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Good health and the bridging of structural holes

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ABSTRACT

Bridges that span structural holes are often explained in terms of the entrepreneurial personalities or rational motivations of brokers, or structural processes that lead to the intersection of social foci. I argue that the existence and use of bridges in interpersonal networks also depends on individuals' health. Poor health may make it more difficult to withstand the pressures and to execute some of the common tasks associated with bridging (e.g., brokerage). I examine this possibility using egocentric network data on over 2500 older adults drawn from the recent National Social Life, Health, and Aging Project (NSHAP). Multivariate regression analyses show that both cognitive and functional health are significantly positively associated with bridging, net of sociodemographic and life-course controls. The relationship between functional (kinesthetic) health and bridging appears to be partially mediated by network composition, as older adults who have poorer functional health also tend to have networks that are richer in strong ties. Several potential mediation mechanisms are discussed. Cognitive function remains significantly associated with bridging net of network composition, suggesting that the inherent challenges of maintaining bridging positions may be more difficult to cope with for those who have cognitive impairments than for those who have functional impairments such as limited mobility. An alternative explanation is that cognitively impaired individuals have more difficulty recognizing (and thus strategically using) bridges in their networks. Theoretical implications and possibilities for future research are discussed.

1. Introduction

Social network bridging is central to macrosocial processes, including the diffusion of information and innovations (Burt, 2004; Granovetter, 1973), the epidemic spread of diseases like HIV (Aral, 2000; Gorbach et al., 2000; Morris et al., 1996), community cohesion (Beyerlein and Hipp, 2005; Putnam, 2000), and the small world phenomenon in general (Watts, 1999). It is also a key mechanism through which social network structure affects individuals. Bridging can be contrasted with triadic closure and all of the social capital benefits (Coleman, 1988) that are associated with it (Burt, 2005). But bridging has its own advantages. Simmel (1950b) was the first to discuss the implications of serving as an intermediary between two parties, including the ability to mediate conflicts and to play two parties against each another for personal gain (i.e., *tertius gaudens*). Furthermore, bridging yields brokerage potential, as those who occupy bridging positions can transfer resources between parties and extract profits from such transfers (Burt, 1976, 1992; Gould, 1989; Gould and Fernandez, 1989; Marsden, 1982). Finally, bridging yields access to distinct pools of information and other resources, which can facilitate social mobility (Granovetter, 1973).

But what makes bridging possible? Two approaches to understanding the origins of bridges underlie social network research. First, we can work backwards from the fact that bridges cannot exist in the absence of clusters and the structural holes that exist between them. Therefore, perspectives which emphasize the predominance of social cohesion in networks and the self-organizing effects of activity occurring within foci and homogenous social circles (Blau, 1977; Feld, 1981; Friedkin, 1984; Lazarsfeld and Merton, 1954; Laumann, 1966; McPherson et al., 2001) focus on the origins of the structural conditions in which bridging occurs. This work notes that clusters, cliques, and other cohesive social groupings emerge out of actors' exposure to and familiarity with each other, as well as their adherence to group norms and pressures toward conformity (e.g., see Friedkin, 1984). Transitivity theory, for instance, is based on the idea that when A nominates B and B nominates C, A also tends to nominate C (Holland and Leinhardt, 1970). There are some social–psychological mechanisms behind the principle of transitivity, but it is usually treated as a structural force (Feld, 1981; Wellman, 1983).

This work undergirds Granovetter's (1973) forbidden triad argument, which views weak social ties as a basis of bridging. Infrequent

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face-to-face contact, restricted access, and emotional distance between actors reduce cohesion and conformity, making it more possible for those who are dissimilar or who move in otherwise separate social circles to form a (weak) relationship. This argument is consistent with Feld's (1981) focus theory, which holds that local bridges exist where pressure toward transitivity is low and where there are less constrictive common "foci" linking two actors. Bridging thus results from individuals' involvement in social contexts that are in some way incompatible or otherwise do not overlap. These observations also can be used to explain the fact that bridges tend to be more unstable and decay more rapidly than embedded ("Simmelian") ties that contribute to triadic closure (Burt, 2002). One reason why Simmelian ties are more "sticky" (last longer) than bridges is that they are more conducive to the development of agreement among actors (Krackhardt, 1998), making them more congenial ties than bridges and less prone to structural imbalance.

These structural approaches to bridging can be contrasted with agency-based perspectives which hold that the roots of many relational phenomena, including bridging behavior, are found in individuals' goals, intentions, or personalities (Emirbayer and Mische, 1998). Although not always writing explicitly in terms of individual agency or rational choice, some scholars emphasize aspects of bridging that serve the interests of self-serving individuals. Simmel (1950b) discussed at length some of the individual-level benefits that derive from the opportunity to act as an intermediary between two parties (e.g., *tertius gaudens*)—an opportunity that is most available when one serves as an intermediary between actors who do not interact with each other. Some researchers have used Simmel's observations to highlight the implications of network structure for brokerage potential in networks (Burt, 1976; Gould, 1989; Marsden, 1982). Gould and Fernandez (1989) detail five forms of brokerage, including gatekeeping and coordinating. Similarly, Burt (1992) discusses the individual-level benefits associated with occupying the space that exists between two otherwise disconnected clusters (structural holes), including control the flow of resources between the two groups.

Other work points to psychological predispositions and personalities (e.g., the "entrepreneurial personality") in an effort to explain individuals' different positions within social networks (see Hallinan and Kubitschek, 1988; Klein et al., 2004; Stokes, 1985). Burt et al. (1998) present evidence that people whose networks contain structural holes tend to have the personality of "entrepreneurial outsiders," as opposed to the personality of "conforming or obedient insiders." Similarly, Kalish and Robins (2006) argue that individualists and people who have a high sense of control are the most likely to maintain ties with unconnected network members. Non-individualistic, extroverted people who have tendencies toward group identification are the most likely to have closed triads. Kadushin (2002) also explores the roots of individual motivations to participate in certain kinds of relationships, noting that participation in structures that are rich with structural holes is often motivated by psychological drives toward self-efficacy and mastery.

