More Than a Helping Hand: Personal Network Structure and Functional, Cognitive, and Emotional Health

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More than a Helping Hand:

Personal Network Structure and Functional, Cognitive, and Emotional Health

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Personal Network Structure and Functional, Cognitive, and Emotional Health

Abstract

Scholars have long found compelling evidence of associations between social relationships and health, largely drawing from summary survey measures of social engagement and support. In recent decades, a growing literature not only reexamines these associations using more-specific and detailed survey-based measures of networks but also offers new understandings of how the structure and composition of networks protect or even harm physical and mental health. The three empirical chapters of this dissertation draw from four propositions to contribute to this growing literature and shed new light on how networks matter: First, the structure and composition of networks matter for health in ways not captured by summary indices alone. Second, relationships are associated with health through multiple mechanisms beyond material aid or direct disease exposure. Third, the mechanisms by which relationships matter for health are not always captured by surveys and the hypotheses that motivated their design. And, fourth, these mechanisms are specific to different outcomes and disease profiles. To evaluate these propositions, the three empirical chapters use data from two unique, multidisciplinary surveys of core discussion networks, which are derived from a classic measure of networks defined as the people (*alters*) with whom an individual (*ego*) discusses "important matters."

In the first empirical chapter, I examine the likelihood of receiving help with household tasks and personal care activities among older adults. Difficulty with household tasks and personal care activities are common measures of functional disability and well-being in later life, and unmet needs for help with these tasks and activities are associated with a range of negative consequences, including loss of independence. Previous research on help emphasizes the importance of access to particular family and household relationships. This chapter looks to the composition and structure of the wider interpersonal environment in which older adults are embedded as captured by the core discussion network. Using logistic regression models with cross-sectional data from the second wave of National Social Life, Health, and Aging Project (NSHAP), I find that network composition and structure is associated with the odds of help when controlling for family and household relationships. I also find that the particular network measures correlated with help differ given the nature of particular tasks or activities. This chapter emphasizes that core discussion networks are not only indicators of access to helpers—including but not limited to family or household members. Rather, core discussion networks are also suggestive of different enabling processes, including different cognitive frames that condition the likelihood of activating and receiving help when coping with different functional limitations.

In the second empirical chapter, I investigate the longitudinal association of network composition and structure with cognitive function. Social relationships are frequently posited as key protective factors of cognitive function, which is critical for well-being in older age. This research is based on two hypotheses: the cognitive enrichment hypothesis, which argues social engagement directly affects cognitive function through mental stimulation; and the stress hypothesis, which argues social support and cohesion indirectly affect cognitive function by promoting positive emotions and protecting against negative emotions, which in turn affect cardiovascular and neuroendocrine functions associated with neuropathology. Using lagged dependent variable regression models with data from the second and third waves of NSHAP, I find that network size is positively associated with cognitive function while frequency of communication with alters is negatively associated with cognitive function, seemingly both supporting and contradicting the cognitive engagement hypothesis. I also find that density and average emotional closeness to alters are respectively negatively and positively associated with cognitive function as expected, but are not significant when controlling for sociodemographic and health measures. This chapter emphasizes the need not only for future research to explore these puzzling findings, but also for additional research on the effects of mild cognitive impairment and dementia on measurement error in survey-based network instruments.

In the third empirical chapter, my coauthor and I examine post-traumatic stress after Hurricane Katrina using longitudinal survey and qualitative interview data from the RISK Project. This chapter uses an innovative mixed method design to not only identify *which* characteristics of the core discussion network are associated with long-term psychological health following a natural disaster but also the multiple *mechanisms* by which those characteristics affect psychological health. Using logistic regression models, we find that geographic distance to alters is associated with a greater likelihood of post-traumatic stress five years after Hurricane Katrina. Qualitative interviews then reveal this association can be explained not by differences in access to instrumental support but rather by decreased feelings of belonging to a local community and decreased feelings of mattering to others among these with geographically dispersed networks. This chapter draws attention to the value of mixed method research, to geographic distance as a key aspect of networks, and to the salubrity of not only receiving but giving support to others.

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Chapter One: Introduction

Social relationships are widely considered to shape the course and outcomes of physical and mental diseases and disorders. Empirical examinations of the association between relationships and health date to Durkheim's (1897) *Suicide* and his finding that higher levels of social integration correlate with lower suicide rates. The contemporary study of relationships and health, however, emerged in the 1970s with Cassel's (1976) Wade Hampton Frost Memorial Lecture to the American Public Health Association, Cobb's (1976) Presidential Address to the Psychosomatic Society, and Berkman and Syme's (1979) Alameda County Study, which was the first prospective study to establish a link between social integration and mortality. Since the 1970s, relationships have been found to associate with numerous health-related behaviors and outcomes, including higher rates of physical exercise; lower rates of alcohol consumption, drug use, and smoking; higher functional health; and lower risk of cardiovascular disease or even the common cold—just to name a few.[1] The salubrity of relationships is now considered a "veritable social fact" (Umberson, Crosnoe, and Reczek 2010:139); interpersonal environments are now a key components of most conceptual models of health (World Health Organization 2010); and isolation is now frequently characterized by both academics and the media as an urgent epidemic with consequences on par with smoking or obesity (Holt-Lunstad 2017; Khullar 2017).

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[1] This research has been summarized in review articles and books (Berkman et al. 2000; e.g., Berkman and Glass 2000; Ertel, Glymour, and Berkman 2009; Holt-Lunstad 2018; House, Landis, and Umberson 1988; House, Umberson, and Landis 1988; Smith and Christakis 2008; Uchino, Cacioppo, and Kiecolt-Glaser 1996; Umberson, Crosnoe, and Reczek 2010; Umberson and Montez 2010).

Much of the existing research on this topic measures the interpersonal environment using survey-based composite or summary measures that consist of proxy items asking respondents to characterize the quantity and quality of their social relationships and activities. For example, the Alameda County Study uses a "Social Network Index" consisting of four types of relationships and activities: marital status; contact with friends and extended family; membership in a church; and membership in other voluntary groups (Berkman and Syme 1979). However, while research using summary measures is compelling and frequently replicated across samples and outcomes, there are many unanswered questions about what these measures actually capture, about the composition and structure of the social networks in which individuals are embedded, and how we can intervene to improve population health. As a result, researchers in sociology, psychology, and public health have increasingly drawn from recently available network data to better understand the ways in which relationships matter for health and to potentially identify more targeted interventions (Berkman et al. 2000; Cohen 1988; Cornwell and Schafer 2016; Marsden 2006; Smith and Christakis 2008). This dissertation contributes to this growing body of literature through three empirical chapters.

To understand the contributions of this dissertation as a whole and the theoretical propositions on which it draws, it is first necessary to understand how network measures not only differ from summary measures but also extend this earlier research. *Social networks* refer to defined sets of individuals or other social actors and the relationships that connect them to each other within a larger web of affiliations. This dissertation uses data on "*egocentric*" or "personal" networks, which measure the composition and structure of a focal respondent's (*ego*) relationships with others (*alters*). By *composition*, I mean to whom the respondent is connected, and by *structure*, I mean how they are connected to their alters and how their alters are connected to each other. These data thus allow researchers to examine features of the interpersonal environment that cannot be captured by summary measures alone and are uniquely consequential for physical and mental health (Suzman 2009; York Cornwell and Waite 2009). By capturing network structure, these data measure the wiring "through which germs, ideas, norms, and support can flow" (Smith and Christakis 2008:418) and may explain differences in access or exposure to key distributive and normative mechanisms. By capturing information about network members, these data allow for greater specificity not only in measures of composition and structure but also when linking the data to other sources such as qualitative interviews or behavioral data from digital communication technology. Furthermore, for certain measures of the interpersonal environment, survey-based network data are more accurate than the proxy items used to construct summary indexes or scales (Perry, Pescosolido, and Borgatti 2018).

Four propositions are the foundation of this dissertation and draw from the promise of these data. First, the structure and composition of networks matter for health in ways not captured by summary indices alone. Second, relationships are both positively and negatively associated with physical and mental health through multiple mechanisms, which are not limited to material aid or direct exposure to disease. Third, the mechanisms by which social relationships—whether measured using summary or network measures—matter for health in ways not always captured by surveys alone. And, fourth, relationships matter for health in ways specific to the outcome of interest.

To examine these four propositions, this dissertation uses data on respondents' so-called core discussion networks, defined as the people (*alters*) with whom an individual (*ego*) discusses "important matters." The *core discussion network*, first implemented in the General Social Survey (GSS), is a commonly-used survey-based instrument that is thought to capture intimate and long-term relationships (Burt 1984; Marsden 1987; Ruan 1998). I use these core discussion network data to both reexamine and extend previous research. In the first two empirical chapters, I use rich network data available from the National Social Life, Health, and Aging Project (NSHAP) to investigate two research questions that are central to well-being in later life: who gets help when they need it, and whether relationships prevent cognitive impairment. In the third empirical chapter, I draw on collaborative research using mixed method data from the Resilience in Survivors of Katrina (RISK) Project on the networks of women who were living in New Orleans at the time of Hurricane Katrina. In this project, my coauthor and I not only reexamine whether social relationships correlate with psychological health following exposure to the storm, but also investigate the mechanisms by which identified associations distribute psychological health.

THEORETICAL FRAMEWORK

Proposition #1. The structure and composition of social networks matter for health in ways not captured by summary indices alone.

As noted above, much of the existing research on relationships and health uses summary measures of concepts such as social engagement or support. These concepts are frequently "used interchangeably in theoretical discussions and have been applied to virtually identical empirical phenomena and measures" (House, Umberson, and Landis 1988:301). Summary measures of relationships have been frequently critiqued for conceptual ambiguity and for obscuring the independent associations of their constituent items with the outcomes of interest. With few exceptions (e.g., Kadushin 1983), research on the associations between personal networks and health is a more recent development, with network measures conceptualized as having both direct and indirect associations (Berkman et al. 2000; Cornwell and Schafer 2016; Marsden 2006; Smith and Christakis 2008).

To understand the relative contributions of network measures, I define here the concepts captured by summary measures. *Social engagement* refers to the level of involvement with relationships, including frequency of interactions with informal relationships, such as a spouse, children, friends or neighbors, and frequency of participation in formal groups, such as recreational activities, volunteer organizations, or religious institutions. *Social support* refers to sustaining functions performed for the focal individual by their social relations. Social support includes emotional, informational, and instrumental assistance (House and Khan 1985; House, Umberson, et al. 1988; Thoits 2011). Emotional social support includes companionship and demonstrations of positive feelings toward the focal individual, including love, esteem, encouragement, empathy or sympathy. Informational support includes facts or advice to help the focal individual solve a particular problem and appraisal or affirmation of how the focal individual has chosen to solve the problem. Instrumental social support includes intangible behaviors, such as physical assistance, and tangible resources, such as transportation or financial aid. Finally, whereas *social isolation* refers to the relative absence of relationships and their benefits, *social integration* refers to the overall existence, quantity, and quality of relationships, both informal and formal, as well as the overall level of social engagement.

In contrast to summary measures, egocentric survey instruments can be used to measure several features of respondents' personal networks, including size, composition, density, bridging potential, tie strength, and tie content, among others. Egocentric survey instruments consist of one or more “*name generators*” that solicit the alters within the network and “*name interpreters*” that provide information about the characteristics of the alters, their relationships with the ego, and their relationships with other alters in the network. *Network size* is the number of alters named in response to the name generator(s). *Network composition* refers to counts, proportions, or the range of different types of alters such as how many women or family members are represented in the network. *Tie strength* refers to the duration and intensity of relationships as well as the frequency of interaction between ego and alters. *Tie content* refers to the types of exchange conducted with alters. Tie strength and content can also be calculated separately for particular alter types such as frequency of interaction with kin versus non-kin alters. *Density* is to the extent to which the alters know and communicate with each other whereas *bridging potential* refers to opportunities to act as a broker within the network, calculated as when the respondent is connected to alters who are not connected to each other except through the respondent.

The move toward egocentric network measures in studies of relationships and health was driven not only by the relative theoretical and predictive contributions of these measures, but also by new publicly-available survey data. Numerous name generators have been used in surveys, including those designed to capture relationships constituting the broader interpersonal environment as well as relationships specific to the outcome of interest (Marsden 1990, 2006). For example, in his study of post-traumatic stress among Vietnam veterans, Kadushin (1983) used four name generators, including fellow veterans with whom the respondent remains friends. Similarly, in their study of access to dental health care services, Pullen, Perry, and Maupome (2018) include two name generators, including those the respondent could “really count on for help when you have dental health problems” in the past 12 months.

As noted above, my three empirical chapters use data from adaptations of the “important matters” name generator, also known as the core discussion network. Burt (1984) first developed this name generator for the 1985 GSS by adapting the 1978 Northern California Communities Study question on persons with whom respondents discuss “personal matters” (Fischer 1982; McCallister and Fischer 1978). He finds that the social ties identified by the “personal matters” name generator are likely to be friends and family who are emotionally close to the respondent, geographically proximate, and in frequent contact with both the respondent and one another. He concludes that an adaptation of the “personal matters” name generator would be efficient to administer as a single-item instrument while soliciting intimate ties most likely to serve “the diverse research needs of persons interested in public opinion, social support, well-being, personality, participation, and so on…” (Burt 1984:317).[2] Though frequently criticized, the “important matters” name generator has since been implemented in numerous surveys in the United States and abroad (Bailey and Marsden 1999; Bearman and Parigi 2004; Börsch-Supan et al. 2013; Brashears 2011; Marsden 1987, 1990; Ruan 1998; Small 2017; Suzman 2009; Youm et al. 2014).

