Knowledge asymmetry and brokerage: Linking network perception to position in structural holes

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Abstract
Although brokers who span structural holes have been shown to occupy a valuable position in organizations, emerging research suggests that the returns to these brokers can vary depending on whether alters can credibly threaten to disintermediate the broker and close the structural hole. Yet, the factors that shape the likelihood of disintermediation have not been extensively explored. In this article, we build from the premise that an alter's knowledge about the structural hole is a necessary condition for disintermediation. Without this knowledge, the alter will not know with whom to disintermediate. Drawing on research about cognitive social structures, we argue that individuals are most likely to be in a structural hole under the condition of knowledge asymmetry—that is, when brokers know about the structural hole, but alters do not—which reduces the likelihood of disintermediation by alters and increases the benefits for brokers. Using advice network data from a high-tech organization, we find evidence of knowledge asymmetry in existing structural holes, and moderation of this relationship by two factors also related to disintermediation: (1) broker's reputation and (2) alter's position as a provider (vs. acquirer) of resources. We also show that knowledge asymmetry is related to higher returns for brokers. The broader theoretical contribution is a better understanding of how network perceptions are related to positions across structural holes, an important structure from which power is derived in organizations and markets.

Keywords
cognitive social structures, design and boundaries, network forms, network structure, network theory, organizational structure, social networks, structural holes

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Introduction

An important tenet in research on social networks is that certain structural positions can be more valuable than others to the extent that these positions increase a social actor's access to or control over valuable resources. One particularly valuable position is that of the broker, or the actor who links two otherwise disconnected "alters" across a structural hole (Burt, 1992, 2001, 2004). Structural holes appear in many different markets and organizational contexts, and the brokers who attempt to maintain them do so with varying degrees of success (Burt, 1997, 2001, 2004; Fernandez and Gould, 1994; Podolny and Baron, 1997). In organizations, brokers appear to derive significant benefits from their positions, ranging from larger bonuses and faster promotions (Burt, 1992; Podolny and Baron, 1997), to greater influence (Fernandez and Gould, 1994; Padgett and Ansell, 1993), and higher potential for creativity and innovation (Burt, 2004; Fleming et al., 2007; Tsai, 2001) than others.

Given that structural holes impact a range of individual and organizational outcomes, a well-established line of research investigates the origins of this type of brokerage (e.g. Kleinbaum, 2012; Zaheer and Soda, 2009). Scholars have raised the fundamental question of why some actors self-select into brokerage positions (Sasovova et al., 2010a) and how they subsequently manage to successfully maintain their competitive advantage in those structural roles (e.g. Rider, 2009; Ryall and Sorenson, 2007). A number of studies have consistently indicated that individuals are likely to occupy and benefit from brokerage positions when the *threat of disintermediation*, or the prospect that two alters may threaten to "cut out the middleman," is low (Bidwell and Fernandez-Mateo, 2010; Ryall and Sorenson, 2007). That is, structural holes are maintained when alters are unwilling or unable to engage in direct exchange that would eliminate the role of the broker as go-between. Despite this research, however, factors that influence alters' propensity to disintermediate the broker remain less well understood.

Building on this line of research, we consider how the occupancy of brokerage positions is related to an individual's knowledge of the network of interactions. There is a strong rationale to expect that heterogeneity in knowledge of an organization's network of ties may affect the likelihood and persistence of a broker (alter) occupying a (dis)advantageous position in a structural hole. First, a substantial body of work on cognitive social structure (CSS) has shown that knowledge of an organization's network of relationships is highly heterogeneous across network members because of differences in individual or contextual factors (e.g. Bernard et al., 1984; Casciaro, 1998; Janicik and Larrick, 2005; Krackhardt, 1987, 1990; Krackhardt and Kilduff, 1999). Second, differences in the visibility of the true nature of one's relationships (whether dependable friend or disloyal foe) seem to shape the returns to one's position in the network (e.g. Fernandez and Gould, 1994; Padgett and Ansell, 1993). Finally, implicit in brokerage theory is the notion that the threat of disintermediation depends on the alters' knowledge of the broker's relationship with the other alter (i.e. knowledge of the structural hole). In short, without knowing with whom they might form a direct connection to disintermediate the broker, alters will not be able to do so.

In our study, we explain an important condition for broker disintermediation: the alters' perception of the structural hole. Although this mechanism by itself is not sufficient to explain when disintermediation will happen, it is nonetheless a necessary condition for an attempt to disintermediate the broker. Hence, understanding this factor is a critical step to further clarifying what leads alters to disintermediate a broker.

More generally, the purpose of this study is to assess whether structural holes are related to differences in individuals' *local network perception*, defined as an individual's knowledge of their second-order network or the network of those to whom they are tied.[1] We argue that structural holes are more likely to exist (and brokers more likely to benefit from their position) under the

condition of *knowledge asymmetry*—that is, when a broker knows about a missing connection between alters, but the alters lack knowledge of the other alter's relationship with the broker. This difference in knowledge might accumulate because of the positions the individuals hold (i.e. a treatment effect) or because individuals with differential knowledge might self-sort into those positions (i.e. a selection effect). Regardless of how these differences in knowledge of the second-order network arise, knowledge asymmetry can perpetuate the existence of structural holes because the more a broker knows about the structural hole and the less a broker's ties are visible to his alters, the less the brokerage position is exposed to the threat of disintermediation. We expect that under those conditions, a broker will more likely take advantage of the structural position.

We test our theory of knowledge asymmetry and the threat of disintermediation on a network of informal advice ties in a high-tech organization.[2] Such intra-organizational networks are a particularly useful laboratory to test our theory of knowledge asymmetry because knowledge of network ties is likely heterogeneous in a complex organization. These data are cross-sectional in nature, limiting our ability to draw out any causal relationship between cognition and position occupancy. However, they represent an advantageous empirical context to establish a relationship between local network knowledge and network structure because, unlike many cases in markets and organizations where brokerage is "built in" for regulatory reasons, these informal advice relationships tend not to be institutionalized or prescribed by formal organization structure. Thus, the threat of disintermediation is salient because organizational barriers do not inhibit it. Because of the risk that information can get changed in the process of transferring from one individual to the next, in advice networks of the type we study, the ultimate recipient of the information (the alter) should tend to prefer to have their advice "straight from the source," without broker's mediation, all else equal. Furthermore, because of the nature of these data, in which it is possible to observe individuals embedded in multiple brokerage structures, we are able to control for individual differences, such as self-monitoring (Oh and Kilduff, 2008; Sasovova et al., 2010a) or schematic processing ability (Janicik and Larrick, 2005), and test whether positional difference (broker or alter) is related to knowledge asymmetry even when estimating the results "within individuals."

Our study offers several theoretical contributions to research linking network perception with network positions. To our knowledge, our study provides the first evidence that, indeed, there is asymmetry between the knowledge brokers and alters hold about their existing structural hole net of individual-level differences, and that symmetric knowledge of structural holes is a necessary (but not sufficient) condition for disintermediation and eventual elimination of the structural hole. Moreover, we argue and show that this knowledge asymmetry is reduced by two primary factors that should reduce alter's motivation, and perhaps ability, to disintermediate the broker: (1) an alter's perceptions about broker's reputation and (2) an alter's position as a provider (vs. acquirer) of resources during brokerage. We conclude by linking knowledge asymmetry to differences in broker performance and discuss the implications of these findings and directions for future research.