The point of this paper is to provide an alternative framework for understanding individuals' occupancy of bridging positions. In addition to individual rational interests, personalities, and the structural forces that act upon them, their physical and cognitive capacities may affect, directly and indirectly, their opportunities and/or abilities to occupy bridging positions. A vast body of research examines the argument that social network structure affects individuals' physical and mental health (e.g., see Berkman and Kawachi, 2000; House et al., 1988), but few scholars have explored the reverse possibility. In the next section, I develop two broad approaches to exploring the role health plays in shaping individuals' opportunities to form and sustain bridges in social networks.

2. Possible implications of health for bridging

Health may affect individuals' bridging opportunities and behavior directly or indirectly. First, it is important to note that different kinds of positions within social networks make different demands on their occupants. Bridges can be especially demanding with respect to occupants' physical and cognitive capacities, therefore posing a particular challenge to those with physical or cognitive impairments. Second, health declines may indirectly deprive individuals of weak ties, which could restrict bridging. This section fleshes out these perspectives in greater detail regarding several specific mechanisms.

2.1. Health problems and the challenges of bridging

One basis for the claim that health might affect one's bridging opportunities is that physical and cognitive impairments make it more difficult to perform some of the tasks associated with bridging. The basic notion that severe impairments can affect individuals' abilities to engage in social action is not new. Research has shown that health problems reduce involvement in voluntary associations, for example (Li and Ferraro, 2006; Thoits and Hewitt, 2001). Similarly, some medical sociology and disability research treats health as a set of enabling (or disabling) physical and cognitive conditions that directly facilitate (or hamper) social action (see Frank, 1991; Lester and Tritter, 2005; Robillard, 1999). Thus, health can be viewed as a resource, and is sometimes discussed explicitly as a form of human capital (Becker, 2007).

Bridging positions may be more difficult to maintain for people who have certain health problems. One reason is that bridging positions are especially taxing, high-pressure positions. Scholars have noted that more effort is required to fulfill the social responsibilities associated with bridging positions than other types of positions (e.g., Burt, 2002; Feld, 1981). Because bridges span the structural holes that exist between unconnected social clusters, occupying a bridging position sometimes involves transmitting high volumes of information and other resources. Some aspects of bridging also suggest cognitive challenges. For example, if the clusters being linked are very different, especially if they are governed by different social norms, interacting concurrently with both requires the ability to "switch" back and forth between different cognitive frameworks (Mische and White, 1998; White, 2008).

Furthermore, social friction is inherent in the architecture of structural holes. This was implied in research on structural balance and ranked clusterability (Davis and Leinhardt, 1972), which argued that separate clusters tend to be connected by negatively valenced ties. Similarly, scholars concur that so-called "brokers" (a term that is sometimes used to refer to people who occupy bridging positions) often face conflicting demands which can germinate into role conflict (Aldrich and Herker, 1977; Friedman and Podolny, 1992; Podolny and Baron, 1997). Coleman (1990) noted that "boundary spanners" in organizational contexts often experience role conflicts arising from the separate, sometimes inconsistent sets of expectations originating in separate actors (see also Kahn et al., 1964; Spekman, 1979). To make matters worse, there are no third-party ties in common between those on either side of a bridge. No one else is invested in both parties simultaneously, so there is no one who can monitor or "look out for" the integrity of the bridge itself, apart from the bridging position occupant(s).

Embeddedness in a dense network, comprised mainly of closed triads, seems to require less effort to maintain. As Burt (1992) puts it: "Leisure and domestic clusters are a congenial environment of low-maintenance . . . contacts" (24). Of course, being embedded in a dense network is not always easy. Dense networks offer their own challenges, including increased monitoring, more stringent rules, and greater pressure toward conformity. Tightly knit networks also tend to host more rigid, segregated role expectations (e.g., see Bott, 1957; Hill, 1988). But bridging positions require intact physical and cognitive capacities to an extent that other types of network positions do not, in part because these capacities are more central to the *execution* of bridging responsibilities. These observations combine to support a general assertion: Structural holes constitute perhaps the most inhospitable, challenging of social climates, and individuals who have better physical and cognitive health may be better able to weather such climates.

Lastly, poor health may intervene between individual agency (e.g., intention) and action. As noted above, some network scholars (especially Burt, 1992) have argued that individuals occupy bridging positions because of the "strategic" advantage in accessing and controlling resources that comes with those positions. Yet, a long line of research in cognitive psychology suggests that before one can strategically navigate a social structure, one must first "learn" that structure (DeSoto, 1960). This work demonstrates that most people assume widespread symmetry, transitivity, and balance in social structures, as cognitive "schemas" based on these properties organize individuals' perceptions and memories of social structure (DeSoto and Kuethe, 1959; Freeman et al., 1988; Press et al., 1969; Zajonc and Bumstem, 1965). These are tendencies which can impede perception, or recall, of structural holes. Thus, one's perception and recollection of structural holes may depend on various factors, including the extent of one's experience with such structures (Janicik and Larrick, 2005), contact frequency (Freeman et al., 1987), one's position in the structure being assessed (Krackhardt, 1987), and one's degree of concern over one's own social status (Flynn et al., 2006). It is also reasonable to suggest that because structural holes are more difficult to perceive and process cognitively than other kinds of structures (as people cannot rely on oversimplified cognitive schemas to identify them), intact cognitive function is also key to the *detection*, and thus indirectly to the strategic use, of bridging positions. Cognitively impaired individuals who have the same number of bridging opportunities as others may simply be less able to recognize these opportunities because this requires the ability to apply more complex cognitive schemas.

For all of these reasons, the general hypothesis that will be tested in this paper is: People who have poorer physical and/or cognitive health have fewer structural holes and fewer bridging opportunities in their personal networks. However, I should stress that it is beyond the scope of this paper to determine the exact mechanisms that account for this pattern. It may have something to do with the physical and/or cognitive challenges of bridging, or challenges associated with identifying bridging opportunities. And, as I discuss in the following section, there may be structural mechanisms operating within networks as well, which support a more indirect link between health and bridging.