The literature examining associations of the core discussion network with health is growing similarly for reasons both theoretical and methodological (Cornwell and Schafer 2016). The growth in health research using the “important matters” name generator compared to some other name generator or multiple-item instrument has been driven to some extent by the time

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[2] The extent to which the “important matters” name generator reliably solicits intimate ties is subject to much debate (Bearman and Parigi 2004; Small 2013). I address this issue in the discussion section of each of the three empirical chapters as well as in the conclusion chapter.

constraints of large-scale surveys. However, there is also evidence that adaptations of this name generator solicit a segment of the interpersonal environment that has unique implications for health. For example, in their study of diarrheal disease in 18 villages in northern Ecuador, Zelner et al. (2012) compare network effects ascertained from two name generators: the core discussion network and a "passing time network" (i.e., "In the past week, outside your household, with whom did you participate in activities having to do with food, like preparing or sharing it?") They find that the village-level density of both networks is associated with lower risk of diarrheal disease, but that while the passing time network effects could be explained by mediating variables such as community sanitation and hygiene, the core discussion network continued to have independent effects. They theorize that the density of the core discussion network is associated with villages that are "*motivated* and better organized to pursue *collective goals* such as building and maintaining effective water and sanitary infrastructure" and conclude that the core discussion network "better [exposes] the essential structure of the community" (Zelner et al. 2012:2233 emphasis added).

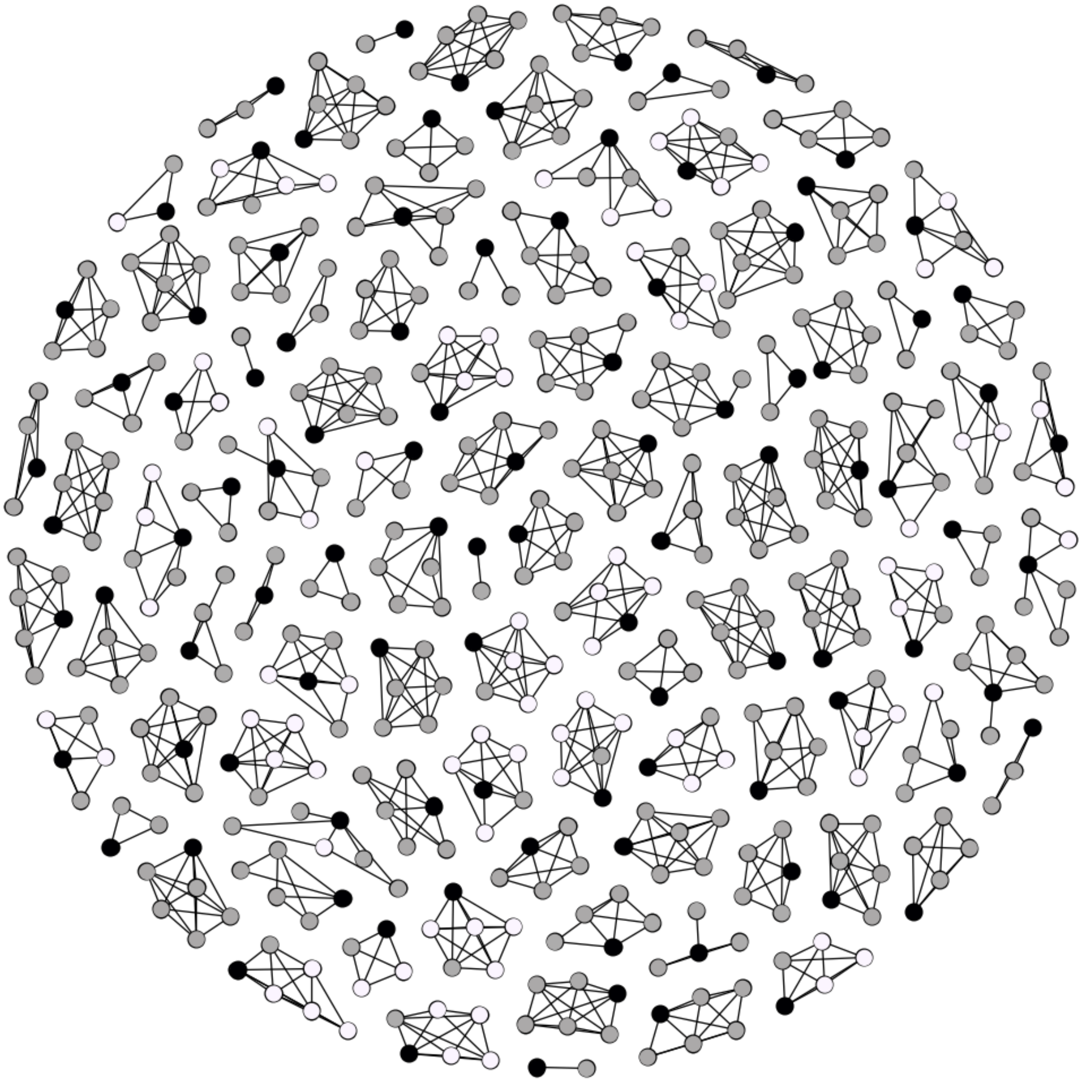
NSHAP and the RISK Project provide exceptional opportunities to understand the associations of core discussion network composition and structure with multiple health-promoting resources, health-related behaviors, or health outcomes. NSHAP is a longitudinal, nationally-representative study of older Americans (Wong and Waite 2015). Because of its representative and multidisciplinary design, NSHAP has become one of the most widely-used surveys of the core discussion network (Cornwell 2009a; Cornwell and Laumann 2015; Cornwell and Schafer 2016; Goldman and Cornwell 2015; Kotwal et al. 2016; Schafer 2013a; Schafer and Koltai 2015a, 2015b; Suzman 2009; York Cornwell and Waite 2012). It was the first nationally-representative account of older Americans' personal networks, allowing researchers to reassess decades-long questions on how networks as a whole distribute social support in addition to decades-long debates on how relationships change in later life (Cornwell, Laumann, and Schumm 2008; Cornwell and Schafer 2016; Waite, Iveniuk, and Laumann 2014; Wong and Waite 2015). It is also still the only other nationally-representative study of Americans' core discussion networks beyond the GSS, and it collects not only detailed measures of relationships but also highly detailed self-reported and objective measures of health (Cornwell et al. 2009; Paik and Sanchagrin 2013; Small 2017).

Numerous studies have used these data to better understand how features of the interpersonal environment are associated with specific health-related outcomes. The name interpreter questions ascertaining characteristics of the alters and their connections to the respondent allow researchers to capture respondents' relationships with both greater levels of flexibility and specificity than permitted by summary measures alone. For example, York Cornwell and Waite (2012) examine the associations of network composition and structure with disease management, independent of summary measures of social support from a spouse, friends, or family. They find that larger core discussion networks are associated with controlled hypertension, but only if respondents discuss health problems with their alters. Schafer (2013a) further finds that discussing health problems with non-kin ties in particular is associated with a higher likelihood of using complementary and alternative medicines.

Finally, name interpreter questions ascertaining how alters are connected to each other allow researchers to create detailed measures of network structure and to evaluate the consequence of these different network configurations for health – or vice versa. NSHAP studies examining the effects of network structure draw from sociological theories about the effects of these configurations on access to resources, including informational, instrumental, and emotional social support, and the distributive and normative mechanisms that explain those effects (Cornwell and Schafer 2016). For example, Goldman and Cornwell (2015) find that bridging potential is associated with a greater likelihood of learning about and using complementary and alternative medicines. They draw from early research on structural holes to explain this value of access to non-redundant social relationships in the search for information on non-traditional treatments (Burt 1995; Granovetter 1973). Additionally, Schafer and Koltai (2015b) find that density is associated with greater protection against elder mistreatment, independent of summary measures of social support. They draw from early research on the effects of closure among alters on social surveillance and social control of network members (Coleman 1988).

In the first two empirical chapters, I likewise use the name interpreters to understand: (a) how the composition of the network and access to health discussants is associated with access to informal care or (b) how engagement with particular alters is associated with cognitive function. I also find that network measures are associated with the outcomes of interest, independent of summary measures. And, in the first empirical chapter, I similarly draw from early research on the enabling and constraining effects of both network composition and density on the likelihood of receiving instrumental social support (Fischer 1982; Hirsch 1980; Hurlbert, Haines, and Beggs 2000; Marsden 1987; Wellman and Wortley 1990). Figure 1.1 illustrates the variation in the proportion kin and density of NSHAP respondents' core discussion networks. Leveraging these network data, this chapter advances gerontological understandings of differences in the social process that distribute informal care for different functional limitations and furthermore advances sociological understandings of the functional specificity of different network configurations, as detailed further below.

Figure 1.1 Random Sample of Respondent's Core Discussion Networks from the National Social Life, Health, and Aging Project



Note: The figure displays the social network diagrams or "sociograms" of a random sample of 100 respondents from the second wave of the National Social Life, Health, and Aging Project, collected by NORC at the University of Chicago in 2010 and 2011. I visualized the networks sequantially using the Force Atlas and Fruchterman Reingold algohorithms in Gephi. Respondents are colored black, their kin alters are colored grey, and their non-kin alters are colored white.

The RISK Project is also the first of its kind and offers important opportunities for understanding the associations of core discussion network composition and structure with health resources, behaviors, and outcomes (Green, Lowe, and Rhodes 2012). The RISK Project examines the long-term effects of Hurricane Katrina on low-income mothers living in New Orleans, Louisiana at the time of the storm. The study sample was drawn from the *Opening Doors Demonstration* in Louisiana, which was a multi-site, randomized-controlled study of community college programs that was interrupted by the hurricane. The allows the study to combine predisaster and long-term follow-up data to investigate the effects of Hurricane Katrina on respondents' physical and mental health, economic well-being, and social relationships. The study further uses a multiple method approach that combines a survey with qualitative in-depth interviews (Waters 2016). The incorporation of the "important matters" name generator and multiple name interpreters in the survey allows researchers to use alters' characteristics to identify them in the qualitative interview data. The ability to merge the network data in this manner allows researchers to pinpoint the mechanisms that explain quantitative correlations, and this again permits a level of specificity not possible with summary survey measures of social engagement or support. In my collaborative research in the third empirical chapter, my coauthor and I use these features of the RISK Project data to identify the mechanisms by which distance to alters is associated with long-term post-traumatic stress disorder after the hurricane, independent of a summary measure of social support.

Proposition #2. Social relationships are both positively and negatively associated with physical and mental health through multiple mechanisms, which are not limited to direct exposure to disease or the indirect effects of material aid.

Relationships are associated with health in many ways. Berkman and Glass (2000) suggest a typology of five categories of mechanisms: (1) person-to-person exposure to infection or toxins; (2) social engagement and participation; (3) social influence and control; (4) informational and instrumental social support, including practical assistance or access to material resources; and (5) emotional social support, including coping assistance during stressful experiences. These mechanisms operate through biological and psychological pathways, including: (a) adopting or ceasing health-related behaviors; (b) changing cognitive or emotional states such as loneliness or depression; (c) moderating the physiological stress response; and (d) preventing injury or speeding recovery (Berkman et al. 2000; Smith and Christakis 2008; Uchino, Cacioppo, and Kiecolt-Glaser 1996). Thoits (2011) breaks these pathways down even further into seven *even more specific* psychosocial mechanisms, including social influence or comparison, social control, self-esteem, sense of personal control or self-efficacy, belonging and companionship, and role-based purpose or mattering.

Importantly, different features of relationships can be positively or negatively associated with health through each of these mechanisms. For example, role strain theory argues that fulfilling multiple social roles such as worker, parent, and friend can increase feelings of purpose or mattering, but they can also lead to feelings of strain and a lack of self-efficacy (Thoits 2011). Additionally, relationships infamously have been found to influence individuals to adopt unhealthy eating and exercise habits and consequently increase their body weight, but on the flip side relationships may influence individuals to adopt healthy eating and exercise habits (Christakis and Fowler 2007; Umberson et al. 2010).

The three empirical chapters are theoretically grounded in literature on these different mechanisms and pathways but each in different ways. As already noted, in the first empirical study, I examine how networks shape receipt of instrumental social support among persons with functional impairments. A theoretical assumption motivating this study is that this support will ameliorate the physical and psychological sequelae of functional impairments and unmet need through multiple biological and psychological pathways enumerated above, including decreased feelings of isolation or depression, increased feelings of belonging, or even faster recovery from the underlying physical condition causing the impairments themselves. In the second empirical chapter, I examine both the effects of social engagement with and emotional support from core discussion network alters on cognitive function. I draw on epidemiological literature that posits different neurobiological pathways for each of these two aspects of social relationships, and these pathways even further expand the list of pathways enumerated above. In the third empirical chapter, my coauthor and I examine how networks associate with post-traumatic stress. We use qualitative data help to understand the mechanisms by which identified quantitative associations operate. We draw from Thoits' (2011) review of psychosocial mechanisms and find that distance to alters is positively associated with post-traumatic stress among hurricane survivors primary through emotional support—specifically, impediments to feelings of belonging and mattering—rather than instrumental support.