Theory: Knowledge asymmetry in brokerage triads

Structural holes and local network knowledge heterogeneity

Strictly speaking, brokerage can occur in open or closed triads (Obstfeld et al., 2014) and, in certain contexts, a broker can benefit by closing a structural hole when they can maintain a role as intermediary (Obstfeld, 2005; Xiao and Tsui, 2007). However, disintermediation can be seen as a threat in the type of brokerage most often related to structural holes, where benefits derive from increased access to information and higher levels of control over alters (Burt, 1992). In these contexts, brokerage is understood as a "relation in which one actor mediates the flow of resources or
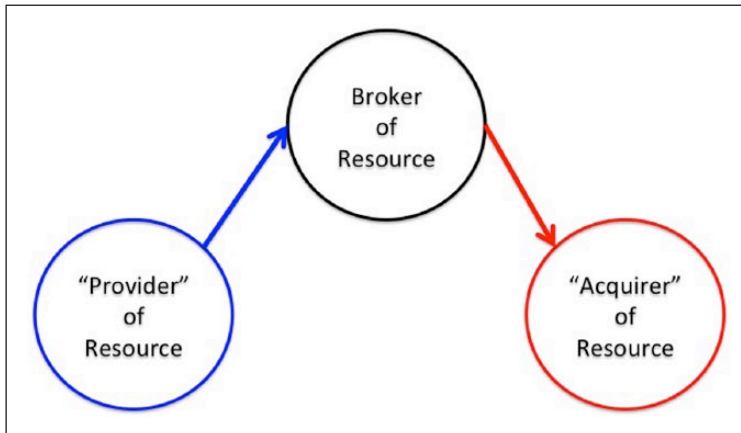
Figure 1. Alter positions in the resource flow of a brokerage structure. For each set of brokerage relationships, a broker passes resources between two disconnected alters. We follow Gargiulo et al., (2009) in calling the one who passes the information TO the broker the "provider" and the one who receives the information FROM the broker the "acquirer."

information between two other actors who are not directly linked." (Fernandez and Gould, 1994: 1457; cf. Marsden, 1982: 202) If we permit directionality in these relationships (e.g. Bob gains advice from Amy but not vice-versa), then a wide variety of brokerage structures are possible (e.g. pure conduit: A→B→C, one mutual tie: A→B↔C, etc.). Specifically, for the purposes of this article, our focal structure is an intransitive triad in which one actor (typically called a broker) has at least one tie from one alter (or resource "provider") and at least one tie to another alter (or resource "acquirer") who lack a direct tie between them (e.g. see Figure 1). This broad conceptualization permits other sets of ties between the broker and alters (e.g. two mutual ties such that alters are at times provider and at times acquirer) to still be classified as a brokerage structure.[3]

The possibility that knowledge of network ties varies among individuals in an organization permeates much research on network perception (Casciaro, 1998; Krackhardt, 1987, 1990; Krackhardt and Kilduff, 1999; cf., Bernard et al., 1984). Common to multiple studies is the claim that individual and contextual factors enable or constrain an actor's knowledge of the network. Accurate knowledge of the network has been attributed to numerous factors, including one's personality traits (Flynn et al., 2006; Sasovova et al., 2010b), schematic processing skill (Janicik and Larrick, 2005), informal power (Casciaro, 1998; Flynn et al., 2006; Krackhardt, 1990), coordinating events or activities (Chwe, 1999, 2003; Krackhardt and Kilduff, 1999; cf., Adut, 2008), or the content of the tie itself (Casciaro et al., 1999). Conversely, social structure itself can shape network perception. For example, Krackhardt and Kilduff (1999) find that people perceive close and distant ties as more balanced than moderately distant ties, while a study by Sasovova et al. (2010b) indicates that more central actors develop better network perceptions. These studies provide clear evidence that, within a social structure, knowledge of social ties is not homogenous; rather, actors can hold different perceptions of the social structure in which they are embedded.

Despite the abundant evidence of heterogeneity in perceptions of the network among members of that network, studies on the persistence of structural holes have been relatively inattentive to the influence of network perceptions. In particular, most extant studies rest on the common assumption that individuals' knowledge about each others' relationships (or non-relationships) is homogenous across members in a structural hole (i.e. among a broker and his two alters). At most, the influence

of knowledge of network ties on successful brokerage has been addressed only indirectly. For example, in Padgett and Ansell's (1993) well known study of brokerage in Renaissance Florence, the nature of Cosimo d' Medici's ties to the elite families and the "new men" are ambiguous to each group. Cosimo seems to withhold information that would resolve the ambiguity of his connections to either group. In other cases, brokers are presented as actively shaping alters' (mis)perceptions of ties across a structural hole. For instance, underlying Caro's (1982) account of Lyndon Johnson's successful career as Senate Majority Leader are rich descriptions of his attempts to convince Southern Democrats that he is less loyal to Northern Liberals, and vice versa, when in fact his ties to both groups were strong (see also Simmel, 1950 on tertius gaudens behavior). Other studies link variance in the publicity of brokers' relationships to the success of brokerage. In Fernandez and Gould (1994), the failure of partisan liaison brokers to change health policy seems to depend upon the fact that their advocacy was highly visible and, therefore, their alters are made aware that they have come out in favor of one alter and against another. Taken together, these studies indicate the possibility that knowledge may vary across positions (broker and alter) in a structural hole. Yet researchers have yet to articulate a theory explaining why we should expect differences in knowledge of the structural hole among its occupants.

Knowledge asymmetry in brokerage triads

In order to better understand this issue we ask, "What is the relationship between perceptions of the local network and the occupancy of relevant positions (broker vs. alter in a brokerage structure)?" In what follows, we integrate research on network cognition and brokerage to derive predictions about the relationship between local network knowledge and position occupancy based on the premise that disintermediation is a threat to the existence of structural holes (Ryall and Sorenson, 2007). As mentioned above, differences in knowledge might come because of the position or actors with differing knowledge might select into these positions. In other words, we expect that those in alter positions in a structural hole should have less local network knowledge than those in brokerage positions because (1) alters and brokers self-select into their positions based on each occupant type's knowledge of the structural hole (i.e. selection effect) and (2) alter's lack of knowledge, relative to the broker, is caused by limits to information flow related to the disadvantaged alter position and the advantaged broker position (i.e. treatment effect). We acknowledge the legitimacy of either process and describe each type of logic separately.

Individual selection and knowledge asymmetry. In brokerage theory, brokers tend to benefit from transferring resources between disconnected alters who effectively "pay" (either explicitly or implicitly) for these services (Bidwell and Fernandez-Mateo, 2010; Fernandez-Mateo, 2007). The increased benefit associated with these brokerage positions should increase the motivation to occupy these positions, relative to seeking out alter positions. As such, an individual's accurate knowledge of a structural hole should enhance one's propensity to self-select into a brokerage position by increasing willingness and motivation to occupy such a valued position. The ability to find these positions has been closely linked with individual differences like level of self-monitoring (e.g. Flynn et al., 2006; Oh and Kilduff, 2008; Sasovova et al., 2010a) and differences in schematic processing (Janicik and Larrick, 2005), as well as structural differences like centrality in the overall network (Casciaro, 1998), all of which would allow an individual with more knowledge to pinpoint those opportunities and select into them more easily. In short, the selection logic is as follows: because brokerage positions are beneficial to the broker, those that know where they can serve as a middleman will be more successful in finding and taking advantage of those opportunities than

those that do not know about these opportunities. The latter will consequently be more likely to occupy the disadvantaged alter position in a structural hole.[4]

Positional treatment effect and knowledge asymmetry. It is also possible that differences in knowledge of the relationships across a structural hole among participants in that structure develop as the result of occupying these positions. First, alters, because they only have one connection among the other two participants (compared with the broker's two connections), are more likely to experience information disadvantages that lead them to develop incorrect perceptions about relationship(s) across these structural holes. For example, brokers may hide the fact that they hold a relationship with another alter to which the first is not connected. Without a tie to the other alter, the first alter will have less opportunity to gain information to resolve this inaccuracy. Second, the idea that accurate knowledge of the structural hole for a broker may itself result from an actor's occupancy of a brokerage position admits the possibility that a broker may not know they are a broker. For example, some brokers who effectively transfer advice from one individual to another may believe that these two individuals are directly connected. Yet, the information and control benefits of the brokerage position increase the probability that ignorant brokers learn about their alters' disconnection. That is, over time, they learn the basis of their advantage and come to hold accurate knowledge about the structural hole.

Whether it is through the selection or treatment effects discussed above, we expect that brokers have more accurate knowledge than their alters either because individuals holding accurate knowledge are more likely to self-select into brokerage positions rather than alter positions or because individuals occupying brokerage positions tend to develop more accurate local-network knowledge than alters. This leads to the following hypothesis about the relationship between those (cross-sectionally) found in different positions in a structural hole (broker or alter) and their knowledge:

Hypothesis 1. Brokers hold more accurate knowledge about the structural hole than do alters.

