took issue with a perceived conflation of culture with society

by showing that cultural preferences (i.e. highbrow versus popular culture interests) have an independent effect on ego-network density (Lizardo 2006), thus shaping the structure of social networks. Lizardo and Stephen Vaisey also find that world-view affects the network composition of individuals (Vaisey and Lizardo 2010). Similarly, building on a large body of work, Mark Pachuki and Ronald Breiger have advanced the argument that culture and networks are mutually constitutive (2010) – meaning that culture has an independent effect on networks. Daniel McFarland showed that the likelihood that network position will predict rebellious behavior in students is mediated the formal organization of the classroom itself (McFarland 2001).

Additionally, homophily, based on actor attributes, has long been recognized as an external force affecting network dynamics (Lazarsfeld and Merton 1954; Mark 1998 2003, McPherson Lovitt, 2001). And attribute-based network antecedents, as well as cultural and organizational effects have also been well studied in organizational science (see Rivera, Soderstrom, Uzzi 2010 and Brass et al. 2004 for overviews).

One promising but relatively unexplored avenue for integrating these two otherwise opposed research streams is through the problem of network activation. Individuals are always embedded within a network of social relations – this is perhaps a fundamental aspect of being human. Most network research associates position and structural pattern with different group and individual outcomes – largely ignoring the actions of the individual embedded within the larger system of ties. For example, the social capital literature finds that favorable structural positions are linked with individual success. This

implies that individuals in such positions have greater access to information and opportunities, but where, when, and to whom individuals turn to in order to request information or resources is left unexamined. Thus network research in general has been accused of lacking a theory of agency (McAdam 1992: p. 60, Emirbayer and Goodwin 1994, p. 1442). The problem of network activation allows researchers to consider the actions taken by individuals within larger structural patterns, thereby explicitly addressing the problem of agency within the larger theoretical framework of network research. Since individuals are also acting within cultural and organizational contexts, which are likely to also affect behavior, network activation also allows opportunities to examine the relationship between context, culture, action, cognition, and network structure.

However, the literature on network activation is limited. In 2000, Jeanne Hurlbert, Valerie Haines and John Beggs showed that despite similar network structures, individuals in poorer communities were less likely to activate existing ties in order to access informal support after experiencing a hurricane (2000). William Stevenson and Danna Greenberg proposed a collective action model of agency in networks, showing that political activists in similar network positions altered their strategy depending on the political opportunity structure (2000). Linda Renzulli and Howard Aldrich showed that business managers draw more from ties when their networks are dense, homosocial (male/male), and occupationally heterogeneous (2005). Most recently Sameer Srivastava has explored the effects of organizational uncertainty on patterns of tie activation

(Srivastava 2012) and self-conceptualizations on intra-organizational ties (Srivastava and Banaji 2011).

Uncertainty and Networks

In this research, we are interested in the effect of uncertainty on patterns of network activation. Uncertainty is an extra-structural contextual factor that appears to have a robust effect on network dynamics. A number of experimental studies have found that uncertainty leads individuals to both form and increasingly rely upon existing relationships (Kollock 1994, Lawler and Yoon 1998, Molm, Takahashi, and Peterson 2000, Yamagishi, Cook, and Watabe 1998). Joel Podolny showed that market uncertainty led organizations to pick exchange partners with whom they had previously transacted and alters of similar status at a higher rate than in stable contexts (1994). Mark Mizruchi and Linda Stearns showed that high uncertainty leads bankers to rely upon trusted individuals, which also led to less successful business outcomes (2001).

In this line of research, homogeneity of information is linked to uncertainty through the mechanism of dense or repeated network ties. For example, Mizruchi and Stearns hypothesize that the dense networks ties chosen during periods of greater uncertainty may restrict available information, in keeping with the weak ties/structural holes mechanism, which suggests that network structure regulates information content – where weaker ties will carry novel content and dense ties will carry redundant content. The actual content of the information carried by these networks however is not included in the analysis.