Proposition #3. The mechanisms by which social relationships matter for health are not always captured by survey instruments alone.

These mechanisms enumerated above, while often described, are rarely identified empirically. This is largely due to the availability of survey measures capturing the concepts central to the enumerated mechanisms and their biological pathways. Relationships are not uniform and in large-scale regional or population-based surveys, it can be difficult if not impossible for investigators to anticipate all the ways respondents' particular relationships will matter for the range of outcomes in which the users of the data may be interested. However, attention to the incorporation of both quantitative and qualitative data collection and analysis in network studies has increased in recent years (Bellotti 2014; Crossley 2010; Domínguez and Hollstein 2014; Edwards 2010). This development allows researchers to better identify mechanisms by better illustrating how individuals "perceive and define their friends, the nature and content of their relationships, and the opportunities and constraints offered by local networks" (Bellotti 2014:77). Qualitative approaches allow researchers to identify the meaning of network composition and structure, including explanations of their distribution in the population and their health effects. This proposition was a key motivation for the third empirical study and is an issue to which I return in the conclusion chapter.

Proposition #4. Social relationships matter for health in ways specific to the outcome and population under study.

The functional specificity hypothesis of social support argues that certain types of alters convey specific resources (Cutrona and Russell 1990; Feld 1984; Freeman and Ruan 1997; Perry and Pescosolido 2010; Pescosolido 1992; Simons 1984; Wellman and Wortley 1990). Simply, there are differences in "*who* gives *what* to *whom* regarding *which* problems" (House 1981:22).

For example, classic findings from the East York Study in Toronto suggest that access to intimate family alters such as a spouse or child may be even more strongly predictive of instrumental social support than structural characteristics of the social network (Wellman 1979; Wellman and Wortley 1990).

Perry and Pescosolido (2010) find support for this hypothesis in their study of individuals experiencing an acute mental health crisis. Using data from the Indianapolis Network Mental Health Study, they examine the degree of overlap between persons with whom respondents report discussing “important matters” and separately, those with whom they report discussing “health problems.” They then examine the association of these networks with health utilization outcomes, including satisfaction with mental health treatment or trust in physicians. Somewhat similar to York Cornwell and Waite (2012), they find that the number of alters with whom respondents discuss health problems is associated with utilization outcomes, but the number of alters with whom they discuss important matters is not. They argue that the types of alters solicited by the core discussion network may be important for certain health-promoting instrumental and emotional forms of support such as those theorized or identified in the three empirical studies included in this dissertation, but not for “social regulation processes, including the transmission of health-related attitudes and behaviors” (Perry and Pescosolido 2010:355).

However, extensions of the functional specificity hypothesis contend not only that access to certain *network members* or *ties* conveys specific forms of support, but further that certain *network configurations* convey specific forms of support. The classic example of this argument is that the likelihood of a job referral might increase with weak ties and structural holes, but the likelihood of investing increases with close ties and network density (Burt 2001). Particular network configurations ease particular types of interactions that enable the network to provide particular types of resources and that also create interpretive contexts that condition the likelihood of activation for particular types of resources (Hurlbert et al. 2000:601). Additionally, particular network configurations may not only ease the provision of health-promoting resources particular to those needed given the individual's current challenges, but particular network configurations may also encumber new and different challenges that stress or strain the respondent (Cornwell 2009a). I conduct an empirical test of this extension of the functional specificity hypothesis in the first empirical chapter, but argue that the implications of this hypothesis undergird all the findings presented here.

The proposition that social relationships matter for health in ways specific to the outcome of interest is not limited to emotional or instrumental social support mechanisms or even the functional specificity hypothesis of networks. Timmermans and Haas (2008:661) argue that sociologists studying health should move further toward a "sociology of health, illness, and diseases" that "focuses on how social processes affect the severity or course of diseases and how, in turn, specific stages of disease affect social relationships, work, neighborhood, or family life." They in effect argue that sociologists need to better adopt social epidemiological approaches that emphasize the biological and psychological etiology of their outcomes of interest. In each of the three empirical chapters, I develop and test hypotheses about the associations of particular network measures with particular outcomes, drawing on theoretical accounts of the mechanisms associated with the network measures as well as the profile of the populations and outcomes of interest. However, much more work is needed to better identify the underlying physiological processes, and I return to this issue in the conclusion.

PLAN OF THE DISSERTATION

I summarize each empirical chapter below. In the conclusion chapter, I return to the theoretical arguments, findings, and limitations from these three empirical studies, and I suggest new directions for research on social networks and health that draw upon both the long legacy of survey-based network studies and the availability of new technologies.

Empirical Study #1: Who Gets Help?: Living Arrangements, Social Networks, and Help with Activities of Daily Living in Later Life

In the first empirical study, I investigate the likelihood of receiving help with household tasks and personal care activities among older adults. Difficulty with these activities is a commonly used measure of functional disability, and unmet need for personal assistance is strongly correlated with adverse health outcomes and hospitalization or institutionalization in long-term care (Freedman 2014; Schulz et al. 2016). Previous research emphasizes the importance of family and household relationships for meeting personal assistance needs such as a spouse, adult children, or co-residing others (Allen, Piette, and Mor 2014; Choi et al. 2015; Desai, Lentzner, and Weeks 2001; LaPlante et al. 2004). However, substantial variation the likelihood of help remains within family and household arrangements, and the extent to which the characteristics of the broader interpersonal environment enables or prevents the availability and activation of help with functional disabilities remains an open question. This is particularly important for older adults living alone. They are more likely to report unmet need for assistance and are also more likely to have weaker networks (Allen et al. 2014; Desai et al. 2001;

Klinenberg 2016; Knipscheer et al. 1995; Soldo, Wolf, and Agree 1990). This leads to the question: could more intimate, more kin-oriented, or denser networks improve the likelihood of help and therefore the well-being of older adults living alone?

I hypothesize that network composition and structure beyond family or household arrangements are associated with the likelihood of help. Extending the literature on the functional specificity of networks (Perry and Pescosolido 2010; Wellman and Wortley 1990), I further hypothesize that the particular network features associated with help differ for household tasks versus personal care activities. I expect that network density facilitates surveillance and coordination of help with household tasks while network kin composition and intimacy facilitates the provision of help with personal care activities among alters and the likelihood of activation on the part of the ego. Finally, given the characteristics of those living alone and their interpersonal environments, I hypothesize that network composition and structure mediate the association of living alone and the likelihood of help.

I use cross-sectional data from the second wave of NSHAP to examine the associations of network composition and structure with the likelihood of receiving help with household tasks and personal care activities. I estimate separate logistic regression models for household tasks and personal care activities, controlling for family and household arrangements and physical and mental health. I find that, for both outcomes, network composition and structure are associated with the likelihood of help. Consistent with extensions of the functional specificity hypothesis, however, I find that the particular network measures correlated with help differ depending on the activities and the nature of help required. Help with household tasks is associated with network density and proportion of alters with whom the respondent can discuss health problems, possibly reflecting information sharing and the ability to coordinate care responsibilities for activities that do not require physical presence of the helper. Help with personal care activities though is marginally associated with average emotional closeness to alters, possibly reflecting the need for trust and intimacy when asking for forms of help that transcend normative boundaries of many social roles such as help bathing or toileting.

This study indicates that different network configurations—not just different alters—are associated with different types of support. This study also suggests that networks are indicators not only of access to support, but also of the interpretive contexts that condition the likelihood of activating and receiving support when coping with functional limitations.

Empirical Study #2: Do Social Networks "Get Into the Head"?: Social Networks and Cognitive Function in Later Life

In the second empirical study, I examine the longitudinal associations of network composition and structure with cognitive function. Social relationships have long been posited to protect cognitive function (Fratiglioni, Paillard-Borg, and Winblad 2004; Hertzog et al. 2008; Plassman 2010), but they are also frequently identified as a priority for future research, emphasizing the need for additional longitudinal studies and greater specificity in measures of social relationships beyond summary measures (Bielak 2010; Committee on Preventing Dementia and Cognitive Impairment et al. 2017:14). Existing research on social relationships and cognitive function uses summary measures and draws from two hypotheses: first, the *cognitive enrichment hypothesis*, also known as the "use it or lose it" hypothesis, which posits social engagement directly affects cognitive function through mental stimulation (Hertzog et al. 2008; Hultsch et al. 1999; Salthouse 2006:70; Stine-Morrow 2007; Stine-Morrow et al. 2008);

and second, the *stress hypothesis*, which posits social support and cohesion indirectly affect cognitive function by promoting positive emotions and protecting against negative emotions, which in turn affect cardiovascular and neuroendocrine functions associated with neuropathology (Cohen 1988; Fratiglioni et al. 2004; Wilson et al. 2003). By drawing from these hypotheses and examining the longitudinal associations of core discussion network composition and structure measures, I attempt in this chapter to identify the specific features of older adults' interpersonal environments associated with cognitive function, rather than the global concepts of social engagement or support captured by summary measures.

Using longitudinal data from the second and third waves of NSHAP, I estimate lagged dependent variable regression models, and I find mixed support for the cognitive enrichment and stress hypotheses. Consistent with the cognitive engagement hypothesis, I expect network size and frequency of communication with alters to be positively associated with cognitive function by providing opportunity to engage with others and to be exposed to new situations, ideas, and vocabularies. Also consistent with this hypothesis, I expect network density, measured as the extent to which alters know and talk with one another, to be negatively associated with cognitive function since such network closure might constrain the respondent's time and energy and prevent exposure to new situations, ideas, and vocabularies. However, I find that network size is positively associated with cognitive function while frequency of communication with alters is negatively associated with cognitive function, seemingly both supporting and contradicting this hypothesis. I also find that density is negatively associated with cognitive function, but is not significant when controlling for sociodemographic and health measures. Consistent with the stress hypothesis, I expect that perceived social support and average emotional closeness to alters are positively associated with cognitive function. However, I find these associations are not significant when controlling for sociodemographic and health measures.

This study is a necessary first step toward identifying the particular characteristics of older adults' interpersonal environments that are positively associated with cognitive function and are negatively associated with the odds of cognitive impairment or dementia. This study, however, emphasizes the need for future research to explore these puzzling findings, including studies using additional or different name generators that capture more peripheral alters. By capturing detailed measures of the even broader interpersonal environment in which older adults live day-to-day, these alternative data would allow researchers to better understand the effects of communication with different types of alters. This study also emphasizes the need for additional research on the effects of cognitive impairment on measurement error in survey-based network instruments.

Empirical Study #3: The Emotional Cost of Distance: Geographic Network Dispersion and Post-Traumatic Stress among Survivors of Hurricane Katrina

The third empirical chapter was published in *Social Science and Medicine* with my coauthor Nicole Deterding. We investigate the network characteristics associated with long-term post-traumatic stress after Hurricane Katrina. Social relationships offer important emotional and instrumental support following natural disasters (Aldrich and Meyer 2015; Barnshaw and Trainor 2007; Galea, Nandi, and Vlahov 2005; Hurlbert et al. 2000; Kaniasty and Norris 1995; Reid and Reczek 2011). However, because of their scale, natural disasters may also overwhelm social networks due the level of need in local communities (Lock et al. 2012). Additionally, displacement may geographically disperse alters, making it even more difficult to provide and receive necessary support. We hypothesize that cohesive, highly interconnected, and geographically proximate social support networks are associated with psychological recovery after disaster-related traumas due to their likelihood and ability to provide both emotional and instrumental social support.

We use longitudinal, mixed-methods data from the Resilience in Survivors of Katrina (RISK) Project on low-income mothers who were living in New Orleans at the time of Hurricane Katrina. We use a sequential explanatory analytic design. With logistic regression, we estimate associations between network characteristics and the likelihood of post-traumatic stress, including the proportion of alters who live over 100 kilometers away. With linear regressions, we estimate the associations between network characteristics and the three post-traumatic stress sub-scales. Using maximal variation sampling, we then turn to qualitative interview data to elaborate identified statistical associations.

We find geographic network dispersion is positively associated with the likelihood of post-traumatic stress, controlling for individual-level sociodemographic characteristics, exposure to hurricane-related trauma, perceived social support, and displacement status. We further identify two social-psychological mechanisms underlying this result in the qualitative data: respondents with distant alters report a lack of deep belonging and a lack of mattering due to the inability to fulfill obligations to these distant ties. These results reinforce that while social relationships convey both instrumental and social-psychological resources that buffer against stress, they can also be a cause of role strain when demands exceed the ability—or when distance impedes the ability—to provide support. These results also highlight the value of mixed method analyses for identifying the nature of the connections between social network characteristics and health outcomes.

Chapter Two: Who Gets Help?: Living Arrangements, Social Networks, and Help with Activities of Daily Living in Later Life

Between 2015 and 2060, the American population aged 65 and older is projected to double from 47.8 to 98 million (Ortman, Velkoff, and Hogan 2014). Among the challenges of an aging population are projected increases in informal care for older adults with functional disability (Schulz et al. 2016). Neither disability nor need for informal care is inevitable. However, disability is more common at older ages, affecting an estimated 20 to 40 percent of people aged 65 and older (Freedman et al. 2013), and this proportion is expected to increase (He and Larsen 2014). These trends are compounded by policies shifting care responsibilities from institutions to families (Levitsky 2014; Schulz et al. 2016). Already, younger cohorts are more likely to provide care despite a significant proportion of those currently aged 65 and older reporting unmet needs (Ankuda and Levine 2016; Freedman and Spillman 2014) – the consequences of which are severe and costly (Allen et al. 2014).