2.2. Health problems and network composition

There are several mechanisms by which health problems could lead to triadic closure and increased network density, and thereby reduce bridging opportunities. First, many scholars describe a surge of social support from network members that follows the onset of severe health problems. This idea underlies the social support convoy model and research on social support networks (see Berkman and Kawachi, 2000; Kahn and Antonucci, 1981; Thoits, 1995; cf., Lipton et al., 1981). Network members who respond to health decline with offers of support often increase contact with each other as well. This facilitates network members' mutual awareness of each other's resources, availability of time, and coordination of caregiving duties (Beggs et al., 1996; Kazak and Marvin, 1984). To the extent that this activity joins together previously unconnected network members, the density of the support recipient's network may increase, thus closing structural holes.

A somewhat more likely scenario is that health problems and disabilities eventually strain the types of social relationships that otherwise would give rise to bridging within one's network. This process takes some explaining. With the exception of spousal ties, kin relations, and exceptionally close friendships, most social ties depend on the norm of direct reciprocity (Gouldner, 1960). Unfortunately, people who suffer from severe health problems and disabilities may have more trouble reciprocating in basic social exchanges. This introduces an element of inequity which can jeopardize social relationships (Kuijer et al., 2001; Sprecher, 2001; Thompson and Pitts, 1992; Utne et al., 1984). The decay and dissolution of inequity-strained ties does necessarily reflect selfishness on the part of those who under-benefit in these relationships. Rather, over-benefited parties are often unwilling to endure severely inequitable relationships as well, as the inability to reciprocate can lead to guilt, depression, self-consciousness, embarrassment, and decreased sense of control (Dowd, 1975; Jang et al., 2002; Schieman and Turner, 1998; Ville et al., 2001).

Care for severe impairments is often an uncomfortable experience for both the caregiver and the care recipient, especially when it involves uncomfortable physical contact (e.g., lifting the recipient from a wheelchair) or helping with unpleasant bodily functions or hygiene tasks. These experiences violate the normal boundaries of many social relationships, and even close friends and family members may reduce contact in these situations to avoid embarrassment. For these reasons, "[b]oth friends and peripheral kin may drop out of networks when the . . . [recipient] needs help with personal care or body contact tasks, which violate norms of privacy and are incongruent with the usual expectations of the relationship" (Stoller and Pugliesi, 1991: p. 182).

These strains usually pose less of a threat to spousal or close kin relations, in part because these types of ties are not usually predicated on norms of direct reciprocity. Kin ties in particular depend more on generalized forms of reciprocity which are indirect, which oscillate between "give" and "receive" less predictably, and/or which involve intergenerational exchanges which can flow in only one direction for years at a time (Ingersoll-Dayton and Antonucci, 1988; Wentkowski, 1981). For instance, parents invest many resources in their children with the expectation that the reward will come later in their lives (Antonucci and Akiyama, 1987; Neufeld and Harrison, 1995). Because of this, close kin relations are more likely to endure in the face of increased caregiver burden and the strains it puts on caregivers (Adams and Bleiszner, 1995; see also Horan et al., 2006). Bound by normative obligations to provide care or by affection for the recipient, family members may be unable or reluctant to withdraw care or stop contact (Stoller and Pugliesi, 1991).

One possible result of the social strains caused by some physical and cognitive health problems, then, is the disproportionate loss of the kinds of weak ties which give rise to bridging, combined with the strengthening of already-strong ties. Thus, the onset of a serious health problem or disability may lead to the paring down of one's social network and greater interconnectedness among the alters within it. This, in turn, means fewer structural holes and less bridging. Therefore, the general hypothesis proposed above can be modified as follows to suggest an indirect association: People who have poorer health have fewer structural holes and fewer bridging opportunities in their personal networks, *partly because their personal networks are more comprised of strong ties and close relations who are likely to know each other*.

3. Data and analysis

I test these hypotheses using data from the National Social Life, Health, and Aging Project (NSHAP), a nationally representative study of 3005 non-institutionalized older adults between 57 and 85 years of age. NSHAP is a population-based study conducted by the National Opinion Research Center (NORC) in 2005–2006. The sample for the study was selected from a multi-stage area probability design screened by the Institute for Social Research (ISR) for the Health and Retirement Study (HRS). The original HRS design oversampled by race/ethnicity. NSHAP retained this design and also oversampled by age and gender to produce approximately equal cell sizes by gender across three age categories. The final response rate is 75.5%.[1]

3.1. Why older adults?

This NSHAP sample is extraordinarily useful from a social gerontological standpoint. For one, health problems such as cognitive impairment and limited mobility are more common among older adults. If health is associated with bridging, older adults' independence, brokerage potential, and access to unique resources may be threatened more than younger adults'. Second, older adults value their independence and control over personal affairs, especially in the face of modernization processes, which some social gerontologists claim disempower older adults and increase their dependency on younger generations (Burgess, 1960; Townsend, 1981; Turner, 1989). Social network researchers have shown that being embedded in relationships with people who are strongly connected to each other (i.e., "Simmelian ties") reduces not only one's bargaining power and access to unique pools of resources (Burt, 1992; Granovetter, 1973), as well as individuality and independence (Krackhardt, 1999; Simmel, 1950a,b). For older adults, having overbearing support givers can engender emotional distress, feelings of vulnerability, low self-esteem, and a sense of being coerced (Cohler, 1983; Coyne et al., 1988; Krause, 1987; Lee et al., 1995; Martire et al., 2002; Silverstein et al., 1996; Vinokur and Vinokur, 1990). In fact, dependency on others, coupled with isolation from a broader network, is one of the key risk factors of elder mistreatment (Harris, 1990; Lachs et al., 1994; Quinn and Tomita, 1986). Maintaining bridging positions may therefore be especially critical to older adults' abilities to avoid some of these common experiences in later life.

3.2. Social network data

NSHAP collected extensive information about older adults' social connectedness (see Cornwell et al., 2008). I will focus on measures drawn from data concerning older adults' egocentric networks, collected during the NSHAP in-person interviews. An egocentric network consists of N actors, including ego (p_i) and a set of alters (p_k), where k is network size. It can be delineated in a square matrix, A, containing $N \times N$ elements. Elements in A that represent relationships between ego and alters are denoted by $a(p_i, p_k)$. To get this information, interviewers asked respondents the following:

> From time to time, most people discuss things that are important to them with others. For example, these may include good or bad things that happen to you, problems you are having, or important concerns you may have. Looking back over the last 12 months, who are the people with whom you most often discussed things that were important to you?