Disintermediation threat and knowledge asymmetry

An important premise of our argument that asymmetry in network knowledge helps explain the existence of structural holes is that such asymmetry reduces the threat of disintermediation by limiting an alter's ability to know that they are being brokered or even with whom to connect in order to disintermediate the broker. This idea, in its simplest form, assumes that all alters will be motivated and able to disintermediate the brokers if they only know with whom to connect. However, because alter's knowledge of the structural hole is a *necessary*, but *not sufficient* reason for disintermediation, this is not always the case. In particular, as situational factors reduce an alter's willingness or ability to cut out the middleman, we expect alters to remain in these alter positions, that is, not disintermediate the broker, *even when they have knowledge about the structural hole*. This would imply that, in conditions where motivation or ability to disintermediate is low, alters will hold more accurate knowledge of the local network. Put differently, we expect knowledge asymmetry between brokers and alters to be less evident when the broker provides a valued service or good to the alters. We will discuss two such conditions and derive predictions for empirical tests based on these conditions: (1) high perceived reputation of the broker[5] and (2) alter's position as provider or acquirer of resources.

Higher broker perceived reputation. There are two reasons why we should expect to see alters knowingly being brokered by those they rate as high quality performers in an organization. First, we should expect that the reputation or status of the broker, or similar measures of a broker's perceived

quality, should increase an alter's *willingness* to be tied to such brokers rather than disintermediate and risk losing their tie. Specifically, alters place greater value on exchanges with highly reputable brokers because such brokers are more likely to have capabilities that facilitate exchanges and bring valued resources (Hargadon and Sutton, 1997; Rider, 2009). Moreover, high-status brokers are valuable to alters because they effectively endorse exchange with the others in a network (Podolny, 2001; Rider, 2009; Stuart et al., 1999). Alters can also increase others' perception about their own quality in the organization when they are seen to associate with those of higher status (Podolny, 1993, 2005). By contrast, alters run the risk of forgoing these advantages if they disintermediate the broker. Since the incentives to disintermediate decrease with broker's perceived reputation, we would expect that an alter will hold more accurate knowledge of broker's ties when they rate these brokers highly.

Our expectation of more accurate knowledge of highly rated broker's ties is also consistent with another mechanism that would reduce the likelihood of disintermediation. Not only are alters less motivated to disintermediate a highly rated broker, but also they might be less *able* to do so. Since those rated highly in any organization are often powerful the ability of lower-status or less reputable alters to close the triad may be severely constrained. Because lower-status alters are more willing to defer to a higher status broker (Anderson et al., 2012; Gould, 2002), those alters will be less likely to close such triads.

In sum, the higher the perceived reputation of the broker, the less alters will be willing or able to disintermediate the broker. Thus, alters in such situations are more likely to knowingly remain as alters in a structural hole. It is worth highlighting the complementary idea that because higher reputation or status generates more attention (Simcoe and Waguespack, 2010), alters could be more aware of the relationships of these highly reputable brokers. Thus, perceived high quality can work against a broker to the extent that knowledge of a highly reputable other's network ties increases the likelihood of disintermediation. However, because having a highly reputable broker reduces alters' willingness and ability to disintermediate, this increased awareness would reduce the knowledge asymmetry generally found across a structural hole. Thus, we expect that among the individuals found in an alter position, those being brokered by individuals with higher perceived quality will hold more accurate knowledge about the structural hole than those being brokered by individuals with lesser reputations. This leads to the following hypothesis:

> *Hypothesis 2*. Alters being brokered by brokers with stronger reputations will have more accurate knowledge of the structural hole than alters brokered by brokers with weaker reputations.

Alter position in the resource flow. Another factor that should be associated with differences in knowledge between alters across a structural hole is each alter's position in the flow of information (or resources more generally). Figure 1 describes the different roles an alter can play in a "conduit-style" brokerage structure (see Obstfeld et al. (2014) for a longer discussion). In this figure, the broker sits between two disconnected alters. One alter, represented by the circle on the left, passes information or other resources to the broker. The other alter, represented by the circle on the right, receives these resources. We follow Gargiulo et al. (2009) in calling the recipient alter (represented by the circle on the right) the "acquirer" of the resources and the other alter the "provider" of the resources. Below we will discuss two (complementary) logics that would suggest that the alter in the "provider" position is more likely to remain in this position even when they know they are being brokered than the alter in the "acquirer" position.

First, a provider of resources is more likely to be willing to delegate the task of disseminating information, reducing the provider's motivation to disintermediate the broker. Because

maintaining ties with others can be a costly endeavor (Burt, 2002; Hansen, 2002), being brokered is, at times, used as a way for actors to reach into the network without the associated costs and effort (e.g. Travers and Milgram, 1969). Disintermediation is less valuable to the provider because she benefits from delegating the task of directly spreading information through these brokers. Conversely, an acquirer of these resource flows should have more motivation to cut out the middleman in the exchange, when compared to the provider of resources. Similar to the child's game of "telephone," as resources pass through nodes, particularly information, they can get changed or transformed, ultimately reducing the benefit of this information to the end user (Hansen, 1999; Rodan and Galunic, 2004; Sorenson et al., 2006). The acquirer of this information, as the ultimate user of this resource, will want the original message and not the transformed message. This increases the likelihood that the acquirer will want to disintermediate the broker, if they only know with whom to connect.

A second way to reach this conclusion comes from the work of Gargiulo et al. (2009) who emphasize closure's effect on role performance and norms. They argue that closing a structural hole, which would disintermediate the broker's role as go-between, will result in reduced autonomy for the actors involved. Therefore, those actors who need others to behave according to their expectations will seek closure, while those who will benefit from autonomy will not seek closure. They suggest that the provider would benefit form the autonomy of providing the information when he sees fit, enhancing the benefit he gains from being the holder of that information. Conversely, the acquirer would benefit from closure because he would increase the pressure on the provider to provide the information, or act in a less self-interested way. Consistent with these claims, the authors show that network closure negatively affects the performance of the provider and positively affects the performance of the acquirer.

These complementary logics result in the conclusion that the alter in the acquirer role should be more willing to disintermediate the broker than the alter in the provider role, all else equal. Since the acquirer is more motivated to disintermediate a broker and if local network knowledge is a necessary condition for disintermediation, it follows that actors found in acquirer positions should know less about the opposite broker-alter tie than those alters found in provider positions. In other words, providers are less likely (than acquirers) to want to disintermediate the broker even when they know about the structural hole. Therefore, knowledge asymmetry between a broker and an alter should be higher if the alter is in the provider role than the acquirer role in the flow of resources. Based on the above discussion, we hypothesize the following:

> *Hypothesis 3.* The provider of the resource will have more accurate knowledge of the structural hole than the acquirer of the resource.

Knowledge asymmetry and broker performance

Finally, our theory also carries implications about the relationship between knowledge asymmetry and broker performance. Implicit in our theory is the idea that the broker should perform better, all else equal, when knowledge asymmetry is present because the latter reduces the threat of disintermediation. The threat of their structural hole being disintermediated should reduce brokers' potential performance because it decreases the freedom and power to act in a self-interested way (Burt, 1992; Simmel, 1950). First, closure leads to increased norms and pressure to conform to group expectations (Coleman, 1988; Gargiulo et al., 2009; Simmel, 1950), reducing broker's ability to act in a way that benefits himself over the group. Second, if alters disintermediate a broker they gain more exchange alternatives (the other alter) than alters in a structural hole (only the broker). Consistent with exchange theory, the presence of credible alternatives to brokerage decreases the

dependence on the broker and the value that the broker can extract from the exchange (Emerson, 1976). The potential to face increased pressure from closure or less control with increased alternatives to the alter will reduce broker's freedom to act as he wants. As the threat of disintermediation increases, the broker will be willing to give up some advantage, in the form of lost negotiating power, to maintain the structural hole (Ryall and Sorenson, 2007). To the extent that knowledge asymmetry decreases the threat of disintermediation, brokers found in a structural hole with knowledge asymmetry should perform better than brokers in a structural hole without knowledge asymmetry.

Hypothesis 4. Knowledge asymmetry in a structural hole will be associated with higher broker performance.

In fact, the premise that the reduced threat of disintermediation increases broker performance allows us to derive another, more alter-specific hypothesis about the relationship between broker returns and knowledge asymmetry. As discussed above, perhaps because of a desire to delegate or the freedom to use their resources at their disposal (Gargiulo et al., 2009), an alter in the provider position should be less willing to disintermediate than an alter in the acquirer position. This implies that accurate knowledge of the structural hole by the "acquirer" increases the threat of disintermediation more than accurate knowledge held by the "provider." Accordingly, we should expect that lower broker performance is associated with higher levels of knowledge by the acquirer.

Hypothesis 5. Acquirer's accurate knowledge of the structural hole will be associated with lower levels of performance for the broker.