These findings show that uncertainty drives individuals to rely on social networks – then infers that information content is negatively affected by the density and closure produced by relying upon these social ties. By using the act of network activation to examine the nature of the resource that is passed through social networks, we find a different process at work: individuals draw from social networks in situations of both stability and uncertainty, but those networks channel a different range of information in uncertain and certain contexts.

Uncertainty and Information

In this case, we observe a situation in which relationships are relatively constant, yet their contents change across different contexts – implying that something independent of the relationships is causing the change, i.e. there is some mechanism linking uncertainty to homogeneity of choice that is external to the relationships themselves.

Existing research indicates that such mechanisms exist at both the group and individual level. Although the relationships remain the same, group processes and the need for solidarity may change in uncertain circumstances. There is evidence that when faced with uncertainty groups will work together to construct stabilizing narratives that lead to and justify specific courses of action (Gibson 2011). This process of consensus formation by nature leads to a focus on a smaller range of outcomes – or outcome – and so may be responsible for decreasing the range of information contents transmitted across networks.

The idea of turning to trusted friends or partners is a rational strategy in the face of uncertainty. However individuals do not always (or perhaps rarely) act rationally, particularly in uncertain circumstances. Daniel Kahneman and Amos Tversky have shown that individuals tend to rely upon heuristics, rather than rational calculation, when making decisions (Kahneman, Slovic, and Tversky 1982). For example, individuals suffer from recognition bias: they prefer familiar alternatives despite underlying risk factors or probabilities. In a different research context, Thomas Schelling found that, faced with extreme uncertainty, individuals will choose focal points in order to direct their actions. Famously he conducted an experiment in which he presented subjects with a difficult dilemma. They were to meet another individual in New York City without having any opportunity to communicate with that person – for example, in order to arrange the meeting place. A large number chose Grand Central Station at noon, providing an emergent solution to the problem (Schelling 1960).

Faced with uncertainty, individuals converged upon a well-known solution, which in this particular experimental set-up, resolves the larger dilemma. Kahneman and Tversky's work suggests that the resulting coordination may simply be the result of individuals suffering the same cognitive bias. We believe that individuals in uncertain circumstances are likely to choose common solutions to problems, thus creating homogenous outcomes, either because in this way they "expect to fulfill the expectations of others" (Schelling 1960), which may be their only sense of what course of action to purse in a given situation, or simply because they are succumbing to recognition bias in uncertain

circumstances. Either way, we expect that the focalization of network contents will occur independently of a change in the pattern of relations between actors.

DATA:

Social Networks in the English East India Company

Our data comes from the 4,725 recorded voyages of the English East India Company (Farrington 1999). The English East India Company was an early modern overseas trade organization, which existed as a monopoly from 1601 to 1835. Among other information, this data includes the ship, captain, ports, and travel dates of each listed voyage. This voyage data has been used elsewhere to construct a trade network, which was the basis of a structural analysis (Erikson and Bearman 2006). Here, when we discuss social networks we mean the more limited, colloquial definition of informal and horizontal ties between individuals – not the overall pattern of relations that structure social and economic processes.

East Indiaman ships in the East Indies stopped at ports in the East to take on goods. Often several East Indiamen ships would be docked at the same port at the same time. While at port, captains exchanged information about their prior experiences. We observe that exposure to other captains at port affects the decision of where to travel to next – i.e. information is transmitted about past destinations that affects the direction of future travels. Even more specifically, captains often chose to travel to a port just visited by a captain with whom they have been in recent contact. Although this is an interesting substantive finding in and of itself (social networks helped to direct the operations of an

early modern trading company), we are interested here in the variability of the information transferred across different contexts.

In this case, the content of interest that is carried by social networks is information about ports. We can observe which ports captains travel to and consider the diversity of choices made under different conditions. Thus the data is unusually well suited to investigate social network usage and uncertainty as it is behavioral, allows for the observation of the outcome of exposure to information via social networks, and reveals the contents of information transmitted via social networks, i.e. the ports chosen. Additionally, the data covers a long time sequence, which includes distinct periods of uncertainty, in the form of wars between nations, as well as uncertainty in the form of inexperience among captains.