Respondents could name up to five people (so, $k \leq 5$), but they also indicated if they had more than five discussion partners. This name generator elicits names of strong, frequently accessed, long-term contacts (Marin, 2004; Ruan, 1998)—ties through which normative pressures and social influence are likely to operate (Burt, 1984).[2] Therefore, respondents' egocentric networks are not likely to contain many weak ties, which will reduce the prevalence of structural holes and bridging.

Elements in A can be valued, since relationships in the egocentric network are reported in terms of the number of days of contact per year (0–365) between network members.[3] Because ego is connected to all k alters, $a(p_i, p_k) > 0$. Elements in A that capture relationships between pairs of alters are represented by $a(p_j, p_k)$, where $0 \leq a(p_j, p_k) \leq 365$. This information is collected by asking respondents how often each of their network members contact each of their other network members. A is a symmetric network, so that $a(p_i, p_k) = a(p_k, p_i)$ and $a(p_j, p_k) = a(p_k, p_j)$.

It is important to note a potential complication with using egocentric network data in a study involving cognitive function. Part of my theory is that people who suffer from cognitive impairments are less able to maintain structural holes and to execute bridging responsibilities. But cognitive impairments may also impede people's abilities to recognize structural holes—that is, if their ability to employ complex cognitive schemas is compromised. Therefore, we must keep in mind that egocentric network data which involve perceptions of alter–alter relationships, like NSHAP's, could be affected by cognitively impaired respondents' simplified cognitive schemas.

3.3. Bridging measures

I am interested in how physical and cognitive health relate to individuals' bridging within their core networks. There are several ways to operationalize bridging, depending on how it is conceptualized. My strategy is to examine two measures of (perceived) bridging and analyze how health is related to each of them as a check on sensitivity.

A person bridges what might be a structural hole whenever a pair of their network alters are not directly connected to each other, that is, $a(p_j, p_k) < 1$. In a symmetric egocentric network like those measured by NSHAP, there are $k(k-1)/2$ possible pairs of alters. A basic measure of perceived bridging is simply the number of pairs of alters in the network that are seen as not being directly connected to each other (referred to here as "perceived brokerage potential").[4] (See Kalish and Robins (2006) for a discussion of the advantages of evaluating structural holes using triad-level measures instead of summary measures.)

[1] Additional information about the NSHAP study can be found at: http://www.norc.org/NSHAP.

[2] Respondents' interpretations of what is "important" varies, as does the content of discussion with different alters (Bearman and Parigi, 2004; Straits, 2000). These variations do not substantially impact many of the characteristics of networks (Bailey and Marsden, 1999). But to minimize potential impacts, NSHAP embedded leading examples in the name generator (see above). Also, the survey content which precedes the name generator may affect interpretations of the item and the number of alters named (McPherson et al., 2006; Sudman et al., 1996). NSHAP was designed with the social networks module appearing first, so interview order is not an issue here.

[3] It is useful to experiment with alternative definitions of whether ties to and among alters in the network exist. In this paper, I define a network tie as present between two persons if contact occurs between them at least once a year. I conducted a supplementary analysis in which a tie is said to exist only when contact occurs at least once a month, and another using once a week as a cutoff. Using these alternative cutoffs does not affect the main findings, except that the positive association between functional health and bridging becomes increasingly significant as more stringent definitions of contact are used.

[4] We could also assess the effective size of a person's network, which estimates the number of non-redundant contacts (Burt, 1992). However, because effective size is simply a scaled measure of density (Borgatti, 1997), it is highly correlated with the brokerage potential measure ($r = .96$), which us easier to interpret.

Table 1
Descriptions of key variables (N = 2570)[a].

Variable		Weighted mean	Standard deviation
Bridging measures			
Brokerage potential	Number of pairs of alters in R's network that are not directly connected to each other. Range: 0–10.	1.587	2.107
Sole bridge status	Whether R serves as the sole intermediary between alters who otherwise would not be connected to each other {Yes = 1, no = 0}.	.196	.399
Network structural controls			
Kin composition	Proportion of alters who are kin by blood or marriage is calculated, then divided into tertiles to reduce skewness. Lowest tertile = 0, highest = 2.	1.068	.776
Closeness to alters	Average response to: "How close do you feel is your relationship with [name]?" Responses range from "not very close" (=1) to "extremely close" (=4).	3.115	.508
Frequency of contact with alters	Rs were asked how often they contact each alter. Eight possible responses range from "less than once a year" to "every day." We transform responses to estimates of number of days of contact per year with each alter (e.g., "every day" = 365). We then take the average across all alters. Observed range: 2–365.	198.256	85.448
Number of alter-pairs	Number of alter–alter-pairs in R's network. Range: 0–10.	6.123	3.597
Sociodemographic characteristics			
Age	R's age in years, divided by 10. Range: 5.7–8.5.	6.785	.782
Female	Whether R is female {Yes = 1, no = 0}.	.541	.498
African-American	Whether R is African-American {Yes = 1, no = 0}.	.093	.366
Latino	Whether R is Latino. {Yes = 1, no = 0}.	.063	.295
Education	(*Ref.*) R had no high school education {1 = Yes, 0 = No}.		
	R graduated high school {1 = Yes, 0 = No}.	.278	.445
	R had some college {1 = Yes, 0 = No}.	.292	.448
	R graduated college {1 = Yes, 0 = No}.	.258	.423
Retired	Whether R is retired {Yes = 1, no = 0}.	.588	.484
Marital status	(*Ref.*) R is married/lives with partner {1 = Yes, 0 = No}.		
	R is separated/divorced {1 = Yes, 0 = No}.	.112	.329
	R is widowed {1 = Yes, 0 = No}.	.170	.416
	R was never married {1 = Yes, 0 = No}.	.029	.178
Depression	Average of 11 standardized ordinal items from a modified CES-D (α = .80). Range: −.603 to 2.727.	−.033	.569
Cognitive function	Number of items from the Short Portable Mental Status Questionnaire (SPMSQ), such as "What day of the week is it?", that R answered correctly. Range: 0–10.	9.489	.996
Functional health	Average of 9 ordinal items (reverse-coded) assessing R's difficulty with ADLS (α = .78). Range: −3–0.	−.259	.485

[a] Means incorporate person-level weights, with post-stratification adjustments for non-response. Estimates pertain to all respondents who have at least two network members and information on all of the variables used in the regression analysis.