Methods

Data sources

We tested our theoretical predictions by using cross-sectional CSS data on directed network ties at a high-tech organization called "Silicon Systems," previously described by Krackhardt (1990). These CSS data are particularly well-suited for examining the relationship between local network knowledge and structure because they elicit employees' perceptions of others' relations inside of this organization. Because we are not making causal claims about where the knowledge asymmetry comes from, these cross-sectional data are sufficient in this first test of our novel hypotheses on the knowledge asymmetry inside of structural holes.[6]

To test our hypotheses, we focused on an actor's knowledge of advice ties.[7] Advice ties of this type provide an excellent laboratory to test our theory because they typically are non-institutionalized, yet they are prevalent in any organization. Moreover, since advice tends to be exchanged in an organization through informal channels, advice ties are likely to be misperceived by some organizational members, but are important patterns of interaction that help work get accomplished. We considered knowledge of directional advice ties to reflect the possibility that an actor might hold accurate knowledge about advice exchange in one direction but not in the other direction. As an illustration, consider that Anne (j) and Sam (k) exchange advice. Such exchange is mutual in that Anne seeks advice from Sam and that Sam seeks advice from Anne. The focal actor (i) accurately perceives that Anne seeks advice from Sam, but inaccurately perceives that Sam seeks no advice from Anne. To account for such heterogeneity, the survey measures whether actor (i) perceives: (1) that j seeks advice from k, and that (2) k seeks advice from j. Accordingly, we included

in our sample two observations for each actor (*i*) in the 78 brokerage triads found in the organization.[8] The unit of analysis is the perception of a directed advice tie in a triad.

Analytical approach

Our analytical approach consists of three steps. First, we examine the relationship between an actor's local network knowledge and their position occupancy in a structural hole (H1). Accordingly, we constructed a sample that included all individuals in brokerage triads (i.e. three individuals per 78 triads and two observations per individual).[9] In a second step, we focused on the factors that might moderate this knowledge asymmetry and the likelihood to disintermediate the broker. Here, we focused on the subsample of alters (i.e. two individuals per 78 triads and two observations per individual resulting in 312 observations). We first assessed the relationship between alter's perception of broker's quality and their knowledge of the structural hole (H2). We then considered how local network knowledge is associated with the type of alter position – provider or acquirer (H3). Finally, we focused on the subsample of brokers in order to examine the relationship between broker performance and knowledge asymmetry in general (H4) and knowledge asymmetry for specific alter positions (H5).[10]

Consistent with our theory discussion above, these tests are *not* designed to understand the causal direction of the relationship between position and knowledge asymmetry, that is, knowledge asymmetry might be the result of position or it might cause actors to be found in a position. Instead, in order to establish that knowledge, asymmetry is found in structural holes and is related to differences in performance, we seek to observe whether knowledge asymmetry exists across a structural hole (H1), its relationship to the threat of disintermediation (H2 and H3), and its relationship to broker performance (H4 and H5).

Knowledge asymmetry and brokerage position[11]

Dependent variables

Position occupancy. Our analyses for Hypothesis 1 (Table 1) use knowledge of the local triad (i.e. the tie opposite of the focal actor across the structural hole) to predict occupancy of an alter's position in a brokerage triad. For the dependent variable, we constructed a binary variable coded 1 if an actor occupied an alter's position in a brokerage triad, and 0 if an actor occupied the broker position in that triad.

Knowledge accuracy. As described by Hypotheses 2 and 3 (Table 2), we use alter's accurate knowledge as the dependent variable. To measure accurate knowledge of the structural hole (our key explanatory variable in Table 1), we adopted a modified version of Krackhardt's approach commonly used by studies on cognitive networks (Krackhardt, 1987). We first measured the "actual" advice tie that existed and was coded 1 when both individual *j* and individual *k* reported an exchange relation between *j* and *k*. We further assessed the accuracy of each participant's cognitive representation of brokerage relations (and non-relations) by comparing the CSS data to actual network data. Accordingly, we constructed local network knowledge measures by comparing the "actual" advice tie (or its absence) to a focal individual's perception of that tie. Accurate knowledge was coded 1 if the alter (or broker) correctly perceived the existence (or nonexistence) of an advice tie, and 0 otherwise.

It is important to note what accuracy entails for each position. For brokers, the key relation of interest in our theory is the disconnection between alters – in this case, accurate knowledge was coded 0 if a broker reported that a tie existed between the two alters in a brokerage triad, despite

Table 1. Logistic regressions for position occupancy: predicting alter in brokerage triad (vs broker).

Variables	(1)	(2)	(3)	(4)
Respondent's attributes (actor *i*)				
Respondent's reputation (perceived power)	−1.194*** (0.437)	−1.104*** (0.065)	−1.595*** (0.511)	N/A
Respondent's tenure in organization	−0.155 (0.107)	−0.170 (0.113)	−0.163 (0.112)	N/A
Respondent's age	−0.152*** (0.047)	−0.155*** (0.050)	−0.185*** (0.053)	N/A
Respondent's formal authority (1–3)	3.445*** (0.880)	3.389*** (0.912)	4.168*** (0.949)	N/A
Respondent's network centrality (advice)	−0.003 (0.007)	−0.003 (0.008)	−0.005 (0.011)	N/A
Respondent's accurate network perceptions	5.885*** (1.249)	5.741*** (1.287)	7.260*** (1.947)	N/A
Dyad member's attributes (actor *j*)				
Member's age	0.061*** (0.022)	0.067*** (0.023)	0.057** (0.025)	0.050** (0.025)
Member's formal authority (1–3)	−0.072 (0.279)	−0.068 (0.272)	−0.168 (0.277)	−0.249 (0.276)
Member's tenure in organization	0.071 (0.075)	0.067 (0.068)	0.048 (0.053)	0.029 (0.052)
Dyad member's attributes (actor k)				
Member's age	0.061*** (0.022)	0.063*** (0.024)	0.053** (0.025)	0.047* (0.025)
Member's formal authority (1–3)	−0.072 (0.279)	−0.116 (0.290)	−0.223 (0.282)	−0.307 (0.280)
Member's tenure in organization	0.071 (0.075)	0.064 (0.081)	0.042 (0.054)	0.022 (0.053)
Dyad's attributes (*j-k*)				
Formal authority difference (squared)	−0.440* (0.244)	−0.441* (0.242)	−0.335** (0.138)	−0.239* (0.138)
Tenure difference (squared)	−0.005 (0.011)	−0.005 (0.010)	−0.004 (0.005)	−0.002 (0.005)
Age difference (squared)	−0.000 (0.001)	−0.001 (0.001)	−0.001 (0.001)	−0.001 (0.001)
Knowledge asymmetry				
Accurate knowledge of perceived dyad		−0.927** (0.423)	−0.990*** (0.331)	−0.982*** (0.335)
Observations	468	468	468	324
Log likelihood	N/A	N/A	−177.28	−137.540
Pseudo R-squared	0.37	0.38	N/A	N/A
Clustered standard errors (respondent)	Yes	Yes	No	No
Respondent random-effects	No	No	Yes	No
Respondent fixed-effects	No	No	No	Yes
Avg. # of obs per group (min-max)	N/A	N/A	16 (2–66)	25 (12–66)

Data Source: CSS data on advice networks in a high-tech company (Krackhardt, 1990). Subsample of broker and alter analyses.
Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2. Logistic regressions for accurate triadic knowledge: conditions affecting likelihood of disintermediation.