Validity, Reliability, and Generalizability

There is ample historical evidence that the captains did draw from social networks when making decisions about where to travel. In the period in which we focus, 1601 to 1760, captains had a large amount of organizational autonomy and often diverted ships from official routes for their own trading purposes (Barlow 1934, Anderson, McCormick and Tollison 1983, Marshall 1993, Adams 1996, Furber and Rocher 1997, Erikson and Bearman 2006). Thus captains independently altered the course of their travels while at sea. Captains also exchanged information at ports. While at ports they lived and ate meals together at the English factory, which was something like an overseas warehouse, headquarters, and dormitory (Cotton 1949). Captains were clearly interested in and

exchanged information about ports. "The private correspondence of the East India Company's officials, some of whom were country traders on a large scale, are full of very detailed message on the number and timing of the local shipping and the effect of their arrival and departure on markets and prices" (Chaudhuri 1978: p. 192). There is even evidence that East India captains spent significant amounts of social time together when they had returned to England (Bowen 2007).

The close social bonds betweens captains increased the likelihood that they would rely upon each other for information – even when other Europeans (Dutch or Portuguese for example) or Asian traders were potential sources of information. Additionally English captains were often engaged in trading similar goods – mechanical trinkets, looking glass, magnifying lenses, etc. – so market information from other captains would be particularly useful. Finally, we might consider the generalizability of these results. The English East India Company was an early modern organization. The captains were operating in a profit-driven environment similar to what faces modern firms. Although technologies have evolved, the basic incentives in place were similar.

Variables:

The outcome variable is the choice of the captain to travel to a port. We are primarily interested in the effect of uncertainty on the decision to travel to more or less popular ports. Therefore the key result in our first model rest upon the interpretation of interactions between variables representing uncertainty, social network activation, and port popularity.

Uncertainty is addressed along two dimensions. We consider war a form of heightened uncertainty. There were several wars between European powers during the period of the East India Companies, as well as wars with Asian powers. We consider only European wars as these, as they were fought on the sea as well as by land and therefore had a more direct contribution to uncertainty for captains than confrontations with Asian powers, which were confined to land battles. This data was gathered from the Great Powers Wars dataset (Levy 1989). In war, it is the actions of others that are both unpredictable and threatening. Another form of uncertainty arises when individuals simply lack knowledge about their environment. We capture this with a measure of inexperience. First Voyage is a binary variable that captures whether the focal actor had captained a prior voyage to the East Indies; a cumulative measure of experience does not capture the more significant difference between first voyage and subsequent increases in experience. We use War and First Voyage to represent conditions of uncertainty.

Popularity is a simple measure of the number of trips to a port within the five years prior to the time at which the captain arrives at that port. Smaller time frames do not capture representative variation between ports, particularly in the early years when traffic was lower. If captains always choose to go to more popular ports, this produces an effect similar to the Matthew Effect or Power-law distribution (Barabasi and Bonabeau 2003, Merton 1968). More popular ports get more visits, becoming even more popular; unpopular ports receive less visits and become even less popular. Even without the feedback loops implied by such models, it should be clear that individual decisions to

travel to already popular destinations will produce greater clustering at the level of the population. More individuals will be concentrated in the more popular ports. Conversely, if less popular ports are chosen, there will be less concentration.

Social Networks captures instances in which a captain acts on information about a port they were exposed to via another captain, who had traveled to that port prior to contact with the focal captain and during their current voyage. As already described, captains were embedded within a social network of East India Company employees once they disembarked at a port, if not before. Information was a valuable resource as prices and market conditions were volatile in pre-modern markets. Therefore we consider the transmission of this information as a process whereby individuals activated network contacts in order to access valuable resources.