One problem with this brokerage potential measure is that it does not rule out the possibility that other intermediaries aside from ego exist within the network. A lack of a tie between two alters does not necessarily mean that a structural hole exists there. Technically, ego (p_i) only bridges a structural hole between p_j and p_k when ego is the *only* intermediary between them. Superior measures of bridging, then, would eliminate the possibility that some fourth party serves as an alternative intermediary between p_j and p_k, which occurs if p_j and p_k are both tied to a common third alter, thus creating a four-cycle (see Kalish and Robins, 2006; Lazega and Pattison, 1999; Pattison and Robins, 2002). One useful measure, then, is a dichotomous indicator of whether the respondent reports being the *sole* intermediary between any of their network members ("sole bridge") within the *perceived* network. Of course, we cannot completely rule out the possibility that there is some fourth person out there who is also linked to p_j and p_k, but we at least know that there is no such person (according to the respondent) within the egocentric network.[5]

3.4. Independent variables

The key variables used in the analyses are summarized in Table 1. According to the research discussed earlier, at least two aspects of health may influence (perceived) bridging capacity. First, functional health is measured using an index of 9 questions about respondents' difficulty with activities of daily living, such as: "How much difficulty do you have bathing or showering?" I reverse-code and standardize these responses, then average them together to create a functional health index (α = .86), where positive values indicate better function. Cognitive function is measured using the Short Portable Mental Status Questionnaire (SPMSQ), which includes questions like "What day of the week is it?" It is scored as a count of the number of such items the respondent gets incorrect, with a maximum of 10 (Pfeiffer, 1975).[6]

[5] Thus, the validity of this measure partly relies on the assumption that because both p_j and p_k are strongly linked to p_i, any third alter who might link the two is likely to be strongly tied to p_i as well (Granovetter, 1973), and therefore would be present in the network if relevant as an alternative intermediary. If not, we would expect this third alter to be weakly tied to p_j and p_k.

[6] Table 1 shows that there is little variation in the SPMSQ. Most people answered all 10 items correctly. About 5% of the sample answered three or more incorrectly,

Table 2
Correlations among bridging potential and other network characteristics (N = 2570)[a].

Variable	(1)	(2)	(3)	(4)	(5)
(1) Brokerage potential	–				
(2) Sole bridge status	.621***	–			
(3) Closeness to alters	−.245***	−.214***	–		
(4) Frequency of contact	−.375***	−.259***	.309***	–	
(5) Kin composition	−.547***	−.382***	.306***	.250***	–
(6) Number of alter-pairs	.501***	.114***	−.093***	−.269***	−.242***

[a] Estimates pertain to all respondents who have at least two network members and information on all of the variables used in the regression analysis, including the sociodemographic and health measures.
*** p < .001 (two-tailed tests).

I control for several sociodemographic characteristics, including age, gender, race/ethnicity, education, employment status, and marital status. I also control for depression, since not doing so may make it difficult to tell to what extent any associations between SPMSQ score and bridging are due to cognitive impairment or psychological distress, which covary. Following my arguments concerning the potential for indirect association between health and bridging, I also consider several structural characteristics of respondents' networks. Factors that may reduce bridging potential include: (1) high frequency of contact with network members, since frequent interaction increases the likelihood that alters will know each other; (2) closeness to network members, for similar reasons; and (3) having a large contingent of kin in the network. (Note that the frequency of interaction measure is not included in the analysis of the frequency-based measure of bridging, however.) Network size is taken into account in some form in all of these analyses, as described below. Correlations among the measures of respondents' bridging and other network characteristics are presented in Table 2.

3.5. Analysis

My argument is that health problems can limit individuals' bridging in a couple of ways: (1) by making it more difficult to meet the physical and/or cognitive demands involved in attaining and maintaining bridging positions, or to perceive structural holes; and (2) by altering the composition of individuals' social networks in such a way that there are fewer weak ties, which, in turn, is likely to reduce bridging. The latter is an indirect pathway, whereby network composition mediates the relationship between health and perceived bridging. The NSHAP data are cross-sectional and there are no viable instruments, so I cannot definitively demonstrate causality. But I can at least perform a mediation model (Baron and Kenny, 1986; Judd and Kenny, 1981) to determine which pathway is more plausible based on the available data.

The first step in the mediation model is to demonstrate that there is a relationship between health and perceived bridging. This is accomplished via regression analyses predicting both of the bridging measures using measures of network composition (controlling for sociodemographic measures). Perceived brokerage potential, which is measured as the number of pairs of alters in an individual's network that are seen as not being directly connected to each other, is predicted using negative binomial regression. The count of the total number of pairs of alters in the network (connected or not) is used as the exposure variable. This model essentially predicts the proportion of pairs of alters that are not seen as being directly connected to each other (i.e., the inverse of network density). Negative binomial models are like Poisson models in that they predict count outcomes, but negative binomial models also include a parameter, σ^2, that accounts for overdispersion (McCullagh and Nelder, 1989). Sole bridging status is predicted using logistic regression. (In this model, a control is added for the number of alter-pairs in the respondent's network.)

Second and third steps are required to determine if network composition is a potential mediator in any relationship between health and perceived bridging. In the second step, three measures of network composition (kin composition, closeness to network members, and frequency of interaction with network members) are predicted using the three health measures (depression, cognitive function, and functional health), controlling for sociodemographic characteristics. Respondents were asked to rate how close they are to each of their network members on an ordinal scale (1 = "not very close," 4 = "extremely close"), and these estimates are averaged together. This variable is predicted using survey-adjusted linear regression. Respondents also reported how frequently they interact with each network member on an ordinal scale (1 = "less than once a year," 8 = "every day"). These reports were used to estimate the number of days per year respondents interact with their network members, and the estimates were then averaged together. This version of the variable works well as a predictor, but it is too skewed for use as a dependent variable in a linear model. Therefore, I sum the estimated number of days per year respondents interact with all of their network members and predict this total using negative binomial regression, and use the number of network members as the exposure variable. Finally, kin composition can be quantified using the proportion of discussion partners who are kin. However, ceiling effects (caused by the cap placed on the number of network members allowed) contributed to skewness which appeared to impair the performance of this variable as a predictor, so it was divided into tertiles to create an ordinal measure. The lowest tertile contains those with less than half kin, and the top tertile contains those with only kin confidantes. This variable is modeled using a survey-adjusted ordered logistic regression model (McCullagh, 1980).