Variables	(1)	(2)	(3)	(4)
Respondent's attributes (actor *i*)				
Respondent's reputation (perceived power)	0.001 (0.224)	−0.066 (0.238)	−0.182 (0.243)	N/A
Respondent's tenure in organization	0.016 (0.050)	−0.017 (0.053)	0.002 (0.053)	N/A
Respondent's age	0.007 (0.023)	0.015 (0.024)	0.010 (0.024)	N/A
Respondent's formal authority (1–3)	0.006 (0.420)	0.232 (0.429)	0.097 (0.447)	N/A
Respondent's network centrality (advice)	0.011* (0.006)	0.011* (0.006)	0.009 (0.006)	N/A
Respondent's accurate network perceptions	−0.949 (0.938)	−2.058** (0.979)	−1.497** (1.005)	N/A
Dyad member's attributes (actor *j*)				
Member's age	0.026 (0.024)	0.064** (0.026)	0.065** (0.026)	0.061** (0.026)
Member's formal authority (1–3)	0.019 (0.266)	−0.135 (0.287)	−0.219 (0.288)	−0.066 (0.308)
Member's tenure in organization	0.011 (0.050)	0.092* (0.054)	0.066 (0.055)	0.082 (0.056)
*Dyad member's attributes (actor *k*)*				
Member's age	0.028 (0.024)	0.014 (0.025)	0.014 (0.026)	0.019 (0.025)
Member's formal authority (1–3)	0.263 (0.273)	0.783*** (0.305)	0.734** (0.305)	0.789** (0.328)
Member's tenure in organization	−0.064 (0.051)	−0.046 (0.053)	−0.077 (0.055)	−0.050 (0.057)
Dyad's attributes (j-k)				
Formal authority difference (squared)	0.121 (0.107)	0.086 (0.115)	0.065 (0.115)	0.106 (0.129)
Tenure difference (squared)	−0.008* (0.004)	−0.009* (0.008)	−0.011** (0.005)	−0.008 (0.005)
Age difference (squared)	−0.001 (0.001)	−0.002* (0.001)	−0.002** (0.001)	−0.002 (0.001)
Knowledge asymmetry moderators				
H2: broker perceived relative reputation	0.021** (0.009)		0.024** (0.010)	0.002 (0.014)
H3: alter is "acquirer" of resources		−2.164*** (0.373)	−2.193*** (0.375)	−1.898*** (0.372)
Observations	312	312	312	296
Log likelihood	−193.91	−176.81	−173.49	−130.87
Pseudo R-squared	N/A	N/A	N/A	N/A
Respondent random-effects	Yes	Yes	Yes	No
Respondent fixed-effects	No	No	No	Yes
# of groups (individuals) (Avg., min-max)	29 (11, 2–20)	29 (11, 2–20)	29 (11, 2–20)	27 (11, 2–20)

Data Source: CSS data on advice networks in a high-tech company (Krackhardt, 1990). Subsample of alters analyses. Standard errors in parentheses; *significant at 10%; **significant at 5%; ***significant at 1%.

the tie's absence. Broker's knowledge was coded 1 if the broker reported that a tie between the two alters was absent. An alter's accurate knowledge was coded 0 if an alter reported that there was no tie between another alter and a broker, despite the tie's presence. We coded an alter's accurate knowledge 1 if an alter reported that a tie between a broker and another alter existed.

Alter ratings of broker performance. To explain variation in brokers' performance (Hypotheses 4 and 5), we measure as alter's rating of broker's performance in the organization. The dependent variable in these analyses was an individual's rating of another's "ability to get things done," as rated on a 1–7 Likert scale.[12] While not a perfect measure of objective performance, this is a reasonable proxy because, as the question reads, it was an individual's perception of the other's ability to accomplish things in the organization, not in the past (as was the reputation score), but currently.

Explanatory and control variables

Broker perceived relative reputation. Our theory suggests that the threat of disintermediation should decline with a broker's reputation relative to alters. As brokers appear as more attractive exchange partners than an alters, the latter should be less likely to disintermediate and therefore more likely to hold accurate knowledge of the local network. To assess this relationship, we used the perceived performance score previously presented in these data by Kilduff and Krackhardt (1994). These scores are a particularly suitable measure of reputation because they reflect the broader perceptions of individual reputation, as assessed by others in the organization. In particular, each individual in the organization was asked to provide a job performance rating about each other individual, based on their past performance in the organization, measured on a Likert scale that varies between 1 (lowest) and 7 (highest). The measure varies within a single broker, where each broker receives two separate scores, each from one alter in the triad. A key reason for using this measure instead of an aggregate measure of perceived reputation by the group is to capture the variance of each individual's perceptions of reputation. Moreover, actors that occupy a brokerage position in more than one intransitive triad will receive this score from more than two alters. Capturing this variance allows us to more specifically test the mechanism of the relative perceived status. We construct the relative scores of perceived reputation by subtracting each broker's scores from each alter's scores. Because this measure is directional, it indicates whether brokers have a higher relative reputation than their respective alters. Finally, we use these relative scores to predict accurate local network knowledge in Models 2 and 4 of Table 2.

Alter provider-acquirer position occupancy. We also focus on the position of the alter: provider or acquirer. For each observation alter could have been the provider of information (advice) or the acquirer. In order to compare knowledge differences between provider and acquirer (Table 2, models 3 and 4), we constructed a binary variable coded 1 if the alter was the acquirer of the advice, and 0 if the alter was the provider of the advice. Cases where there was mutual advice seeking, (i.e. where the alter was both provider and acquirer) were also coded 0.

Triadic level accuracy. The key independent variable in the analyses for Hypotheses 4 and 5 (Table 3, Model 2) was a measure of knowledge asymmetry at the triad level: coded 1 if there was at least one alter that did not know about the other alter-broker tie, and 0 if both alters knew about the other alter's tie to the broker. In Table 3, Model 3, we broke this variable down to whether the broker, acquirer-alter, and provider-alter each knew about the opposite tie (or non-tie for broker).

Table 3. Ordered probit regressions for brokerage performance (perceived power).

Variables	(1)	(2)	(3)
Broker's attributes			
Broker's advice network centrality	0.006 (0.006)	0.008 (0.007)	0.008 (0.007)
Broker's reputation	−0.269 (0.285)	−0.392 (0.338)	−0.131 (0.285)
Broker's tenure in organization	0.006 (0.039)	−0.002 (0.057)	0.056 (0.038)
Broker's age	−0.011 (0.036)	−0.005 (0.033)	0.007 (0.036)
Broker's formal authority (1–3)	1.210** (0.548)	1.362** (0.601)	0.791 (0.584)
Resource provider's attributes			
Provider's age	0.005 (0.020)	0.010 (0.018)	0.009 (0.020)
Provider's tenure in organization	0.054 (0.038)	0.083** (0.039)	0.069** (0.035)
Provider's formal authority (1–3)	−0.489*** (0.185)	−0.318* (0.182)	−0.313 (0.224)
Resource acquirer's attributes			
Acquirer's age	0.026 (0.028)	−0.005 (0.023)	0.015 (0.025)
Acquirer's tenure in organization	0.017 (0.034)	0.069 (0.048)	0.056 (0.038)
Acquirer's formal authority (1–3)	−0.929*** (0.360)	−0.810** (0.373)	−0.954** (0.442)
Alter's evaluation of other alter			
Alter's power (j's ratings of k's power)	0.265*** (0.086)	0.277*** (0.056)	0.248*** (0.080)
Knowledge asymmetry			
Knowledge asymmetry (triad level)	–	1.695*** (0.494)	–
Broker's accurate knowledge of structural hole	–	–	0.397*** (0.131)
Provider's accurate knowledge of broker–acquirer tie	–	–	0.642** (0.286)
Acquirer's accurate knowledge of broker–provider tie	–	–	−0.884*** (0.291)
Observations	142	142	142
Clustered standard errors (broker)	Yes	Yes	Yes
Pseudo R^2	0.25	0.31	0.29

Data Source: CSS data on advice networks in a high-tech company (Krackhardt, 1990). Subsample of brokers.
Robust standard errors in parentheses.
*significant at 10%; ** significant at 5%; *** significant at 1%.

Individual controls. One inferential challenge pertains to the fact that individual-specific characteristics may account for variation in an actor's triadic network cognition. To the extent that the pertinent individual attributes were observable, we controlled for them in our models. Because each triad is composed of three distinct members, our models include individual-level controls for each of these members, *i*, *j*, and *k*. We first include a control for an individual's formal authority in the organization because one's hierarchical position is likely to drive both, one's knowledge of triadic networks and one's successful occupancy of a brokerage position. For example, it is reasonable to expect that organizational members occupying higher rank should be better positioned to broker advice between their subordinates. Individuals in higher organizational positions may also be more likely to hold accurate knowledge of triadic relationships due to better access to information about social ties around them. Accordingly, all our models include a measure of an actor's formal position in an organization that ranges between 1 (low) and 3 (high). In addition to formal

authority, we control for an actor's age and tenure in the organization. We expect older and longer-tenured employees to be differentially exposed to opportunities for occupying and profiting from brokerage positions as well as to be better positioned to develop accurate local network knowledge.