Because the information was valuable, some captains may have hoarded information. This is a possibility and perhaps it did occur on occasion; however captains that had just traveled to a port would have less to gain from withholding timely information from others about a port that they were unlikely to return to on the same voyage. In essence, the captain that was potentially transmitting information was no longer among the pool of competitors attempting to reach a port before others, in order to get the best price on goods, for example. The captain who held and could transmit information would therefore be more likely to consider the advantage to be gained from the future transfer of information from others – via reciprocated gestures of communication.

Our regressions include several *control variables*. Although captains had a great deal of autonomy once at sea, they were issued orders to visit certain ports on each voyage. We use *Formal Destination* to capture these ports. We also expect that *Experience* would have an independent effect on captain's decisions. Captains would both gain information about ports on prior visits, and also form potentially useful commercial relationships. We therefore control for personal experience, which captures whether a captain traveled to a given port in their past voyages. Ports closer to the current port are more likely to be the next port than those far away. Thus we control for log of the distance between the ports.

Models:

We took two approaches to modeling the effect of uncertainty on the information transmitted via social networks. The first approach uses a conditional logit regression modeling the choice of next port for a captain leaving the current port. This approach has the benefit of considering the entire choice set among which the captain chose the next port. It also conditions on all factors that are common across the choice set, including temporal factors and the characteristics of captain making the decision.

We constructed the choice set by assuming that a port became possible to visit five years prior to the first visit and dropped out of consideration five years after the last visit. To control for port specific factors, we included the popularity of the port and the distance

between to the port from the current port.[1] Since the regressions represent repeated choices made by a captain, we used robust standard errors clustered by captain.

Table One about here

Model 1 of Table 1 presents the basic results. More popular ports tend to be chosen more often than less popular ports. Distance between the ports is, as expected, a strongly negative factor. Formal orders and the captain's experience are significant and positive, as expected. Social network information from other captains is also a significant factor. Model 2 considers whether social networks lead captains to choose more or less popular ports. The results suggest that captains use information gathered through social networks to travel to *less* popular ports. Models 3 and 4 then consider how this effect is moderated by uncertainty, captured through a captain's inexperience, *First Trip,* or *War*. The results suggest that in both cases, uncertainty has a positive impact on the popularity of ports chosen through social networks. In other words, in times of more uncertainty, the ports chosen through social network information tend to be more popular than in times of less uncertainty.

Current network theory suggests that the observed homogeneity may be produced by repeated ties. In this case, that would mean that captains in uncertain situations would be more likely to listen to the same captains whenever they encountered them. Since there

[1] We also estimated models with dummy variables for either each of the target ports or for each current port – target port dyad. The models failed to converge, though the results were very similar to those reported.

are multiple trips each voyage, we are able to test this hypothesis for across first and subsequent voyages as well as war and peace. The average number of times that information was transferred between the same pair of captains during the first voyage of one of the captains was 1.125 and the average number of times information was transferred between the same pair of captains on subsequent voyages was 1.108. The difference is small. This is unsurprising given the difficulties involved in selecting, first, whom the captains might have run into at port, and then, what kind of information they would have been able to convey.

Since voyages usually span more than one year, in order to compare rates of contact across wars, the data is split into years rather than voyages. This means that the count of repeated transfer of information between captains captures the number of times the same captain influences another within one year. The average is slightly lower because there are less opportunities for repeated contact in one year compared to the longer time span of voyages. However, the difference between years of war and years of peace is again negligible. In war years, the average rate at which information was transferred between the same pair of captains was 1.071. In years of peace, the rate was 1.083. If repeated relationships formed the basis of the observed focalization of network contents, i.e. the transfer of information about more popular ports, we would expect the rate to be higher in times of war and lower in times of peace.