Given increasing demand and the high stakes of unmet demand, this is a particularly important time to ask: who gets help? Previous research on social determinants of informal care among older adults with functional disabilities draws from two complementary theoretical frameworks: the *availability hypothesis*, arguing care is a function of the availability of family or household members such as a spouse or adult child (Allen et al. 2014; Choi et al. 2015; Desai et al. 2001; LaPlante et al. 2004); and the *task-specific model of helper selection*, arguing that the specific persons who provide care is a function of the match between the type of difficulty experienced, type of help required, and persons available (Allen et al. 2012; Litwak 1985).

In this study, I relate these theoretical frameworks to social network research on instrumental social support more broadly and use this integrated perspective to advance current understandings of the social determinants of informal care, particularly among older adults living alone. While network composition and structure have long been linked to the receipt of instrumental social support (Burt 2001; Hurlbert et al. 2000; Wellman and Wortley 1990), and to the health and well-being of older adults (e.g., Antonucci and Akiyama 1987; Cornwell 2009b; Schafer and Koltai 2015b; York Cornwell and Waite 2012), we know little of how network composition and structure correlate with the receipt of informal care. Networks may include family and household members, but they also extend beyond these primary groups and reflect the larger interpersonal environment in which older adults are embedded. By *composition* and *structure*, I mean both to whom older adults are connected and how those persons are connected to each other.

Understanding how networks correlate with help is especially useful and critical for older adults living alone. Between 2015 and 2035, the American population aged 75 and older living alone will nearly double from 6.9 to 13.4 million (Joint Center for Housing Studies of Harvard University 2014). Those living alone are least likely to receive help and most likely to report unmet need and adverse consequences (Allen et al. 2014; Desai et al. 2001; Soldo et al. 1990), and they are also more socially isolated (Klinenberg 2016; Knipscheer et al. 1995). We might expect these two characteristics of those living alone to be related, and by examining the associations of particular aspects of network composition and structure with the likelihood of help, we might better identify potential interventions aimed toward those living alone with functional disabilities.

In this study, I use data from the second wave of the National Social Life, Health, and Aging Project (NSHAP) to examine whether networks are associated with the odds of receiving informal care. I measure informal care as help with instrumental activities of daily living (IADLs) and basic activities of daily living (ADLs). I test three overarching hypotheses: first, network composition and structure are associated with help above and beyond the availability of family and household members; second, particular network characteristics associated with help for IADLs differ compared to those associated with help for ADLs given the nature of difficulty and help required for these activities; and third, these network characteristics partly explain the association of living alone with help.

BACKGROUND

The Meaning of Help with IADLs versus ADLs

Instrumental activities of daily living (IADLs) and basic activities of daily living (ADLs) are commonly used indexes of functional disability, reflecting different underlying physical and mental impairments and requiring different task modifications, assistive technologies, and forms of personal assistance (Freedman et al. 2013; Freedman and Spillman 2014).

IADLs include difficulty with household and other daily tasks such as preparing meals, shopping for groceries, paying bills, or adhering to medication regimens (Lawton and Brody 1969). IADL limitations are associated with mild cognitive or sensory impairment (Njegovan et al. 2001; Raina, Wong, and Massfeller 2004). IADL help is typically casual, and adults without any impairment may want or need help. IADLs are often collective, household activities: meals prepared communally and shared dishes washed. When individual activities, they do not necessarily require physical presence or immediacy: helpers can prepare meals in advance, organize medication in pill dispensers, or assist with bills remotely.

ADLs include difficulty with personal care tasks, including: bathing such as difficulty washing or getting in or out of the shower or bathtub; eating such as difficulty using utensils; and toileting such as difficulty washing after voiding (Mahoney and Barthel 1965). ADL limitations are associated with higher levels of impairment and increased risk of hospitalization, institutionalization, or early mortality (Freedman and Spillman 2014). ADL help often violates norms of social exchange for many role-relationships (Stoller and Pugliesi 1991). First, assistance may require medical knowledge and can be physically demanding for provider and embarrassing for provider and recipient both, sometimes involving nudity and skin-to-skin contact. Second, ADLs also require consistent daily support that is physically present and rapid if not immediate. Third, those needing ADL help may be less able to reciprocate by virtue of their impairments. ADL help thus comes with a high emotional price and risks to privacy, independence, and identity (Roe et al. 2001).

Likelihood of I/ADL help is largely determined by level of impairment (Freedman and Spillman 2014). Most with I/ADL limitations prefer to maintain independence and instead modify tasks or use adaptive technologies (Allen et al. 2014; Roe et al. 2001; Verbrugge, Rennert, and Madans 1997), turning to personal assistance only when limitations progress or other coping methods fail (Hoenig, Taylor, and Sloan 2003). However, a significant proportion report unmet needs and adverse consequences due to these unmet needs, which range in severity and lead to poor outcomes. For example, absent help, difficulty transferring to a toilet can lead to urinary tract infections, inability transferring from bed can lead to skin sores or worsening mobility, and medication error can lead to heart failure (Allen et al. 2014).

The Availability Hypothesis of Help

The prevailing explanation of help with I/ADLs is the availability hypothesis, which posits help is a function of availability of family or household members (Allen et al. 2014; Choi et al. 2015; Desai et al. 2001; LaPlante et al. 2004; Lima and Allen 2001). This hypothesis is based on the assumption that families and households are primary groups defined by bounded solidarity and generalized systems of exchange wherein support is merely contingent on membership rather than expectations of reciprocation (Antonucci and Akiyama 1987; Soldo et al. 1990; Uehara 1990).

Yet a significant proportion of adults report unmet need regardless of available family or household members (Freedman and Spillman 2014; Hogan and Eggebeen 1995:926–27), and a significant minority of those living alone receive help from non-resident family and friends (Barker 2002; Jacobs et al. 2016). The availability hypothesis is thus insufficient to explain why some receive help while others do not. Scholars have long contended instrumental support is not independent of network composition and structure regardless of family or household arrangement (Bott 1957; Fischer 1982; Haines, Hurlbert, and Beggs 1996; Hurlbert et al. 2000; Wellman and Wortley 1990). These scholars emphasize that provision of support is a complex function of the characteristics of those who provide and receive support, the quality of the tie between them, and the composition and structure of the network.

Drawing from this research, I hypothesize that both the availability of family or household members and network composition and structure will independently correlate with I/ADL help. I expect both living alone to be negatively correlated with help and the proportion of network members who are family to be positively correlate to with help, reflecting the availability of primary group members and the degree to which an individual's broader relational environments are defined by obligations of generalized exchange (Antonucci and Akiyama 1987; Uehara 1990). I also expect network density, defined as the extent to which network members communicate, to correlate with help. For help recipients, density reflects a cohesive relational environment, which might increase the likelihood of activating network members for support (Hurlbert et al. 2000). For help providers, density facilitates resource and information sharing (Haines et al. 1996; Hurlbert et al. 2000; Wellman and Frank 2001) and facilitates social surveillance and control (Cornwell 2009b; Gould 1993; Schafer and Koltai 2015b). These processes allow network members to observe when an individual has difficulty and furthermore observe when others do or do not provide support commensurate with their role relationship to the impaired individual. Thus, density enables networks members to provide help but also pressures network members to provide help consistent with their roles and the expectations of the group (Fischer 1982; Hirsch 1980).

Extending this research, I also hypothesize that network composition and structure partly explain the association of living alone with the likelihood of not receiving help. Researchers emphasize that access to household members "is often more important than kinship ties per se" (Desai et al. 2001:87). Those living alone are least likely to receive help and most likely to report unmet or under-met need (Allen et al. 2014; Desai et al. 2001; LaPlante et al. 2004). There is also evidence that those living alone have fundamentally different networks (Klinenberg 2016;

Knipscheer et al. 1995), which might partly explain observed differences in the likelihood of help among those living alone and those living with others.

The Task-Specific Model of Helper Selection

The task-specific model of helper selection argues who helps results from the match between the activity and the potential helpers available, including their individual and relationship characteristics (Allen et al. 2012; Litwak 1985). For example, spouses are most common sources of assistance because they are intimate, physically accessible, and have knowledge of the recipient's personal care routines (Allen et al. 2012; Choi et al. 2015; Stoller and Pugliesi 1991). However, assistance with particular activities will depend on the abilities of those available: e.g., help transferring will depend more on the physical strength of potential helpers.

This model mirrors the functional specificity hypothesis of social support, which argues that certain types of alters convey specific forms of support (Perry and Pescosolido 2010; Wellman and Wortley 1990): "*who* gives *what* to *whom* regarding *which* problems" (House 1981:22). However, an important extension of this hypothesis is not only do certain *network members* or *ties* convey specific forms of support, but further certain *network configurations* convey specific forms of support. Particular network configurations ease particular types of interactions that enable the network to provide support and they also create the "'interpretive contexts' or 'frames'" that increase or sometimes decrease the likelihood of activation on the part of focal individual (Hurlbert et al. 2000:601). For example, likelihood of a job referral might increase with weak ties and structural holes because of access to non-redundant information, but likelihood of investing increases with close ties and network density because it increases trust in information (Burt 2001).

Drawing from this work and the nature of difficulty and help described above, I hypothesize that particular network configurations correlated with help differ for IADLs and ADLs. While ADL help requires intimacy and trust, IADL help requires mutual awareness of abilities, communication, and coordination (Roe et al. 2001). Thus, the closeness individuals feel toward their network members may be especially important for ADL help while density and the extent to which individuals consult their network about health problems may be especially important for IADL help.

DATA AND METHODS

I use data from NSHAP, which is a nationally-representative longitudinal sample of community-residing older adults aged 57 to 85 at baseline in 2005/2006. The sample was drawn using a multistage area probability design with a balanced sample across age and gender subgroups and an oversample of African Americans and Latinos. Adults living in long-term care or who were otherwise institutionalized were ineligible to participate and are thus not in the sample (O'Muircheartaigh, Eckman, and Smith 2009).

NSHAP did not include measures of help with I/ADLs until the second wave (W2). Conducted in 2010/2011, NSHAP W2 completed 2,422 interviews with baseline sample members and had an unconditional weighted response rate of 74% (O'Muircheartaigh et al. 2014). To my knowledge, NSHAP W2 is the first nationally-representative dataset to include help with I/ADLs in addition to detailed measures of network composition and structure. While the National Health and Aging Trends Study has comprehensive measures of I/ADLs and a comparable network questionnaire, it does not measure emotional closeness or network density, which are central to these analyses.

Measures

Help with IADLs and ADLs

The dependent variables are: (A) help with one or more IADLs among those who report any difficulty with one or more activities and (B) help with one or more ADLs among those who report any difficulty with one or more activities. The six-item IADL index includes: preparing meals; taking medications; managing money; shopping for groceries; performing light housework; and using a telephone (Lawton and Brody 1969). The five-item ADL index includes: dressing; bathing or showering; eating; transferring; and using the toilet (Mahoney and Barthel 1965). Responses for each activity range from 1 (“no difficulty”) to 4 (“unable to do”). I code responses as missing if respondents volunteered they “have never done” the activity. For each activity that respondents reported any difficulty, interviewers ask if anyone helps.

Social Network Measures

NSHAP uses a name generator and a series of name interpreters to construct networks consisting of the respondent (*ego*) and the persons (*alters*) directly connected to them (Cornwell et al. 2009). The network instrument begins with a version of the General Social Survey “important matters” name generator:

> “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?”

The respondent could name up to five alters followed by an additional two alters: their spouse if not already named; and someone not already named with whom they “feel especially close.” Name interpreters then ascertain information about each alter, their relationship to the ego, and their relationships with other alters.

I construct five network measures from this instrument: size; proportion kin; average closeness; proportion health discussion partners; and density. All network measures with the exception of size were standardized for ease of interpretation and comparison. Size is the number of persons named, ranging from 0 to 7 alters. Proportion kin is the fraction of alters related to the respondent, including spouse, ex-spouse, parents, in-laws, children and step-children, grandchildren, siblings, and other relatives. Proportion with whom the respondent discusses health problems is the fraction of alters with whom the respondent reports they are “very likely” to discuss health problems or treatment options as opposed to “somewhat likely” or “not at all likely.” Average emotional closeness is the mean of how close respondents feel to the alters, ranging from 1 (“not very close”) to 4 (“extremely close”). Network density is the proportion of alters connected to one another independent of the respondent. I calculate density as the number of existing ties divided by the number of all possible ties between alters ($k \times [k - 1]/2$ where k is network size). I define a tie as existing between alters when the respondent reports they communicate at least once a month or more under the assumption that a minimum frequency of communication is necessary to facilitate resource sharing and effective social surveillance.[3]

Family and Household Measures

I measure living arrangement and married/cohabiting using indicator variables for living with others (reference) versus living alone and for married or cohabiting versus other (reference).[4] Supplementary analyses not shown include number of children. The number of children question is at the end of the paper-and-pencil leave-behind questionnaire, and the item has a high level of missingness due to both item refusal and questionnaire non-response (23.31%, *N*=245). To estimate the association of help with the availability of children, I use multiple imputation with chained equations (White, Royston, and Wood 2011). The number of children is not significant in any of the supplementary analyses, regardless of how it is coded (indicator, ordinal, or continuous variable), and its inclusion does not change the pattern of results reported here. The number or proportion of children named to the network specifically are also not significant and do not change the pattern of results reported here.