An actor's accurate knowledge of the structural hole may further be influenced by their general propensity to develop a cognitive map of the entire social structure around them. It is reasonable to expect that actors who come to occupy and profit from positions within brokerage triads are systematically different in their abilities to accurately perceive social network ties in general. To account for this possibility, we include a measure of an individual's general cognitive accuracy or accurate network perception – introduced in Krackhardt's studies (1987, 1990) – that accounts for the degree of correspondence between an individual's cognitive representation of the entire network and the confirmed network.[13]

Finally, in theorizing for Hypothesis 1, we cite the importance of personality variables like self-monitoring, as important in determining someone's ability to select into a brokerage position and avoid an alter position. These variables were not measured in our data, but our tests below control for these through individual fixed-effect models. Therefore, while personality factors are important in determining accurate knowledge and position occupancy, our studies are designed to test the relationship between knowledge and position *net of personality effects*.

Dyadic controls. The probability that an actor occupies a position as either broker or alter in a structural hole may depend on the degree of similarity between two other alters. Early sociometric network studies related the logics of the "forbidden" triadic relations to the homophily principle (Davis, 1970; Granovetter, 1973), predicting that similar alters should be more likely to lead to a closure of an open relation. Accordingly, we include in the models a measure of difference between two alters *j* and *k* with respect to alters' age and formal position. Because the measure is constructed as an absolute difference between the respective values for actors *j* and *k*, it takes lower values for greater homophily between the two actors.

Finally, the models designed to test for the effects on broker performance (Table 3 related to the analyses for Hypotheses 4 and 5) include a control for the performance rating each alter (*j*) attributes to another alter (*k*). How the focal alter rates another alter in the triad reflects the value of brokerage, as perceived by the focal alter. Consistent with previous literature (Bidwell and Fernandez-Mateo, 2010; Rider, 2009), we expect that brokers can extract higher profits when an alter places higher value on the other alter.

Empirical analyses

To explain variation in position occupancy, we use a triad member's perception of a focal dyad embedded in a triadic structure as our unit of analysis. Because the dependent variable is dichotomous, the following logistic regression model is estimated to assess the determinants of cross-sectional variation in position occupancy:

$$k = \log \frac{\pi}{1-\pi} = \alpha + X^{'}\beta$$

where κ represents the linear transformation of the log of the probability, π, of the dependent variable occurring divided by the probability of the variable not occurring. The model estimates are a constant α and β, estimated coefficients of X, a vector of the independent and control covariates. To mitigate the concerns related to unobserved individual characteristics, we additionally re-estimated the models "within individual."[14] For robustness, we include, in separate models,

respondent random-effect (Table 1, Models 2 and 3; Table 2 Models 1–3) and fixed-effect (Table 1 Model 4, Table 2 Model 4) specifications. To account for a non-independence of observations due to repeated observations by a respondent, where possible, we cluster standard errors by the respondent and by the triad, for robustness. Finally, in additional analyses, we cluster standard errors by both respondent and the triad (unreported) and obtain similar results.

Results

We begin by estimating the association between knowledge asymmetry and occupancy of a brokerage position. To so do, we focus on the sample that includes respondents occupying the positions of brokers and alters in structural holes. The analyses provide strong support for our theoretical framework: variation in occupancy of a brokerage positions (alter vs. broker) is strongly associated with variation in accurate local network knowledge. Table 1 shows the estimates obtained using the logit model to predict the probability that an individual occupies an alter's position in a brokerage triad. Model 1 reports the association of the covariates with brokerage occupancy. Model 2 adds the measure of knowledge accuracy – as can be seen, the coefficient on the respondent's accurate knowledge of a perceived dyad is negative and highly significant; this indicates that alters are less likely than brokers to hold accurate knowledge that they are in a structural hole. An important concern may be that our results are driven by unobserved traits of the respondent which may correlate with the occupancy of the alter's position as well as accurate knowledge about the network. For example, it could be that alters exhibit lower human capital, in general, and are therefore more inclined to hold less accurate knowledge. To rule out this concern, Models 3–4 re-estimate the baseline specification in Model 2, but include respondent-random effects and respondent-fixed effects, respectively. As can be seen, the negative sign and statistical significance on the coefficient are preserved, even when variation is estimated "within respondent." The results are also substantial in magnitude. The coefficient in Model 4 indicates that having inaccurate knowledge about the opposite tie in the triadic structure is associated with a 50 percent increase in the odds that an individual occupies an alter's position. Models 1–4 further show that the probability of occupying an alter's position in brokerage decreases with one's age, reputation, formal authority, and general accuracy about the network (Models 1–3), increases with the age of the to other members of the triad and with the difference in formal authority between these two other members of the triad (Models 1–4). A potentially interesting relationship exhibited in the control variables is the finding that those higher-up in the organization (formal authority) are more likely to be alters in a brokerage triad. In light of Burt (2004)'s finding that brokers tend to be managers, it is worth to further explore this result. While beyond the scope of the current study, this finding highlights an opportunity for future research, as we explain in the discussion section below.

Taken together, the results presented in Table 1 provide clear evidence that broker's accurate knowledge of alters' disconnection and alters' inaccurate knowledge of broker-alter ties (i.e. knowledge asymmetry) is associated with occupancy of specific positions across the structural hole. This is consistent with our first hypothesis, which predicted knowledge asymmetry between broker and alter such that a broker had more knowledge about the local triad than either alter (H1).

We further estimate the association between the threat of disintermediation and knowledge accuracy. To do so, we focus on the subsample of alters, given that they are the ones who may potentially disintermediate the broker. Since the dependent variable (accurate knowledge of the opposite tie) is binary, we perform logit regressions. As can seen in Table 2 (Models 1 and 3), the coefficient for a broker's perceived reputation indicates that an increase in a broker's reputation is associated with a 2 percent increase in the odds that the alter holds accurate information about his or her local network. This is consistent with H2, which predicts that higher broker reputation

should decrease the threat of disintermediation – and therefore increase an alter's knowledge accuracy. Moreover, consistent with H3 (Models 2 and 3), the negative coefficient for an individual in the "acquirer" position is associated with a 68 percent decrease in odds that an alter holds accurate information about his or her local network. In other words, those alters less likely to disintermediate the broker, due to their occupancy of the "acquirer's" position, are more likely to hold accurate knowledge of the structural hole (reducing knowledge asymmetry for that specific alter). In Model 4 we report the results using a respondent fixed effect specification. In specifying the model in this way, two individuals are dropped from the sample (accounting for 16 observations) because these individuals were either always correct or always incorrect in observing the opposite tie. This loss of variance can explain why the effect for broker's relative reputation reduces in significance. However, even with this reduced power, the alter position effect still remains significant.

It is also important to point out that these results are unlikely to be explained by unobserved individual heterogeneity in the respondents (e.g. personality, self-monitoring, etc.). To address this concern,[15] Models 1–3 in Table 2 show the results estimated using a respondent random-effect specification and Model 4 uses a respondent fixed-effect specification. Estimates in these models can be interpreted as within individual effects. In short, we find at least partial evidence that reduced knowledge asymmetry is associated with broker reputation and clear evidence that knowledge of being brokered depends on an alter's position in the structural hole.

Table 3 illustrates the relation between knowledge asymmetry and broker's performance. Accordingly, these results are estimated on the subsample of brokers. We use an ordered probit regression, suited for estimating regressions when a dependent variable is an ordered count, to examine the association between an actor's knowledge of a perceived dyadic tie within brokerage and broker's performance. Because observations are non-independent and repeat for brokers, we adjusted for non-independence by clustering standard errors by broker.

Consistent with H4, we find that knowledge asymmetry is positively associated with broker's performance, as documented in Model 2. The positive coefficient suggests that brokers are more likely to accomplish things in the organization ("get things done") when brokers hold accurate knowledge about the structural opportunity, but alters, on average, do not. Consistent with H5, Model 3 shows that that the direction (positive or negative) of the relationship between knowledge asymmetry and broker's performance varies across alters' position in the flow of resources. Broker's accurate knowledge is associated with higher levels of perceived broker power. Similarly, a positive coefficient on the provider's accurate local network knowledge variable indicates that accurate knowledge by the alter in the provider position is associated with higher broker performance. Conversely, the negative coefficient on the acquirer's accurate knowledge suggests that accurate knowledge by the alter in the acquirer position is associated with lower levels of broker performance. Taken together, these results clearly indicate that knowledge asymmetry has a positive relationship with performance outcomes for the broker. More specifically, brokers are perceived to be able to accomplish more when the threat of disintermediation is reduced by knowledge asymmetry in general, and by inaccurate acquirer knowledge in particular.