In the third step, the bridging measures are predicted using the three measures of network composition. In these models, the network composition measures are employed as predictors, but the health measures are not. If significant relationships are observed in both the second and third steps of this sequence (net of sociodemographic controls), the results are consistent with the idea that network composition may mediate between health and perceived bridging.

Finally, a fourth set of models examines whether health remains a significant predictor of perceived bridging even after network composition measures are included. If not, this can be taken as evidence that network composition fully mediates the relationship between health and perceived bridging. If health remains significant in these final models, network structure is likely only a partial mediator (Kenny et al., 1998).

however, suggesting mild cognitive impairment according to Pfeiffer (1975). When using a dichotomous indicator of whether respondents scored above this cutoff, the SPMSQ is still significantly associated with bridging.

All of these analyses pertain to respondents who have at least two network members. All models include person-level weights to account for differential probabilities of selection (with post-stratification adjustments for non-response by age and urbanicity). Analyses are conducted using Stata's survey ("svy") commands which, in addition to weighting, incorporate the clusters and strata of NSHAP's sample design, and employ Taylor linearized variance estimation.

4. Results

This analysis pertains to the 2570 respondents in the NSHAP sample who have at least two network members and who provided data on both measures of bridging. For the most part, perceived bridging opportunities are relatively scarce in these networks. These respondents' networks contain 9784 alters in networks of varying size, and 15,201 potential pairs of alters. Overall, 11,337 (about 75%) of these alter-pairs are reportedly directly connected to each other. About half of the respondents report at least one disconnected pair in their network, and about 35% report more than one. The average number of disconnected pairs per network (that is, the number of alter-pairs without an apparent direct connection to each other) is 1.6. None of this is surprising, as core discussion networks tend to be quite dense, both among older adults and in the general population (Cornwell et al., 2008; Marsden, 1987).

Table 3 presents results from the regression analyses predicting the number of pairs of alters in older adults' core networks that are reportedly not directly connected to each other (i.e., "perceived brokerage potential"). I will not spend much time discussing the relationship between sociodemographic controls and perceived bridging. There are some general trends, however, that are worth pointing out. The oldest adults, women, and unmarried respondents all tend to report fewer unconnected alter-pairs in their networks and are less likely to report being the only bridge between unconnected network members. Latinos and those with less formal education tend to have less perceived brokerage potential in their networks, and retirees are less likely to report having sole bridging status. Finally, depressive symptomology is positively associated with bridging. (Although this is not a focus of my analysis, it would be interesting to explore to what extent this reflects role conflict or stress associated with maintaining ties to disconnected network members, or, alternatively, the negative effects of not being embedded in a tight-knit, dense network. Depression is mainly included here because it is a consistent covariate of the SPMSQ measure.)

I will spend most of the results section examining associations between the two health measures and perceived bridging. The first step is to establish that there is an association between these sets of variables. The two initial models in Table 3 (columns 1 and 3) show that there are significant positive relationships between respondents' cognitive and functional health, on the one hand, and perceived bridging, net of sociodemographic measures. A one-unit increment in cognitive function (equivalent to answering one additional question correctly on the SPMSQ) is associated with reporting about 8% more unconnected alter-pairs in one's networks. It is also associated with 19% greater odds of reporting being the sole bridge between any two pairs of network members. Better functional health is also associated with more bridging. A one-unit increment in functional health (e.g., reporting "no difficulty" with all of the ADLs as opposed to reporting "some difficulty" with them) is associated with a 20% increment in brokerage potential as well as 55% greater odds of reporting being the sole link between two unconnected network members.

One of my hypotheses is that network structure partially mediates the relationship between health and bridging. The second step in exploring mediation is to determine if there is a link between health and network composition. Results of this part of the analysis (presented in Table 4) suggest that older adults who have slightly better cognitive function actually have closer contacts in their networks. Yet, at the same time, cognitive function is not significantly

Table 3
Coefficients from regression models predicting bridging in older adults' networks from health, closeness to and frequency of contact with network members, and network composition.

Predictors	Brokerage potential (negative binomial)[a]		Sole bridge status (logistic)[b]	
Age (divided by 10)	10.293* (.038)	4.591 (.027)	1.218* (.119)	1.131 (.120)
Female	27.437*** (.041)	28.235*** (.040)	1.449** (.188)	1.691** (.273)
African-American	−9.691 (.066)	1.863 (.055)	.929 (.151)	1.227 (.207)
Latino	−32.354** (.123)	−9.698 (.113)	.679 (.137)	.918 (.230)
Education (ref = less than high school)				
Graduated high school	−2.432 (.084)	−3.777 (.084)	.974 (.160)	.882 (.177)
Some college	31.254** (.083)	13.958 (.081)	1.374 (.263)	1.054 (.214)
College degree	42.377*** (.080)	15.756* (.072)	1.191 (.238)	.771 (.159)
Retired	−7.144 (.065)	−13.355*** (.046)	.725* (.096)	.621** (.091)
Marital status (ref = married/partnered)				
Separated/divorced	72.012*** (.061)	25.626*** (.058)	4.722*** (.821)	3.199*** (.589)
Widowed	11.342 (.071)	11.272 (.074)	2.227*** (.354)	2.343*** (.430)
Never married	75.802*** (.124)	15.597 (.107)	5.321*** (1.637)	2.832** (1.026)
Depression	16.291** (.043)	9.054* (.036)	1.352** (.141)	1.282* (.142)
Cognitive function	7.907* (.034)	5.690* (.024)	1.185* (.079)	1.213** (.083)
Functional health	20.380* (.088)	4.095 (.078)	1.551** (.204)	1.368* (.194)
Closeness to network members		−12.212* (.056)		.616** (.096)
Frequency of interaction w/network members		−.379*** (.000)		.993*** (.001)
Kin composition		−50.154*** (.039)		.326*** (.030)
F (d.f.)	18.57*** (14, 36)	87.03*** (17, 33)	13.22*** (15, 35)	23.47*** (18, 32)

* $p < .05$.
** $p < .01$.
*** $p < .001$ (two-tailed tests).
[a] The total number of pairs of alters in the network is included as the exposure variable. Negative binomial coefficients are transformed to reflect percent change ([(exp b) − 1]100). Standard errors for the original coefficients are in parentheses.
[b] Includes control for the number of alter-pairs in the network.