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[3] Supplementary analyses not shown use a weighted density measure where the ties between alters are weighted by frequency of communication. However, the weighted measure does not change the pattern of results and is more prone to measurement error.

[4] While nearly all those who are married are living with at least one other person (i.e., their spouse), approximately a third of persons who are unmarried are living with others (e.g., their children). Supplementary analyses not shown examine more detailed measures of living arrangements that include marital status. Supplementary analyses also not shown exclude marital status from the models. The patterns of results do not change in either set of supplementary analyses.

Covariates

Since greater difficulty is associated with a higher likelihood of help and differences in network composition and structure, I control for measures of physical health to proxy physiological need for help (Freedman and Spillman 2014; Schafer 2018). I control for self-reported physical health, which uses a Likert scale: “poor” (reference); “fair”; “good”; “very good”; “excellent.” I control for an indicator of self-reported use of walking equipment such as a cane, walker, or wheelchair.[5] I also control for the number of I/ADLs with which respondents report difficulty since both theoretically and mechanically, the likelihood of any help with any activity will be a function of number of activities with which respondents report difficulty (Freedman and Spillman 2014).

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[5] While previous research demonstrates that the use of assistive technology equipment helps older adults maintain functional independence and is significantly associated with *fewer hours* of personal assistance (Hoenig, Taylor, and Sloan 2003), these models suggest that the use of assistive technology more than doubles the odds of *any* help with I/ADLs. Supplementary analyses suggest that the indicator of walking equipment use included here closely approximates walking or mobility impairment. For example, more than two-thirds of those reporting the use of walking equipment have abnormally slow walking speed, measured using a timed walk exercise adapted from the Short Physical Performance Battery (Huisingh-Scheetz et al. 2014). There is a high level of missing data on the timed walk exercise and so walking equipment is included here as an additional proxy of physical need for assistance. Alternative forms of assistive technology equipment such as modified eating utensils or a graph bar in the shower or next to the toilet might differentially lower the odds of help with I/ADLs, but these data are not available.

I also control for depressive symptomology, which previous research finds is negatively associated with a lower likelihood of help and a higher likelihood of social isolation (Allen and Mor 1997; Choi and McDougall 2009).[6] I use the 11-item Centers for Epidemiologic Study of Depression Revised (CESD-R) scale. Interviewers ask respondents how often in the past week they experienced a series of emotions such as “depressed” or “lonely.” Responses range from 0 (“rarely or none of the time”) to 3 (“most of the time”). Summed items have a maximum of 33. Above 9 indicates likely clinical depression (Steffick et al. 2000). The Cronbach’s alpha is 0.79.

Previous research suggests that older individuals, women, and those with lower educational attainment are more likely to receive help (Allen and Mor 1997; Desai et al. 2001; Freedman and Spillman 2014; LaPlante et al. 2004), and so I control for age, sex, and education. I code sex as male (reference) and female. I code education as a series of indicator variables: less than high school (reference); high school or equivalent; some college or technical school; and bachelor’s degree or more.

Analytic Strategy

I test my hypotheses using logistic regressions predicting the likelihood of help with one or more IADLs and the likelihood of help with one or more ADLs. I first estimate the models with all covariates except the five network measures. I then add the network measures and test

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[6] There is some concern that depression could be endogenous: that is, those who are depressed are so because they do not get help. In supplementary analyses not shown, I estimate the models with and without depression. The pattern of the results does not change and the magnitudes of the network coefficients are similar.

their joint significance. This approach allows me to asses potential mediating effects of the network measures in the association of living alone with the likelihood of help (Baron and Kenny 1986). If the addition of the network measures decreases the association of living alone with likelihood of help, then this would indicate a potential mediating effect worth further investigation. To test my hypothesis that the association of particular network measures differ across the two outcomes, I use seemingly unrelated regressions.

I evaluate model fit using BIC, AIC, and pseudo *R*-squared in addition to Hosmer-Lemeshow specification tests (Hosmer and Lemeshow 2004). I evaluate multicollinearity—a common concern in network analysis—using variance inflation factors (Allison 1999). All multivariate models adjust for the multistage, clustered sampling design and include NSHAP-provided person-level weights to adjust for the probability of selection and nonresponse. I estimate the models in Stata 15MP using the subpopulation option for survey data to adjust the standard errors (StataCorp 2017).

The analytic samples include respondents reporting difficulty with IADLs or ADLs and with no missing data on covariates. 9 respondents were dropped from the IADL sample and 4 were dropped from the ADL sample because of missing data. An additional 27 (4.10%) were dropped from the IADL sample and 19 (3.65%) were dropped from the ADL sample because they had missing values for density due to a network size of zero or one.[7]

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[7] Supplementary analyses not shown use multiple imputation by chained equations, with 10 imputations, to account for missing data. The substantive findings do not change. Supplementary analyses not shown also estimate the models with density coded as zero for respondents with a network size of zero or one. The substantive findings again do not change. Since we might expect that persons with a network size of zero or one would be especially

I conduct two secondary analyses as robustness checks, which I report in the appendix. First, I estimate separate logistic regression models predicting the likelihood of help with each I/ADL item. Second, I examine the characteristics of the persons whom respondents name as helping most often, including their relationship to the respondent and their position in the network. These two analyses support the main results described below and demonstrate that network position is associated with providing help among alters when controlling for their gender and characteristics of their relationship with the respondent.

RESULTS

Table 2.1 displays the unweighted prevalence of difficulty and help with I/ADLS. 30% (*N*=713) report difficulty with one or more IADLs and the large majority of these receive help (75%, *N*=534). Among those reporting IADL difficulties, respondents report difficulty with 2.13 (*SD*=1.39) IADLs on average (see Table 2.2 below). 23% (*N*=560) report difficulty with one or more ADLs but only 38% (*N*=215) receive help. Among those reporting ADL difficulties, respondents report difficulty with 2.13 (*SD*=1.30) ADLs on average. Among those with difficulty, activities with the lowest rates of help are ADLs associated with physical and emotional barriers to asking for and providing help: toileting (24%, *N*=59); transferring (31%, *N*=75); dressing (38%, *N*=140); and bathing (44%, *N*=107). Figure 2.1 displays the proportion of

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social isolated and thus have lower odds of receiving help compared to persons with a network size of two or more, I estimated logistic regressions of the likelihood of help on an indicator for having a network size of zero compared to having a network size of two or more, controlling for all else. This indicator is not significantly associated with help either IADLs or ADLs.

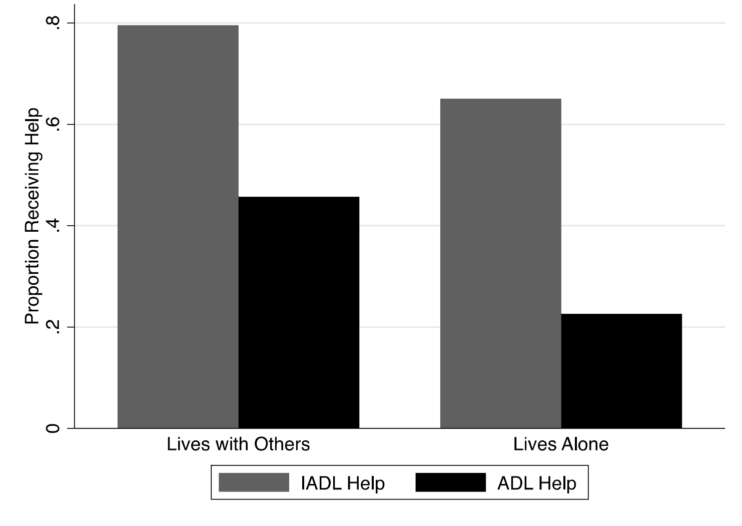
respondents reporting difficulty and receiving help by living arrangement. Those living alone are less likely to receive help with either IADLs or ADLs, but the difference is greatest for ADLs, as expected given the physical nature and immediacy of these tasks.

Table 2.1 Frequencies of Difficulty and Help with Instrumental Activities of Daily Living (IADLs) and Activities of Daily Living (ADLs)

	Reporting Difficulty		Reporting Help	
Activity	Item N	%	Item N	%
Household Tasks – Instrumental Activities of Daily Living (IADLs)				
Preparing Meals	2409	13%	75	76%
Taking Medications	2288	5%	50	60%
Managing Money	2170	10%	63	73%
Shopping for Groceries	2086	13%	44	86%
Light Housework	2017	16%	92	77%
Using the Telephone	2279	6%	62	54%
One or More IADLs	1700	30%	179	75%
Personal Care – Activities of Daily Living (ADLs)				
Bathing	2172	10%	134	44%
Dressing	2049	15%	224	38%
Eating	2311	4%	42	59%
Transferring	2169	10%	168	31%
Toileting	2168	10%	185	24%
One or More ADLs	1853	23%	345	38%

Note: Statistics are unweighted. 396 respondents had difficulty with one or more of either household tasks or personal care activities and overlap between the two subsamples.

Figure 2.1 Proportion Receiving Help with Instrumental Activities of Daily Living (IADLs) and Activities of Daily Living (ADLs) among those with Difficulty, by Living Arrangement



Note: Proportions are unweighted.

Table 2.2 displays unweighted descriptive statistics for the independent variables for the full W2 sample and for the two analytic samples, which include persons with difficulty, no missing data on covariates, and at least two alters to have valid data on the density measure. The table includes *p*-values from two-sample *t*-tests comparing those who report any difficulty to those who report none on each index. The I/ADL analytic samples are older and have poorer health compared to persons without any difficulty. Additionally, the two analytic samples are disproportionately female, have less education, and less likely to be married or living with a partner. Among those with IADL difficulty, they are only slightly more likely to live alone (29 percent in the full sample compared to 32 percent in the analytic samples [$p<0.10$]). The I/ADL samples have very similar networks to persons without difficulty. Thus, while previous research suggests disablement is associated with smaller and less dense networks (Schafer 2018), there is little evidence these differences are significant using the threshold of any difficulty.

Table 2.3 displays unweighted descriptive statistics for persons living alone compared to those living with others in the two analytics sample. The table includes *p*-values from two-sample *t*-tests. In both samples, those living alone are older and disproportionately female. Nearly all those living alone are unmarried, though there are few who are living separately from their spouse, possibly because their spouse is in long-term care or rehabilitation. Those living alone also have slightly smaller, less kin-centric, less emotionally close, and lower density networks. Those living alone with ADL difficulty also have a smaller proportion of alters with whom they discuss health problems. I expect these differences in network composition and structure to explain part of the negative association of living alone with the likelihood of help.

Table 2.2 Unweighted Descriptive Statistics of Independent Variables in Full Sample and IADL and ADL Analytic Samples

	Full Sample				Sample with Difficulty with Household Tasks (IADLs)			Sample with Difficulty with Personal Care (ADLs)		
	Mean	*SD*	Min.	Max.	Mean	*SD*	*P* [a]	Mean	*SD*	*P* [b]
Family and Household Characteristics										
Married or Living with Partner	0.59		0.00	1.00	0.51		0.00	0.52		0.00
Living Alone	0.29		0.00	1.00	0.32		0.07	0.32		0.14
Social Network Characteristics										
Size	4.41	1.56	0.00	7.00	4.52	1.39	0.02	4.57	1.39	0.01
Proportion Kin	0.70	0.28	0.00	1.00	0.69	0.28	0.86	0.69	0.28	0.48
Average Emotional Closeness	3.07	0.49	1.00	4.00	3.01	0.46	0.00	3.02	0.47	0.01
Proportion Discuss Health	0.66	0.29	0.00	1.00	0.65	0.28	0.88	0.64	0.29	0.32
Density	0.56	0.33	0.00	1.00	0.60	0.32	0.00	0.60	0.32	0.00
Health Characteristics										
Count of IADL Difficulties	0.50	1.10	0.00	5.00	1.33	1.54	0.00	2.11	1.27	0.00
Count of ADL Difficulties	0.63	1.23	0.00	6.00	2.10	1.34	0.00	1.79	1.68	0.00
Self-Rated Physical Health										
Poor	0.05		0.00	1.00	0.13		0.00	0.14		0.00
Fair	0.22		0.00	1.00	0.37		0.00	0.39		0.00
Good	0.33		0.00	1.00	0.32		0.78	0.31		0.33
Very Good	0.29		0.00	1.00	0.14		0.00	0.13		0.00
Excellent	0.11		0.00	1.00	0.04		0.00	0.02		0.00
Uses Walking Equipment	0.20		0.00	1.00	0.46		0.00	0.52		0.00
Depression Score above Cutoff	0.22		0.00	1.00	0.39		0.00	0.39		0.00
Sociodemographic Characteristics										
Age (Divided by 10)	7.35	0.75	6.20	9.10	7.56	0.77	0.00	7.52	0.77	0.00
Female	0.52		0.00	1.00	0.61		0.00	0.60		0.00
Education										
Less than High School	0.20		0.00	1.00	0.28		0.00	0.27		0.00
High School or Equivalent	0.25		0.00	1.00	0.25		0.95	0.26		0.84
Some College or Technical	0.30		0.00	1.00	0.29		0.35	0.29		0.45
Bachelors or More	0.24		0.00	1.00	0.18		0.00	0.18		0.00
Observations	2413				672			533		

Note: [a] *p*-values from two-sample *t*-tests comparing persons reporting any difficulty with IADLs with persons reporting no difficulty with IADLs. [b] *p*-values from two-sample *t*-tests comparing persons reporting any difficulty with ADLs with persons reporting no difficulty with ADLs.