Discussion

We began by noting that while assumptions about network cognition are implicit in studies on brokerage and structural holes, how local network knowledge is related to structural holes has remained unclear. Previous studies have, at least implicitly, assumed full and homogeneous network knowledge (e.g. Gargiulo et al., 2009; Podolny, 2001; Reagans and Zuckerman, 2008; Rider, 2009), despite strong evidence that network perceptions vary across participants in the social structure (Casciaro, 1998; Casciaro et al., 1999; Flynn et al., 2006; Kilduff and Krackhardt, 1994;

Krackhardt, 1987, 1990; Krackhardt and Kilduff, 1999). In this study, we relax the assumption of homogenous knowledge of social ties and build a sociocognitive model of brokerage that explicitly incorporates variation in actor's knowledge of network ties. Central to our theoretical framework is the notion that structural holes are inherently characterized by a fundamental asymmetry in knowledge: while brokers are more likely to hold accurate knowledge about the structural hole, alters, by contrast, tend to hold more *in*accurate knowledge of ties across the structural hole. Because knowing who to disintermediate with is a necessary condition of disintermediation, this asymmetry in local network knowledge reduces the likelihood that an alter will disintermediate a broker, allowing the structural hole, and broker's role, to remain intact.

The potential threat of disintermediation is reduced in some conditions, and our results show that these conditions are also correlated with reduced levels of knowledge asymmetry—that is, higher knowledge for alters found in these contexts. In other words, there are situations in which alters should be more willing to be brokered; hence, even when knowledge of opportunities to disintermediate is greater, alters may prefer to persist in the relationship with the broker. In particular, we found some support for the idea that when brokers are held in higher esteem by those they are brokering, the threat of disintermediation is reduced because alters are willing to enjoy the benefits of being brokered by someone with a high reputation. Our findings that knowledge asymmetry is reduced by broker reputation is consistent with the idea that alters are less willing, or even perhaps less able, to close these open triads when they are tied to highly reputable brokers for fear of losing the benefits associated with these ties. This is consistent with prior research that suggested that others see reputation through the "prism" of one's relationships (Podolny, 1993, 2001; Stuart et al., 1999). These findings are also consistent with the line of research that documents how highly reputable brokers benefit by reducing alter-centric uncertainty in brokered exchange (Rider, 2009). But note, this benefit can only arise when the ties (and identity of the actors involved) are known across the structural hole. This line of inquiry has implications for fundamentally different strategies for brokers. All else being equal, less reputable brokers should prefer to maintain obscure brokerage relationships to mitigate the threat of disintermediation.

Furthermore, our findings suggest that inaccurate knowledge of the structural hole is more prevalent for the acquirer than for the provider of the information (or resource). This is consistent with the idea that alters who are the provider of the information are less willing to close a structural hole than those who are the ultimate acquirer of the information (Gargiulo et al., 2009). An important implication of this is the idea that there are reasons why an alter might benefit from being brokered. In particular, as the provider of information, instead of maintaining unending numbers of ties, which would be too costly, an alter would benefit from delegating the distribution of certain information or other resources to others. This highlights the second reason, along with maintaining ties to higher status others, that an alter would prefer to remain an alter, all else equal.

Finally, our findings suggest that brokers are more likely to benefit under conditions of knowledge asymmetry, in general. In particular, we find that accurate knowledge of brokerage held by alters in the provider position is positively associated with broker's performance, while accurate knowledge of brokerage held by alters in the acquirer position is negatively associated with broker's performance. We interpret these findings, first, as evidence that the threat of disintermediation, driven primarily by the alter in the acquirer position, is reduced by knowledge asymmetry. Providers of information possess the key resource desired by other actors, and will be less likely to close the triad for fear of losing the freedom to disseminate the information as they desire. By contrast, the acquirer's accurate knowledge of brokerage may incite him to eliminate the broker in order to engage in a direct exchange with the alter in the provider position. Thus, brokers tend to derive greater returns when the acquirer's perception of the broker–provider tie is inaccurate.

In combination, our findings offer new insights to theories on brokerage. While previous studies have largely related the prevalence and success of brokerage to the *broker's accurate knowledge* of a structural opportunity arising from alters' disconnection (Burt, 1992), we indicate that the existence of and returns to brokerage are associated with *alters' inaccurate knowledge* of the broker's connection to another alter. By shifting the focus from brokers to alters, we join an emerging line of research that takes an alter-centric approach to understand how brokers derive and maintain advantages from occupying structural holes (e.g. Bidwell and Fernandez-Mateo, 2010; Gargiulo et al., 2009; Rider, 2009; Ryall and Sorenson, 2007). With this approach, it is possible to provide deeper insights into recent work on how structural holes are shaped by both structural constraint and network opportunities (Zaheer and Soda, 2009). Our theory and findings suggest that knowledge asymmetry plays a part in forming this constraint and providing opportunities for structural holes.

The novel insights presented in the study yield further implications for future research on the cognitive underpinnings of brokerage and social ties more generally. Admittedly, our study is limited in its ability to generate causal evidence of where knowledge asymmetry comes from because of the cross-sectional data used. Nonetheless, the theoretical argument has important implications for understanding how tenuous and precarious brokerage structures are sustained over time (Buskens and Van de Rijt, 2008; Gargiulo et al., 2009). In particular, our findings suggest that structural holes characterized by knowledge asymmetries should be more sustainable over time. Future studies that can successfully navigate the challenges to collecting longitudinal data on CSSs can better pinpoint the causal mechanisms behind the observed knowledge asymmetry. Such inquiries would be able to better disentangle whether the observed correlation between actor's accurate knowledge of a tie and his or her occupancy of a broker or alter position arises due to differential selection of actors with accurate and inaccurate knowledge into positions in a triad or whether knowledge asymmetries are generated once an actor already occupies a position within a triadic structure (or both). Work that further clarifies the causal processes that underlie the cognitive aspects of brokerage would shed light on the broader set of questions on the origins and evolution of social capital (Gulati and Gargiulo, 1999; Hallen, 2008; Sørensen and Stuart, 2000; Stovel and Shaw, 2012; Zaheer and Soda, 2009).

The focus on advice ties in our analysis presents another opportunity to explore the role that affect and trust play in a broker's ability to maintain his advantageous position. In this study, we have bracketed the influence that friendship or trust relations might have on the presence or absence of knowledge asymmetry in any brokerage triad. But there is reason to believe that friendship and trust could further moderate this knowledge asymmetry. For instance, it seems reasonable to think that even if A knows that she is being brokered by B (on to C), she will be more willing to allow B to pass information or other resources to C, if B is a friend. This might be the result of the increased trust related to friendship networks or the higher willingness to reciprocate or support the friend's role in the organization. Furthermore, it is an implicit assumption in our argument that alters might be concerned that the broker will take advantage of them, given their disadvantageous position, thus the more general desire to disintermediate. However, brokers that are more trusted by their alters should induce more willingness for alters to remain as alters in the resource flow, even if such alters are aware of the structural hole and opportunities to disintermediate exist. Accordingly, similar to the other moderating influences we suggest, trust can also moderate the likelihood of being in an alter position given knowledge of the structural hole, that is, reduce apparent knowledge asymmetry. To explore this further, future research would do well to test (a) the role that trust plays in maintaining brokerage ties and (b) the types of (identity) features that affect alters willingness to trust the broker (Podolny, 2008; Stovel and Shaw, 2012).

An interesting finding in the results shown in Table 1, that in this company brokers tended not to be managers, is worth commenting on. While Table 1 limits the analysis only to those in structural holes, subsequent (unreported) analyses on these data indicate that in this organization formal authority has a negative relationship with being a broker. Burt's (2004) seminal paper on the information advantages of structural holes, found that managers tended to be brokers. The key explanation for this difference would seem to indicate that organizational differences, particularly those related to organizational size and the number of formal divisions, might influence who occupies and who potentially benefits from structural holes in the organization. In particular, Burt's (2004) finding is based in a large organization that has separate divisions while our data is in a small "high-tech" firm (33 employees total) with only three levels of managers. Burt (2004) notes in his conclusion that "good ideas emerged, as hypothesized, from the intersection of social worlds, but spread—in the organization studie(d) here—in a way that would continue segregation between the worlds" (p. 394). By contrast, our study focuses on an organization with no distinct social worlds. In a company without divisions, where everyone has the opportunity to work with everyone else, structural holes are not created by division separation. Contrary to the image of a manager bridging social worlds in the large organizations, in our data, the broker seems to be someone who bridges across levels of the organization (more hierarchically). This difference might indicate that smaller organizations of the type we study (where diverse worlds or divisions cannot be bridged) might increase the opportunities for brokerage to those in middle management resulting in higher potential benefits associated with straddling these structural holes. This finding and interpretation, would, of course, need further substantiation and seems worth pursuing in future research. To this end, future research would do well to consider whether the informal structures in smaller organizations create more potential for lower level employees to benefit, to the extent that smaller, flatter organizations might increase the likelihood that lower-level employees tend to straddle more structural holes in the information flow of a company.