Table 4
Coefficients from regression models predicting older adults' network composition from health.

Predictors	Closeness to network members (linear regression)	Frequency of contact w/network members (negative binomial)[a]	Kin composition (ordered logistic)[b]
Age (divided by 10)	–.079*** (.016)	–4.508* (.018)	–.039 (.070)
Female	.115*** (.024)	2.449 (.019)	–.158 (.124)
African-American	.107** (.029)	14.823** (.038)	.173 (.133)
Latino	–.034 (.034)	15.013*** (.030)	.776*** (.158)
Education (ref = less than high school)			
Graduated high school	–.044 (.033)	–2.666 (.027)	.031 (.150)
Some college	–.062 (.032)	–7.796* (.031)	–.383** (.124)
College degree	–.093** (.034)	–15.198*** (.033)	–.482** (.152)
Retired	.024 (.025)	–8.793*** (.024)	.057 (.089)
Marital status (ref = married/partnered)			
Separated/divorced	–.113** (.034)	–13.412*** (.031)	–.943*** (.107)
Widowed	–.011 (.027)	–4.324 (.027)	–.097 (.095)
Never married	–.267** (.073)	–16.437* (.073)	–1.046*** (.280)
Depression	–.111*** (.026)	–3.982* (.019)	–.081 (.084)
Cognitive function	.030* (.012)	–1.300 (.007)	–.096 (.060)
Functional health	–.056* (.026)	–7.655** (.026)	–.271* (.110)
F (d.f.)	9.68*** (14, 36)	10.01*** (14, 36)	19.17*** (15, 35)

[a] The total number of pairs of alters in the network is included as the exposure variable. Negative binomial coefficients are transformed to reflect percent change ([(exp b) – 1]100). Standard errors for the original coefficients are in parentheses.
[b] Coefficients are odds ratios representing the relative likelihood of being in a higher category of kin composition per one-unit increment in the corresponding predictor. Number of children is included as a predictor.
* $p < .05$.
** $p < .01$.
*** $p < .001$ (two-tailed tests).

associated with either frequency of contact with network members or kin composition. Functional health, on the other hand, is consistently negatively associated with all three measures of network tie strength. On average, older adults who are better able to complete everyday activities are less close to their network members, on average, have less contact with them, and have fewer kin ties in their networks. The implications of these results for the mediation hypothesis will be addressed momentarily.

The third step is to determine if there is a link between the potential mediator (network composition) and the main outcome of interest (bridging). Table 5 shows that network composition is indeed strongly and consistently associated with bridging. Older adults who are closer to their network members report having fewer unconnected network members and are less likely to serve as the sole perceived bridge between any pair of alters within their networks. Similarly, those who have more frequent interaction with their network members and/or who have more kin-based networks also tend to report less brokerage potential and lower odds of reportedly being the sole bridge between unconnected network members. Therefore, as structural network research would suggest, individuals who are ensconced in strong-tie networks have fewer bridging opportunities.

The key question now is to what extent network composition may mediate the relationship between health and bridging. We saw earlier that cognitive function is not significantly associated with two of the three measures of network structure. At the same time, cognitive function remains significantly associated with both measures of bridging, net of the three measures of network composition, as shown in Table 3. Taken together, these results suggest a *non-mediated* relationship between cognitive function and (perceived) bridging. It would appear, then, that the association between cognitive function and bridging does not have as much to do with cognitive decline leading to greater support by primary group members, or the loss of weak contacts who cannot cope with caregiving duties, as it does with the more direct difficulties cognitive impairments introduce into the task of executing bridging duties (e.g., being able to deal with the coordinating challenges of brokerage) or the task of perceiving bridging opportunities in one's network, regardless of network composition.

However, mediation may play a role in the relationship between functional health and bridging. The final models in Table 3 (columns 2 and 4) show that this relationship is at least partially attenuated when network composition is controlled. The association between functional health and the reported number of unconnected alter-pairs in ego's network is reduced to non-significance, and the relationship between functional health and sole bridge status is cut by one-third (but remains significant at $p < .05$). These results suggest that the positive relationship between functional health and perceived bridging is at least partially mediated by network composition, and may even be fully mediated in the case of brokerage potential. Older adults who suffer from functional health problems (e.g., limited mobility) have stronger, more frequently accessed, and more kin-based network ties, and this in turn impairs their perceived brokerage and bridging potential.

5. Discussion

Social network scholars have mainly offered agency-based and structural explanations for the presence of bridges in social networks. I have argued that individuals' physical and cognitive health may also play a role in bridging. Analyses of older adults' egocentric social networks suggest that people who have poorer cognitive and functional health may be less likely to span structural holes. Only cognitive function has a consistent positive association with bridging net of other network characteristics like kin composition, however, suggesting several possible explanations.

It could be that the ability to execute the responsibilities and withstand the pressure associated with bridging positions is more mental than it is physical. In this regard, these results could help highlight the cognitive skills that are required to constantly transmit resources and "switch" between separate social domains (see Mische and White, 1998; White, 2008). To the extent that the personal challenges associated with occupying bridging positions contribute to their rapid decay rate (Burt, 2002; Krackhardt, 1998),

Table 5
Coefficients from regression models predicting bridging in older adults' networks from closeness to and frequency of contact with network members, and network composition.