Table 2.3 Unweighted Descriptive Statistics of Independent Variables in IADL and ADL Analytic Samples, by Living Arrangement

	Sample with Difficulty with Household Tasks (IADLs)					Sample with Difficulty with Personal Care (ADLs)				
	Living with Others		Living Alone			Living with Others		Living Alone		
	Mean	*SD*	Mean	*SD*	*P*	Mean	*SD*	Mean	*SD*	*P*
Family and Household Characteristics										
Married or Living with Partner	0.74		0.02		0.00	0.75		0.02		0.00
Social Network Characteristics										
Size	4.62	1.39	4.32	1.37	0.01	4.66	1.39	4.37	1.38	0.02
Proportion Kin	0.74	0.26	0.59	0.31	0.00	0.74	0.25	0.58	0.31	0.00
Average Emotional Closeness	3.04	0.44	2.93	0.50	0.00	3.06	0.44	2.94	0.50	0.01
Proportion Discuss Health	0.67	0.27	0.62	0.32	0.05	0.66	0.27	0.60	0.32	0.03
Density	0.66	0.29	0.47	0.35	0.00	0.67	0.29	0.45	0.35	0.00
Health Characteristics										
Count of IADL Difficulties	1.28	1.55	1.42	1.54	0.28	2.11	1.28	2.12	1.26	0.92
Count of ADL Difficulties	2.12	1.39	2.05	1.24	0.55	1.79	1.75	1.81	1.52	0.87
Self-Rated Physical Health										
Poor	0.14		0.11		0.40	0.14		0.15		0.88
Fair	0.37		0.36		0.91	0.38		0.40		0.79
Good	0.33		0.32		0.94	0.32		0.28		0.35
Very Good	0.13		0.16		0.20	0.13		0.14		0.82
Excellent	0.04		0.04		0.70	0.02		0.04		0.26
Uses Walking Equipment	0.44		0.49		0.28	0.52		0.53		0.78
Depression Score above Cutoff	0.37		0.43		0.16	0.36		0.45		0.05
Sociodemographic Characteristics										
Age (Divided by 10)	7.45	0.75	7.79	0.75	0.00	7.42	0.76	7.73	0.74	0.00
Female	0.53		0.78		0.00	0.51		0.79		0.00
Education										
Less than High School	0.30		0.23		0.07	0.29		0.24		0.27
High School or Equivalent	0.25		0.27		0.50	0.25		0.28		0.45
Some College or Technical	0.28		0.32		0.21	0.28		0.32		0.32
Bachelors or More	0.18		0.17		0.90	0.19		0.16		0.45
Observations	458		214			364		169		

Table 2.4 displays the odds ratios from logistic regressions of IADL and ADL help. Collectively, these models offer support for two of my hypotheses: that network composition and structure associate with the likelihood of help above and beyond physical and mental health or the availability of family and household members and that the particular network measures associated with the likelihood of help differ for each index. However, my hypothesis that network composition and structure partly explain the association of living alone is not supported in the multivariate analyses.

Consistent with the availability hypothesis, living alone is associated with a 56% decrease in the odds of IADL help (OR=0.44 [CI=0.20,0.99] $p<0.05$) and a 77% decrease in the odds of ADL help (OR=0.23 [CI=0.11,0.48] $p<0.01$). Using predicted probabilities, the association of living alone with IADL help translates to a 43 percent chance of getting help among older adults living with others compared to a 29 percent chance of getting help among older adults living alone, holding all other covariates constant at their means. For ADL help, this translates to a 23 percent chance of getting help among older adults living with others compared to just a 9 percent chance of getting help among older adults living alone, holding all other covariates at their means. This is a substantial difference for both outcomes and is expected. Physical proximity not only increases awareness and availability of potential helpers, but lowers the cost of asking for and providing help. Importantly, the association of living alone with the odds of help is stable before and after accounting for the network measures, which suggests that the network composition and structure do not mediate the association of living alone.

Table 2.4 Odds Ratios from Logistic Regressions of Help with ≥ 1 Household Tasks (Instrumental Activities of Daily Living [IADLs]) and Help with ≥ 1 Personal Care (Activities of Daily Living [ADLs])

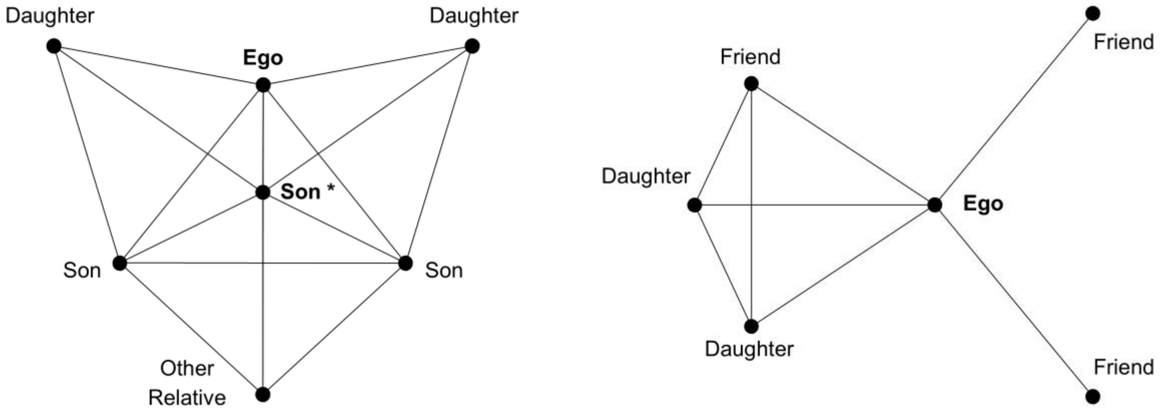
	Household Tasks		Personal Care	
	Model 1	Model 2	Model 3	Model 4
Family and Household Characteristics				
Married or Living with a Partner	1.42	1.4	1.36	1.26
	[0.62,3.23]	[0.62,3.15]	[0.69,2.70]	[0.63,2.53]
Living Alone	0.44^{*}	0.51^{+}	0.23^{***}	0.24^{***}
	[0.20,0.99]	[0.22,1.14]	[0.11,0.48]	[0.11,0.53]
Social Network Characteristics				
Size		0.98		1.00
		[0.81,1.17]		[0.81,1.23]
Standardized Proportion Kin		0.98		1.15
		[0.75,1.27]		[0.90,1.48]
Standardized Average Closeness		0.89		1.45^{+}
		[0.68,1.16]		[0.95,2.22]
Standardized Proportion Discuss Health		1.30^{+}		0.99
		[0.98,1.72]		[0.74,1.32]
Standardized Density		1.56^{**}		0.99
		[1.19,2.05]		[0.73,1.35]

Note: All models control for sociodemographic and health characteristics, including: age; sex; education; count of IADL difficulties; count of ADL difficulties; self-rated physical health; use of walking equipment; and a depression score above the cutoff. *IADL N*=672 *ADL N*=533 95% confidence intervals are in brackets. + $p < 0.1$, $^{*} p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$

Consistent with my expectations about the associations of network composition and structure with help, Model 2 shows that IADL help correlates with network measures most associated with communication and coordination: proportion with whom respondents discuss health matters and network density. The proportion with whom respondents discuss health matters is marginally statistically significantly associated with higher odds of help (OR=1.30 [CI=0.98,1.72] $p<0.10$). Additionally, a standard deviation change in density is associated with a 56% (OR=1.56 [CI=1.19,2.05] $p<0.01$) increase in the odds of help. A standard deviation change in density is equivalent to 0.33. This is a substantively large effect that remains significant across multiple model specifications in supplementary analyses not shown.

Figure 2.2 illustrates what a standard deviation difference in density equal to 0.33 looks like using two respondent sociograms from the analytic sample. Both are 82-year-old, widowed, white males without a college education and have diagnosed chronic conditions and I/ADL difficulty. The respondent in Panel A has a network with a density of 0.67 and six alters, including his five children and another relative. His son helps him most often with household tasks, including shopping for food, housework, and using the telephone, but he independently copes with his ADL difficulties. His son has the highest centrality, talking to all his siblings and his other relative at least once a month. The respondent in Panel B has a network with a density of 0.33 and five alters, including his two daughters and three friends, two of whom are not connected to the others. He independently copes with reported difficulties.

Figure 2.2 Example Sociograms by Receipt of Help


Panel A. Receives Help

Panel B. Does Not Receive Help

Note: The sociograms above illustrate the networks of two randomly-selected respondents from the overlapping members of the IADL and ADL samples. I selected each respondent from two random draws of five male, widowed respondents and who either receive help or not. The example I chose from each random draw of five had a density closest to the mean for that subgroup. I drew the sociograms using the "netplot" package in Stata.

Also consistent with my expectations, Model 4 shows that ADL help correlates with the network measure most associated with trust and intimacy: emotional closeness to alters. A standard deviation change in average emotional closeness is marginally associated with a 45% increase in the odds of help before and after adjusting for other network characteristics (*OR*=1.45, *CI*=0.95,2.22, p<0.10). I also expected proportion alters who are kin to correlate with ADL help. However, though the association is in the expected direction, it is not statistically significant.

I also test whether the estimated associations of density, proportion with whom respondents discuss health, and average emotional closeness differ across the models for the two outcomes using seemingly unrelated regressions. These results indicate that the associations of density and average emotional closeness significantly differ from one another across the two outcomes, but not proportion with whom respondents discuss health.

DISCUSSION

Given expected increases in informal care demand and the consequences of unmet need for health and well-being, understanding who gets help is critical (Ankuda and Levine 2016; Freedman and Spillman 2014; Schulz et al. 2016). Previous research on informal care emphasizes availability of family or household members, drawing from two complementary theoretical frameworks: the availability and functional specificity hypotheses (Allen et al. 2012, 2014; Choi et al. 2015; Desai et al. 2001; LaPlante et al. 2004; Litwak 1985; Soldo et al. 1990). Using an integrated network perspective, I confirm previous research on the importance of household members for help with I/ADLs. Living alone is strongly negatively associated with help.

However, I also find that network composition and structure are independently associated with help, but that the particular network configurations associated with help differ in ways that parallel differences in the nature of difficulty and help. Whereas IADL help is associated with density—possibly reflecting information sharing and the ability to coordinate care responsibilities for activities that do not require physical presence or immediacy, ADL help is associated with average emotional closeness—possibly reflecting a frame of trust and a generalized system of social exchange wherein relationships transcend normative boundaries of social roles and impaired egos can expect support absent reciprocation. IADL help is also significantly associated with proportion with whom respondents discuss health matters, but the association does not significantly differ from the estimate for ADL help.

These findings are correlational and cannot be used to make causal inferences, but they offer important insights to services and tools aiding older adults with disabilities. Clinicians and social service providers have increasingly recognized effects of network structure and composition. Dhand et al. (2016) find patients with higher density networks after stroke had better recovery. They advise physicians to administer network surveys, but these surveys are long and cumbersome, particularly measuring density. These analyses suggest network surveys should focus on those measures relevant for particular outcomes of interest. These analyses also suggest potential effectiveness of web and mobile products designed to disseminate information and coordinate care among network members, which may increase both density and emotional closeness through increased communication (Goyer 2017).

Beyond their contributions to social gerontology research and practice, these findings also apply to more general studies of instrumental social support activation, as well as research on chronic disease management and recovery from acute health problems. Decades of research demonstrate instrumental support is associated with network composition and structure (e.g., Haines et al. 1996; Hurlbert et al. 2000), but much has been limited to subjective global assessments (Seeman et al. 1987), regional studies (Fischer 1982; Wellman and Wortley 1990), and emergencies (e.g., Haines et al. 1996). The analyses presented here use detailed network measures from a nationally-representative sample to understand a crucial component of routine assistance: help when needed most. These analyses furthermore suggest that the configurations of networks as a whole are functionally specific to the help needed, not just particular alters as suggested by original formulations of the functional specificity hypothesis (Cutrona and Russell 1990; Freeman and Ruan 1997; Perry and Pescosolido 2010; Simons 1984; Wellman and Wortley 1990).

However, more research is needed. Understanding the distribution of help among older adults aging in place while living alone is especially urgent. The population of those living alone is expected to drastically increase in the next few decades (Joint Center for Housing Studies of Harvard University 2014), yet they are least likely to receive help and most likely to report unmet needs (Allen et al. 2014; Desai et al. 2001). In these data, a more than 10 percentage point difference in the probability of help with ADLs persists between those living alone and those living with others even after controlling for sociodemographic, health, and network composition and structure.

These analyses have several limitations. First, these data are cross-sectional, and I cannot rule out reverse causality. For example, Fischer (1982:156–57) proposes, "Density, or centrality, may not be the *cause* of personal support, but its *by-product*." High density may correlate with help because increased communication between alters responding to ego's increased care needs. Low density may similarly correlate with *not* receiving help because egos have become embarrassed by care needs and withdrawn from their relationships (Roe et al. 2001). Higher average emotional closeness may correlate with help because less intimate relationships have dissolved as care needs increased (Stoller and Pugliesi 1991). And, those living with others aside from their spouse may do so because of increased perception of care needs and resistance to long-term care (Freedman and Spillman 2014; Soldo et al. 1990; Zhang, Engelman, and Agree 2013).