While the theory developed in this article provides a novel perspective to understand the prevalence of and returns to brokerage positions, it is nevertheless subject to important constraints. As we began to show with our discussion and analysis of two of the potential moderators of knowledge asymmetry, the theorized relationship between knowledge asymmetry and brokerage will depend on the existence of a disintermediation threat. In particular, one scope condition on the theoretical framework pertains to non-institutionalized brokerage. Our study focuses on informal advice ties in which disintermediation is credible and in which open triads may close over time. We do not expect the same mechanisms to operate in the context of institutionalized brokerage, where all parties are typically informed about the structure of relations and where the threat of disintermediation is non-existent. Yet, because a large number of social ties between and within organizations remain non-institutionalized and informal (e.g. Ibarra, 1993), we believe that our theoretical model importantly advances the understanding of the brokerage phenomenon. Furthermore, because our measure of broker performance was limited to perceptions about task ability, we could not explore how knowledge asymmetry might be related to other important organizational outcomes. For instance, to the extent that brokerage processes around innovation succeed through collaboration instead of separation (Lingo and O'Mahony, 2010; Obstfeld, 2005), it might be the case that an organization with high levels of knowledge-asymmetric structural holes would be plagued with lower levels of innovation because of increased inability to close these holes.

With these limitations in mind, this study has made important strides in our understanding of the relationship between local network knowledge and structural holes. Although few would dispute that structural holes represent beneficial opportunities to a broker, how brokers derive returns given the precarious nature of structural holes has been less clear. By integrating cognitive perspectives on networks with the theories of brokerage, this study is the first to outline a sociocognitive

model of brokerage across structural holes. Our main contribution lies in documenting a knowledge asymmetry that underlies a threat of disintermediating the structural hole, and is related to position and performance in these brokerage structures.

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Notes

1. This type of perception about network ties has been called "cognitive social structure" or CSS by David Krackhardt and colleagues (e.g. Casciaro, 1998; Casciaro et al., 1999; Krackhardt, 1987, 1990; Kilduff and Krackhardt, 1994). CSS is a measure of an individual's aggregated perception of ties across an organization's entire network, including perceptions of the networks of those to which they are and are not tied. We are focused on only the second-order network or the network of those to which the focal actor is tied.
2. We are indebted to David Krackhardt and his willingness to share his CSS data with us (Krackhardt, 1990).
3. While generally consistent with structural hole theory (Burt, 1992), the more specific conception of conduit-style brokerage offered by Marsden (1982) suggests that not all structural holes are, strictly speaking, brokerage structures if we permit directionality. For instance, in our analysis, we omit cases of pure structural equivalence (A->B<-C) and hierarchy (A<-B->C) where different logics and dynamics are at play (c.f., Burt, 1987).
4. Note that our argument dos not imply that alters will never choose to remain as alters. We will address the potential heterogeneity in alter's motivation when deriving alter-specific hypotheses in the following section.
5. We use the term reputation to capture perceptions of the broker's quality by the alter, but the mechanisms described in this section are derived from work on both reputation and status as measures of perceived quality. This is not to say that these constructs are the same, but in using the term 'reputation', we mean to capture those ideas related to both status, which is a more specific and relational construct related to perceptions of quality, as well as reputation, a broader term meant to articulate perceptions of how the actor is known to perform.
6. Typical CSS data require a study participant to not only inform on her ego network, but also on what she perceives the "ego network" of every other person in the network or organization to be. On top of issues related to high levels of subject labor, the act of collecting CSS data often teaches the subjects about their network knowledge and inspires increased search in ways that would not have happened naturally. Thus, the intervention of the researcher threatens the reliability of longitudinal CSS data. We hope this study inspires future data collection that does not succumb to these problems.
7. See Appendix B for description of how these advice ties were originally collected.

8. As a robustness check, we also test for knowledge asymmetry indirectly by seeing whether alter has less knowledge than members of a closed triad and then whether broker has more knowledge than a member of a closed triad. These tests find similar results supporting knowledge asymmetry (unreported).

9. Note that because we were evaluating directed ties, each individual has two observations per triad (i.e. i observes the directed tie $j{\rightarrow}k$ and the directed tie $j{\leftarrow}k$).

10. This resulted in a total sample of 156; 78 brokerage triads with 2 alter ratings from each triad. The sample was further reduced to 142 because 14 of the reputation ratings (a control variable described below) were missing.

11. Descriptive statistics and correlations are presented in Appendix – Table A1.

12. This measure was called "power" in Krackhardt's (1990) original papers using these data.

13. Note that one key difference between this general network accuracy measure is that it is about the entire network instead of the perception of a specific tie (or non-tie). Therefore, this value varies by individual and not observation.

14. Hausman's test indicated that random effects were an appropriate specification for the models.

15. In additional analyses (unreported), we re-estimated the models with two-way clustering of standard errors (at the respondent and the triad level). The results were robust to this alternative specification.

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Appendix I

Table 4. Descriptive statistics and correlations for the main covariates (brokerage position).

	Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Broker vs. closed triad's member	0.24	0.43															
2	Alter in brokerage vs. closed triad's member	0.31	0.46	−0.377														
3	Respondent's reputation	4.41	1.61	0.236	−0.170													
4	Respondent's tenure in organization	5.59	3.90	−0.245	0.245	−0.225												
5	Respondent's age	35.1	8.01	−0.272	0.229	−0.094	0.651											
6	Respondent's formal authority (1–3)	1.75	0.81	−0.236	0.140	−0.232	0.717	0.657										
7	Respondent's accurate network perceptions	0.35	0.19	0.171	−0.203	0.195	−0.047	0.030	−0.159									
8	Member's age (j)	34.4	8.22	0.013	−0.125	0.022	−0.080	−0.092	−0.061	0.073								
9	Member's formal authority (1–3) (j)	1.63	0.82	0.013	−0.056	0.042	−0.049	−0.055	−0.010	0.034	0.680							
10	Member's age (k)	36.1	7.89	0.104	−0.255	0.052	−0.125	−0.124	−0.082	0.100	−0.055	−0.081						
11	Member's formal authority (1–3) (k)	1.94	0.78	0.065	−0.276	0.092	−0.097	−0.094	−0.018	0.066	0.065	0.087	0.618					
12	Formal authority difference (squared)	1.27	1.43	0.143	−0.538	0.074	−0.122	−0.132	−0.118	0.128	0.007	0.028	0.421	0.551				
13	Tenure difference (squared)	36.1	38.3	−0.038	0.079	−0.019	0.007	0.017	0.070	0.044	0.089	−0.018	0.314	0.373	−0.017			
14	Age difference (squared)	139.7	159.6	0.050	−0.002	0.003	−0.073	−0.099	−0.023	0.060	0.152	0.253	0.268	0.415	0.074	0.457		
15	Accurate knowledge of perceived dyad	0.64	0.48	−0.011	0.006	−0.028	−0.080	−0.069	−0.004	−0.044	0.085	0.205	0.173	0.187	−0.040	0.279	0.286	
16	Broker reputation	4.13	.044	−0.287	0.216	−0.120	0.041	0.033	0.028	−0.216	−0.004	0.020	0.119	0.215	0.350	0.008	0.024	−0.028

Appendix 2

Collecting Advice Ties (Krackhardt 1990)

Krackhardt (1990) describes the collection of advice network data. In this section of the article, he describes the question presented to subject as follows:

> The directions for the "advice" section of the questionnaire were as follows: In this section, you will find a set of similar questions with a list of people after each question. The question is "Who would this person go to for help or advice at work?" That is, if this person had a question or ran into a problem at work, who would they likely go to to ask for advice or help? Please answer the question by placing a check next to the names of all the people the person is likely to go to … Some people may go to several people for help or advice. Some may only go to one person. Some may not go to anyone, in which case do not check anyone's name under that question. (pp. 348–349)