Predictors	Brokerage potential (negative binomial)[a]	Sole bridge status (logistic)[b]
Age (divided by 10)	3.175 (.027)	1.045 (.107)
Female	28.606*** (.040)	1.637** (.269)
African-American	.984 (.055)	1.176 (.203)
Latino	−10.693 (.110)	.878 (.219)
Education (ref = less than high school)		
Graduated high school	−2.597 (.085)	.997 (.197)
Some college	15.916 (.076)	1.209 (.249)
College degree	16.868* (.066)	.874 (.168)
Retired	−13.488** (.046)	.628** (.091)
Marital status (ref = married/partnered)		
Separated/divorced	26.239*** (.058)	3.192*** (.579)
Widowed	12.545 (.072)	2.390*** (.421)
Never married	14.546 (.105)	2.616** (.897)
Closeness to network members	−12.658* (.053)	.615** (.098)
Frequency of interaction w/network members	−.384*** (.000)	.993*** (.001)
Kin composition	−50.218*** (.041)	.327*** (.032)
F (d.f.)	98.03*** (14, 36)	26.66*** (15, 35)

[a] The total number of pairs of alters in the network is included as the exposure variable. Negative binomial coefficients are transformed to reflect percent change ([(exp b) − 1]100). Standard errors for the original coefficients are in parentheses.
[b] Includes control for the number of alter-pairs in the network.
* $p < .05$.
** $p < .01$.
*** $p < .001$ (two-tailed tests).

the findings reported here suggest that cognitive function is an important resource for brokers.

At the same time these findings dovetail with work in cognitive psychology which points to the difficulty of identifying bridging opportunities in the first place (see Janicik and Larrick, 2005). People who have impaired cognitive capacity may be less able to employ the more complex cognitive schemas that are required to identify bridging opportunities in the first place (see CITE). In this respect, these results could reflect cognitively impaired individuals' reduced abilities to identify structural holes. This would have both empirical and methodological significance. On one hand, this still means that cognitively impaired people are less able to make strategic use of bridging opportunities, as they are less able to spot them in the first place. On the other hand, it suggests a potential limitation of egocentric network data in studying even mildly cognitively impaired individuals' social networks. This should be of particular concern to social gerontologists studying older adults' networks. More research will be needed to disentangle the effects of cognitive impairment on the ability to perceive structural holes and the ability to manage and execute actual bridging responsibilities.

Functional health may affect more than just one's *ability* to occupy bridging positions. The link between functional health and bridging is partly due to the fact that those who have functional health problems like limited mobility have more strong tie-based networks. The way one's network members react to one's impairments may lead to a closing of structural holes. It may be that spouses and other close kin who are bound by strong social obligations respond with unconditional social support to help functionally impaired individuals perform everyday tasks, whereas weaker contacts drop out for one reason or another. Again, the exact mechanisms that give rise to this association need to be pinned down.

More research on the structural implications of health is badly needed. The cross-sectional nature of the NSHAP data leaves the issue of reverse-causation unaddressed here. An obvious counter-argument here is that people who do less bridging in their networks are more likely to develop health problems. While there is overwhelming evidence for the salubrious effects of social connectedness on overall self-rated health, mortality, and depression, there is much less research on how social network position affects health—not to mention specific aspects of health like kinesthetic and cognitive function. An intriguing possibility is that being around structural holes is good for one's cognitive functioning. Some research in health studies suggests that involvement in engaging social environments is protective against cognitive decline (Bassuk et al., 1999). With the need to coordinate contact and resource flow between unconnected parties, the process of repeated switching between them may be at the root of the link between bridging and cognitive health. Another argument, relating to Granovetter's (1973) weak-tie theory, is that bridges provide better access to information about health, treatment, and prevention, which could help to at least slow the onset of health problems. Regardless of the mechanism, reverse-causation poses an interesting empirical possibility that will need to be examined in future work using longitudinal data.

Also, there is a legitimate concern here regarding the measurement of cognitive function. Severely cognitively impaired individuals are not included in the study, which leaves us with a fairly cognitively intact sample. This may render my analyses more conservative. A more serious concern relates to how people responded to the network name generator during the interviews. It is possible that those who have cognitive impairments were more likely to forget to list people who are more peripheral in their structure – for instance, people they speak to less often – thus artificially biasing their networks toward higher density levels. But if this is occurring, it is not just a matter of reporting bias. Rather, as implied above, it speaks directly to cognitively impaired respondents' abilities to recall information about their closest network contacts. It betrays a limited capacity to remember key information about one's network, such as who has which resources. This also would be detrimental to one's ability to realize bridging and brokerage potential and to execute duties associated with it. So, while a reporting bias that is correlated with respondents' SPMSQ scores may indicate a spurious link between cognitive function and network bridging positionality, it still calls our focus to the issue of cognitively impaired individuals' abilities to realize bridging potential and to execute the actions associated with it.

Another issue that should be explored in future research is the possibility that the mechanisms that link individuals' health to bridging may operate at the triad, as well as the individual, level. For one, it may oversimplify matters to assume that poor health affects all ego–alter–alter triads in the same way. It may be that some structural holes within ego's network are more difficult to span than others, such as where ego acts as a broker of extremely high volumes of valuable information. In addition, my argument implies that alters' health should matter as well. (Unfortunately, information about alters' health is not currently available in NSHAP.) Both of these possibilities suggest triad-level mechanisms. As such, a multilevel model, in which ego–alter–alter triads are treated as nested components of individuals' networks, may be more appropriate than the individual-level model used here. There are several potential modeling techniques that could be adapted for this situation (see, for example, Kalmijn and Vermunt, 2007; van Duijn et al., 1999; Wellman and Frank, 2001), although most multilevel models for egocentric networks consider ego–alter-pairs, which means the models would need to be generalized to account for repeated observations of alters within alter–alter dyads as well.

Bridges play an important role in many important social processes. Bridges facilitate the flow and diffusion of information and other resources through social networks, tie disparate social groups together, and help to create small worlds. For individuals, bridges affect one's ability to control the resources that flow through local social structure. From demographic and social-gerontological perspectives, the link between health and bridging may become an increasingly important issue over the next several decades. The population is aging rapidly, which may mean an increase in the overall prevalence of the types of cognitive and functional impairments that reduce individuals' bridging capacities. The implications of this shift for both global social network connectivity and for the distribution of power and control over the flow of resources through social networks need to be explored.

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