Discussion:

Standard network theory links the production or existence of homogeneity to social closure, transitivity, and clustering. Here we find that homogeneity and heterogeneity can be produced within social networks depending upon conditions that lie outside of the ties themselves. The findings consistently indicate that patterns of social network activation vary across conditions of uncertainty. Captains within the East India Company were operating within conditions in which they could not choose their associations. Instead, when they arrived at Eastern ports the range of associates they could turn to for information was determined by the vagaries of other captain's journeys. Network theory suggests that relying upon past contacts build in network closure and homogeneous behavior; however the rate of repeated activation of the same tie is both relatively low and largely invariant across conditions. Instead it seems that captains in uncertain conditions create more homogeneous outcomes by activating ties that suggest more popular ports. More experienced captains and captains in times of peace, our proxies for greater certainty, instead use networks to make informed, yet more diverse choices. A purely structural explanation based on repeated ties cannot explain these outcomes.

There are however findings in psychology that suggest a direct relationship between uncertainty and homogeneity. Kahneman and Tversky suggest that individuals have a built-in preference for better-known items – so that if individuals are confronted with a question to which they do not know the answer, they will simply choose the most recognizable option. When answers are linked to outcomes through behavior this leads to homogeneity at the level of the population as uncertain individuals choose more popular options.

Networks have in past research been seen as an alternative means of coping with uncertainty. People turn to trusted alters in high-risk situations. We see instead that additional methods for coping with uncertainty are incorporated into the network relation. This finding is by no means meant to undermine the importance of networks and network structures in everyday life. We believe instead that it enriches our understanding of networks by drawing upon an increasingly sophisticated understanding of mental processes being built in the fields of psychology and cognitive science (DiMaggio 1997).

Cognitive science and psychology are both closely associated with a strong conception of the individual, particularly by sociologists. However it should be noted that in our research there is no data to determine whether this outcome originated in a decision made by the receiver of information or through a negotiated exchange between the receiver and transmitter of information. This distinction is of particular importance to researchers who wish to identify the locus of action in individuals (i.e. methodological individualists) versus researchers who identify the locus of action in relations (i.e. relationalists). Further research on specific transactions will be necessary to begin to explore these issues.

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Tables:

Table 1: Conditional Logit, Information types and Port Popularity on Decision to Travel to Port, Clustering by Captain

	(1)	(2)	(3)	(4)
Popularity	0.0282***	0.0339***	0.0338***	0.0339***
	(65.20)	(64.06)	(63.58)	(63.87)
Log of Distance	-0.442***	-0.441***	-0.441***	-0.440***
	(-70.45)	(-71.13)	(-71.15)	(-70.49)
Formal Destination	1.312***	1.257***	1.252***	1.260***
	(43.16)	(40.94)	(40.63)	(40.94)
Experience	0.501***	0.508***	0.535***	0.510***
	(11.74)	(12.19)	(12.54)	(12.23)
Social Network	0.148***	0.788***	0.781***	0.813***
	(4.27)	(20.90)	(20.58)	(21.71)
Social Network x Popularity		-0.0181***	-0.0195***	-0.0222***
		(-24.01)	(-23.00)	(-19.19)
Social Network x Popularity x First Trip			0.00426***	
			(4.33)	
Social Network x Popularity x War				0.00480***
				(4.27)
N	335823	335823	335823	335823

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Count Model, Information Types, Uncertainty and Port Popularity

	(1)	(2)	(3)	(4)
	Popularity	Popularity	Popularity	Popularity
Formal Destination	0.209***	0.222***	0.207***	0.223***
	(10.43)	(11.23)	(10.52)	(11.42)
Experience	0.526***	0.437***	0.527***	0.431***
	(21.72)	(16.26)	(22.17)	(16.50)
Social Network	0.101***	0.0459	-0.159***	-0.198***
	(4.07)	(1.48)	(-4.10)	(-4.78)
First Trip		-0.185***		-0.190***
		(-6.13)		(-6.34)
Social Network x First Trip		0.157***		0.122**
		(3.22)		(2.53)
War			0.00915	0.0214
			(0.28)	(0.67)
Social Network x War			0.363***	0.358***
			(7.36)	(7.33)
Constant	3.293***	3.384***	3.288***	3.375***
	(145.39)	(122.17)	(106.82)	(97.63)
N	13684	13684	13684	13684

t statistics in parentheses
Robust standard errors, clustered by captain.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$