Second, these analyses assume a need for help given reported difficulty, met need given reported help, and unmet need given no reported help. However, those without help may simply prefer to cope with difficulties using task modification or technology (Desai et al. 2001; Roe et al. 2001). Additionally, those with help may not receive sufficient help (LaPlante et al. 2004).

NSHAP does not measure who helps with which activities, the amount and quality of help with each activity, and whether needs are met for each activity. These measures allow better identification of unmet need in the population and allow for hierarchical models parsing variance explained by access to particular family or household role-relationships and variance explained by network composition and structure. That said, the proportion of the sample not receiving help is similar to estimates of unmet need (Desai et al. 2001; Freedman and Spillman 2014), and I proxy need using physical and mental health measures.

Third, the "important matters" name generator has been criticized for its validity (Bearman and Parigi 2004; Small 2013) and reliability (Fischer 2009; Pustejovsky and Spillane 2009). NSHAP investigators worked to avoid reliability issues by placing the network instrument at the beginning of the interview (Cornwell et al. 2009). This was intended to reduce bias from respondent burden and spillover effects from previous questions. Additionally, they conducted periodic interviewer retraining to mitigate interviewer learning effects (Cornwell et al. 2009; Cornwell, Schumm, et al. 2014). However, validity issues persist in the data. The "important matters" name generator does not capture the full range of relationships, including weak or peripheral ties that are frequent sources of support (Small 2013), but others suggest alters listed in response to this name generator may be those most important for informal care (Burt 1984). Additionally, the majority of helpers named are included in NSHAP respondents' networks, supporting the assertion that this name generator captures those most likely to provide care (see appendix). However, respondent reports of their networks are subject to measurement error, regardless of the name generator used. The best practices for accounting for bias stemming from this measurement error are still being identified (Almquist 2012; Schafer 2018).

These limitations do not diminish the contributions of these analyses to research on informal care. The results suggest that care and service providers should be aware of the specific activity limitations of their patients or clients and the specific social mechanisms associated with help for those limitations. Future research should measure *who* helps with *which* activities, the amount and *quality* of care provided with each activity, and whether care needs are met. Future research should then leverage these data using longitudinal and hierarchical analyses to disentangle causality and contributions of particular relationships versus the network as a whole.

Chapter Three: Do Social Networks "Get Into the Head"?: Social Networks and Cognitive Function in Later Life

Cognitive impairment affects all aspects of quality of life in older adulthood and is costly not only for the persons affected, but also for their families and larger society (Langa 2018). Caregiving for an older adult with cognitive impairment or dementia is uniquely physically and emotionally burdensome (Kim and Schulz 2008). The number of dementia cases worldwide is expected to triple by 2050 (Langa 2015). Already in 2010 in the United States, the economic burden of dementia was estimated between $175 to $200 billion per year (Hurd et al. 2013). As the population ages, interventions to promote cognitive function and prevent cognitive impairment or dementia are urgently needed.

Social integration is frequently posited as a key factor that both promotes better cognitive function and prevents cognitive impairment or decline (Fratiglioni et al. 2004; Hertzog et al. 2008; Plassman 2010). This research largely draws from two hypotheses: *the cognitive enrichment hypothesis*, which posits social engagement directly affects cognitive function through mental stimulation, and *the stress hypothesis*, which posits social support affects cognitive function by providing emotional sustenance and protecting against negative emotional states, which affect neuroendocrine and cardiovascular functions that are crucial for brain health. However, there is also a third *selection hypothesis*, which posits associations between social integration and cognitive function are the result of endogeneity (Fratiglioni et al. 2004). This research suggests cognitively impaired adults are less able to participate in social activities and maintain peripheral social relationships while their core relationships simultaneously respond to their impairments by increasing interaction and support (Ayalon, Shiovitz-Ezra, and Roziner 2016; Cornwell 2009b, 2009a; Hultsch et al. 1999; Kotwal et al. 2016; Schafer 2013b; Sörman et al. 2017; Thomas 2011).

While there is extensive research on social integration and cognitive function, we do not yet know the longitudinal associations of *social network* composition and structure with cognitive function. By *composition* and *structure*, I mean who older adults are connected to in their network and their reports of how their network members are connected to each other. To the best of my knowledge, longitudinal research on the association between social integration and cognitive function to date uses composite and scale measures of social engagement and support. These summary measures are correlated with but are distinct from measures of network composition and structure (Cohen 1988; House and Khan 1985). Furthermore, measures of network composition and structure benefit from lower variance than global estimates or proxy measures (Marsden 2006; Sudman 1985).

I use newly-available, nationally representative, longitudinal data from the National Social Life, Health, and Aging Project (NSHAP), which collects detailed information on older adults' core discussion networks, defined as the persons ("alters") with whom the respondent ("ego") discusses "matters that are important to [them]." Using these data, I advance current research in three ways. First, by using the longitudinal data, I better identify the association of network composition and structure with cognitive function (c.f., Cornwell 2009a; Harling et al. 2016; Kotwal et al. 2016). Second, by examining more specific measures of network composition and structure, I capture fundamental differences in older adults' interpersonal environments, which reflect differences in the wiring through which relational and material resources are distributed. And third, by not collapsing these measures into a summary scale or index, I better attempt to identify areas for intervention or future research (Committee on Preventing Dementia and Cognitive Impairment et al. 2017; Fratiglioni et al. 2004; Institute of Medicine, Board on Health Sciences Policy, and Committee on the Public Health Dimensions of Cognitive Aging 2015).

BACKGROUND

Cognitive function is multidimensional and refers to interrelated abilities and processes that are dependent on neurophysiology as well as modifiable and non-modifiable factors (Institute of Medicine et al. 2015). It is measured using screening instruments that combine questions and assessments to measure different domains of cognitive function such as memory, executive function, and attention. Later life decline in cognitive function is inevitable due to age-related neurophysiological changes and increased likelihood of neurological diseases and dementia such as Alzheimer's disease (Committee on Preventing Dementia and Cognitive Impairment et al. 2017; Institute of Medicine et al. 2015; Raz and Rodrigue 2006). However, there is tremendous between- and within-person variation in trajectories of cognitive function, which has sparked a large body of research aiming to identify modifiable factors, including social integration (Committee on Preventing Dementia and Cognitive Impairment et al. 2017; Langa 2018).

The Cognitive Enrichment Hypothesis

Research on integration and cognitive function and decline—including incident dementia—draws from three hypotheses. The first is the *cognitive enrichment* hypothesis, also known as the mental exercise or *"use it or lose it" hypothesis*, which posits that differences across social groups in both the level of cognitive function and rate of cognitive decline can be explained by differences in lifestyle and social engagement (Hertzog et al. 2008; Hultsch et al. 1999; Salthouse 2006:70; Stine-Morrow 2007; Stine-Morrow et al. 2008). Lifestyles characterized by high levels of mentally-stimulating or physically active tasks, high levels of interaction and engagement in social groups and civic or religious activities, or high levels of exposure to new situations and challenges are thought to improve cognitive function, slow age-related decline, and prevent the clinical manifestations of neuropathology (Fratiglioni et al. 2004).

The biological explanation for this hypothesis draws from research on cognitive reserve, defined as the ability to maintain function despite neuropathology. This research argues accumulated advantages—such as educational attainment or social integration—increase cognitive reserve and lead to differences in observed function (Stern 2012). This argument is based on findings that dementia patients with higher educational attainment clinically present with the same function as dementia patients with lower educational attainment, despite higher levels of dementia-related neuropathology detected with brain imagining (Stern 2002). The same is found for older adults engaged in high levels of leisure activities (Scarmeas and Stern 2003). This research argues cognitive reserve enables adults with neuropathology to accomplish cognitive tasks by stimulating neurogenesis later in life, or by more efficiently activating remaining undamaged neural networks not affected by the pathology (Stern 2002).

Numerous longitudinal studies find social engagement is associated with higher baseline cognitive function, a slower rate of cognitive decline, or decreased risk of cognitive decline or dementia diagnosis at follow-up (Barnes et al. 2004; Bassuk, Glass, and Berkman 1999; Bielak

2010; Crooks et al. 2008; Ertel, Glymour, and Berkman 2008; Fratiglioni et al. 2000, 2004; Glei et al. 2005; Holtzman et al. 2004; James et al. 2011; Krueger et al. 2009; Scarmeas and Stern 2003; Yaffe et al. 2009; Zunzunegui et al. 2003). Randomized control trials and field experiments similarly find evidence for the claim that social engagement increases cognitive function and protects against decline (Barnes et al. 2013; Carlson et al. 2009; Stine-Morrow et al. 2008, 2014; Ybarra et al. 2008). However, these studies largely use global reports of the number or quality of social relationships or composite indexes of social engagement. Those assessing the effects of "network structure" use survey estimates of network size based on reported number of children, relatives, and friends seen over some time period (Barnes et al. 2013; Bassuk et al. 1999; Béland et al. 2005; Glei et al. 2005; Seeman et al. 2001; Sörman et al. 2017; Zunzunegui et al. 2003).

Drawing from the cognitive enrichment hypothesis, I examine whether these effects hold for core discussion network size, frequency of communication with alters, and network density, referring to the extent to which alters communicate with one another irrespective of the respondent. Core discussion network alters are thought to reflect respondents' more intimate social relations and to be especially protective of later life health, and so I expect that core discussion network size and frequency of community with these alters to be positively associated with cognitive function (Burt 1984; Cornwell et al. 2008; Marsden 1987; c.f. Small 2013).

However, I expect density to be negatively associated with cognitive function. Density is frequently thought to positively associate with health. It facilitates monitoring of network members' health-related behaviors and further facilitates coordinating the information and resources necessary for support provision (Cornwell 2009a; Hurlbert et al. 2000; Schafer and Koltai 2015b). However, cross-sectional studies find density is negatively associated with cognitive function (Harling et al. 2016; Kotwal et al. 2016; Perry et al. 2017). Cornwell (2009a, 2009b) argues that this is because of the difficulty of maintaining a loosely connected network as broker between friends or relatives. He finds that cognitive and functional health impairments are negatively associated with bridging potential, which refers to when the respondent is connected to at least two alters who are otherwise not connected to each other. This is concerning because bridging potential reflects participation in diverse social groups and "distinct pools of information and resources," which facilitates social mobility, expands knowledge of potential health treatment options, and may provide cognitive stimulation through exposure to different ideas and situations (Cornwell 2009a:92; Goldman and Cornwell 2015). This paper attempts to attenuate some of this endogeneity using longitudinal data. If lagged density is negatively associated with change in cognitive function, this would suggest that density has at least a partially exogenous relationship with cognitive function, reflecting an additional social risk among those with cognitive impairment.

The Stress Hypothesis

The stress hypothesis posits social support and cohesion indirectly affect cognitive functioning by protecting against psychosocial stress, which increases disease susceptibility and can become directly pathogenic by increasing inflammatory responses in the brain (Cohen 1988; Fratiglioni et al. 2004; Wilson et al. 2003). The stress process also indirectly affects cognitive reserve and neuroplasticity, defined as the ability to form and reorganize synaptic connections (Cacioppo and Hawkley 2009; Fratiglioni et al. 2004). Longitudinal studies find that perceived emotional social support is a protective factor for cognitive function and decline (Holtzman et al.

2004; Seeman et al. 2001), while perceived isolation and social strain are risk factors (Cacioppo and Hawkley 2009; DiNapoli, Wu, and Scogin 2014; Tun et al. 2013).

In this study, I examine the protective association of perceived social support and average emotional closeness to core discussion network members. These measures are frequently correlated with emotional and instrumental support across multiple datasets and stages of the life course (Cornwell 2009a; Hurlbert et al. 2000; Wellman and Wortley 1990), and they are positively associated with cognitive function in cross-sectional analyses of the NSHAP data (Kotwal et al. 2016). However, as I detail below, these measures are—similar to network size, communication frequency, and density or bridging potential—plagued by selection issues, which this paper attenuates using longitudinal data.

The Selection Hypothesis

There is also a third hypothesis, selection, which argues that both the cognitive enrichment and stress hypotheses are biased by endogeneity. The cognitive enrichment hypothesis argues that social activities and large social networks with non-redundant ties is mentally stimulating, but they are also mentally taxing. The selection literature argues cognitive impairments inhibit abilities to participate in social activities and maintain relationships with peripheral family and friends (Aartsen et al. 2002; Bielak 2010; Brown et al. 2012). Additionally, the controversial emotional selectivity theory argues that those with impairments may consciously decide to focus their increasingly limited attention and energy on a subset of relationships and activities (Charles and Carstensen 2010). The stress hypothesis argues that intimate and supportive relationships protect brain health and promote cognitive function, but core family and friends may respond simultaneously to the preclinical onset of cognitive decline by increasing frequency of interaction and provision of support (Antonucci, Ajrouch, and Birditt 2013; Cornwell 2009a; Cornwell and Laumann 2015; Stoller and Pugliesi 1991:94).

Research on the reverse effect of cognitive function on social integration is less prolific and even less conclusive. Some longitudinal studies find higher cognitive function predicts network size and social engagement (Bielak 2010; Brown et al. 2012), while others find no evidence of these associations (Aartsen et al. 2002; Ertel et al. 2008; Sörman et al. 2017). Using cross-lagged panel models (CLPM), Ayalon et al. (2016) find higher memory function predicts lower subsequent social isolation, while the reverse effect is not significant. Also using CLPM, Thomas (2011) finds the direction of the association differs by gender. For women, social support predicts lower cognitive limitations rather than the reverse whereas for men, cognitive limitations predict lower social engagement rather than the reverse.

Much like the studies of the cognitive enrichment and stress hypotheses, these studies of the selection effect measure social integration using composite indexes or scales, but exceptions include several cross-sectional studies that use NSHAP core discussion network data. For example, using data from the first wave, Cornwell (2009a) finds higher cognitive function is associated with higher bridging potential. Using data from the second wave, Kotwal et al. (2016) find persons screened positively for mild cognitive impairment or dementia not only have lower social engagement or lower social strain, but also have smaller, denser core discussion networks. I extend these studies using longitudinal data from the second and third wave of NSHAP to estimate the association of core discussion network structure and composition with cognitive function using lagged dependent variable models, which attenuate reverse causality.

DATA AND METHODS

NSHAP began with a multistage, area-probability sample of 3,005 adults aged 57 to 85 when interviewed in 2005 at 2006 (Waite et al. 2013). NSHAP has collected three waves of data, but because the first wave (W1) uses a different measure of cognitive function, I use data on W1 sample members from the second (W2) and third (W3) waves. W2 includes 2,422 interviews with W1 sample members conducted in 2010 and 2011 and had an unconditional weighted response rate of 74% (O'Muircheartaigh et al. 2014). W3 includes 1,640 interviews with W2 respondents. 782 were lost to follow-up between W2 and W3: 443 died, 125 were lost because of poor health or institutionalization in long-term term care; and 181 respondents were lost due to some other reason. The analytic sample includes 1,258 respondents, dropping 273 respondents with missing data on cognitive function at either wave, 20 (1.4%) respondents missing data on one or more covariates, and 89 respondents with a network size of less than two and thus an invalid density measure.

Measures

Cognitive Function

W1 measures cognitive function using the Short Portable Mental Status Questionnaire (SPMSQ), which classified 96% of respondents as having "normal" cognitive functioning (Shega et al. 2014). To avoid this ceiling effect and better detect mild cognitive impairment (MCI), NSHAP investigators developed a survey-based adaptation of the Montreal Cognitive Assessment (MoCA-SA) for implementation in future waves. The original MoCA is a commonly used screening tool to detect MCI and early dementia with higher sensitivity than the SPMSQ or

Mini-Mental State Examination (MMSE), which are commonly implemented in national aging surveys (Malloy et al. 1997; Nasreddine et al. 2005). Using a pilot test, NSHAP investigators optimized the MoCA-SA for administration by non-medical personnel in a time-limited national survey. They selected specific items and revised the order and wording to minimize respondent burden (Kotwal et al. 2015; Shega et al. 2014).

The MoCA-SA assesses eight domains of function using 18 items (Dale et al. 2018; Kotwal et al. 2016; Shega et al. 2014): orientation; naming; executive function; visuospatial skills; attention; language; and abstract. The MoCA-SA ranges from 0 to 20 with higher scores indicating better function. The Cronbach's alpha is 0.74. The MoCA-SA is highly correlated with the original MoCA and can be accurately converted to the same scale using (Dale et al. 2018; Kotwal et al. 2015):

$$MoCA = 6.83 + (1.14 \times MoCA - SA)$$

Using the converted scores, respondents can be classified as: normal (> 22 points); screening positive for MCI (18 – 22 points); and screening positive for dementia (< 18 points). Further details, including item-specific scoring instructions and descriptive statistics, are in the appendix.

Social Network Measures

NSHAP uses a name generator and a series of name interpreters to construct networks (Cornwell et al. 2009). The network module begins with an adaptation of the General Social Survey "important matters" name generator, asking respondents to name up to five alters with whom they “most often discussed things that were important” to them over the last 12 months.[8] Name interpreters then ascertain information about each alter. In the analyses presented here, I examine four network measures at W2: core discussion network size; total communication with alters; average emotional closeness with alters; and weighted network density.

I measure monthly communication as the total frequency with which the respondent communicates with their alters in person or using digital technology. Possible responses include “less than once a year” (1), “once a year” (2), “couple times a year” (3), “once a month” (5), “once every two weeks” (5), “once a week” (6), “several times a week” (7), and “every day” (8).[9] The possible range of total communication is thus 1 (for one alter) to 40 (for five alters with whom respondents speak every day). I measure average emotional closeness as the mean of how close respondents feel to their alters, ranging from 1 (“not very close”) to 4 (“extremely close”). I measure weighted density as the total communication among alters divided by the total possible

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[8] I calculate the network measures for the five alters named to the core discussion network to be comparable with the cross-sectional NSHAP study on cognitive function by Kotwal et al. (2016) As noted in Chapter 2 of this dissertation, W2 respondents could name two additional alters: their spouse if not already named and someone not already named with whom they “feel especially close.” Supplementary analyses use information on all seven possible alters at W2. The pattern of results does not change.

[9] I use total communication since this measure is less skewed than average communication. Alternative approaches scale the communication variable to approximate number of days per month or year. I chose to keep the original coding to be comparable to the weighted density measure, which was coded to be comparable to Kotwal et al. (2016). Supplementary analyses not shown examine alternative specifications of total or average communication between the respondent and their alters, including transformations to address variable skew. The pattern of results does not change for either the main results or those in the appendix.

communication among alters. The measure ranges from 0 for a situation in which none of the respondents' alters speak to one another even once a year and 1 for a situation in which all the respondents' alters speak to one another every day. By definition, density is invalid for respondents with a network size of zero or one.[10] Total communication, average closeness, and weighted density are standardized for ease of interpretation and comparison.

Perceived Social Support Measure

I measure perceived social support using the scale developed for the MacArthur Midlife in the United States Survey (York Cornwell and Waite 2009). The support scale has six items: "How often can you rely on [spouse/family/friends] for help if you have a problem?" and "How often can you open up to [spouse/family/friends] if you need to talk about your worries?" Responses range from 0 ("never") to 3 ("often"). The Cronbach's alpha for support is 0.67. I average the items and standardize the score for ease of interpretation and analysis. Higher scores indicate greater support.

Covariates

Following previous research (Dale et al. 2018; Kotwal et al. 2016), I control for age, sex, partnership status, race/ethnicity, education, self-reported health, functional health, and depressive symptomology at W2. I code sex as female or male (reference). I code race/ethnicity as non-Hispanic white or other (reference). I code partnership status as married or living with a

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[10] As in Chapter 2 of this dissertation, supplementary analyses code density as 0 for respondents with a network size of zero or one. The pattern of results again do not change.

partner or not (reference). I code education as a series of indicator variables: less than high school (reference); high school or equivalent; some college or technical school; and bachelor's degree or more.

I measure self-reported physical health as an indicator variable coded as "poor" or "fair" compared to "excellent," "very good," or "good" (reference). I measure functional health using an indicator of "much difficulty with" or "unable to do" one or more of six instrumental activities of daily living, including: preparing meals; taking medications; managing money; shopping for groceries; performing light housework; and using a telephone (Lawton and Brody 1969). The Cronbach's alpha is 0.84. I measure depressive symptomology using an indicator variable constructed from the 11-item Centers for Epidemiologic Study of Depression Revised (CESD-R) scale. Interviewers ask respondents how often in the past week they experienced a series of emotions such as "depressed" or "lonely." Responses range from 0 ("rarely or none of the time") to 3 ("most of the time"). Summed items have a maximum of 33. Above 9 indicates likely clinical depression (Steffick et al. 2000). The Cronbach's alpha is 0.79.

Analytic Strategy

I use the panel design of the NSHAP data to attenuate potential reverse causality suggested by research drawing from the selection hypothesis (e.g., Bielak 2010; Brown et al. 2012; Cornwell 2009a; Kotwal et al. 2016). I estimate three lagged dependent variable regression models, also referred to as conditional or residual change models, where W3 MoCA cognitive function scores are regressed on W2 MoCA cognitive function scores and W2 covariates (Finkel

1995; viz., Glei et al. 2005; Halaby 2004).[11] By adjusting for the prior value of cognitive function, these models at least partially control for omitted variables that influence change in cognitive function and reduce potential for reverse causality (Finkel 1995:10; Menard 2010).

I estimate three lagged dependent variable models displayed in Table 3.2. The first model is estimated for the full analytic sample. The second and third models restrict the sample first to those with normal cognitive functioning at W2 and second to those with high cognitive functioning at W2, defined as a MoCA score in the highest tertile (67% of those with normal cognitive functioning). These latter two models are robustness checks. If the results differ significantly from the full sample, this would indicate that respondents already in decline at W2 are biasing the main results.

Analyses were conducted in Stata 15MP and adjusted for survey design effects resulting from the multistage, clustered sampling design and adjusted for the probability of selection and non-response at W2 using person-level weights (StataCorp 2017). I further adjust the person-level weights using a complete-case weighting procedure to attenuate for selection bias stemming from the exclusion of respondents with missing data on cognitive function and those

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[11] There are, of course, several alternative modeling strategies, including a change score model. However, change scores are systematically related to random error of measurement in the measure and are less reliable than the scores from which they are calculated (Cronbach and Furby 1970). Supplementary analyses use a similar specification to previous research (e.g., Bassuk, Glass, and Berkman 1999), estimating logistic regressions of the likelihood of screening positive for mild cognitive impairment or dementia at W3 among respondents with normal cognitive functioning at W2. The main findings do not change, suggesting that the risk factors identified in these models are not only associated with incremental changes in cognitive function, but also with risk of screening positively for clinically-likely decline.

were lost to follow-up between waves.[12] I evaluate multicollinearity—a common concern in network analysis—using variance inflation factors (Allison 1999; Perry et al. 2018).

RESULTS

Table 3.1 displays descriptive statistics for cognitive function and the independent variables at W2. The sample performs well on the MoCA with an average score of 23.92, just above the cutoff for normal cognitive functioning. The within-individual correlation across the waves is 0.71. The average individual loses an average of approximately a point between waves, reflecting stability in cognitive function, with most losing or even gaining just a few points between waves. Appendix Figure B.1 and Tables B.1 and B.2 display more detailed descriptive statistics of the constituent MoCA items and sample screening classifications: 10% (*N*=122/1258) improve classifications between waves; 21% (*N*=268/1258) decline classifications between waves; and the remainder are classified the same at both waves, with more than half the sample classified as normal at both waves 53% (*N*= 675/1258).

The average respondent is age 71, female (53%), married (62%), has some college or at least a four-year degree (64%), and is white, non-Hispanic (83%). The average respondent is generally in good health, with 19% reporting "bad" or "poor" self-rated health and an average near "no difficulty" across activities of daily living. The sample reports high average perceived

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[12] Supplementary analyses examine the models with and without the NSHAP-provided or selection adjusted person-level weights. The pattern of results does not change. Supplementary analyses also estimate the models by imputing missing data on covariates using multiple imputation with chained equations (White, Royston, and Wood 2011). However, there were very few missing values and the pattern of results does not change.

support (2.39, maximum=3), has an average network size of 3.9 alters, with a mode of 5 alters, and are on average "very close" with their alters (3.08).

Table 3.2, Model 1 displays the results from the longitudinal lagged dependent variable regression of cognitive function among the full analytic sample. This model shows mixed support for the cognitive enrichment and stress hypotheses. The cognitive enrichment hypothesis posits that engagement with alters and exposure to diverse environments and ideas promotes cognitive function. I hypothesized that network size and total communication would thus be positively associated with cognitive function while weighted density, as an indicator of network redundancy, would be negatively associated with cognitive function. Consistent with these expectations, I find that network size is positively associated with cognitive function. However, while weighted density is associated with cognitive function in the hypothesized direction, it is not statistically significant in these models. Furthermore, a standard deviation change in total communication is negatively associated with cognitive function at W3 relative to cognitive function at W2. This is seemingly inconsistent with the cognitive enrichment hypothesis but may reflect a trade-off between higher communication with core discussion network members compared to acquaintances and more peripheral network members not captured by the NSHAP name generator. Among those who have normal (Model 2) or high-normal (Model 3) cognitive functioning, these results are not statistically significant but are relatively stable in terms of the magnitude of coefficients, suggesting these results are not driven by those already in decline.

The stress hypothesis posits that support from social relations promotes positive emotions and protects against negative emotions. I hypothesized that that perceived social support and cohesion among alters, captured by average emotional closeness, would both be positively associated with cognitive function. I find that perceived social support is negatively associated with cognitive function, which is inconsistent with the stress hypothesis, but the association is not statistically significant. I find that average emotional closeness is associated with cognitive function in the hypothesized direction, but it is similarly not statistically significant in the full sample. Among those with high-normal (Model 3) cognitive functioning, however, average emotional closeness is statistically significantly positively associated with cognitive function as expected.

Table 3.1 W2 Descriptive Statistics

Variable	Mean	SE	Min.	Max.
MoCA Score	23.92	0.15	0	30
MoCA Change (W3-W2)	-0.82	0.12	-30	30
Sociodemographic Characteristics				
Age	70.62	0.24	62	91
Female	0.53	0.02	0	1
Married	0.62	0.01	0	1
Education				
No High School	0.11	0.01	0	1
High School or GED	0.26	0.02	0	1
Some College or Technical	0.33	0.02	0	1
BA or More	0.31	0.03	0	1
White, Non-Hispanic	0.83	0.02	0	1
Health Characteristics				
Poor/Fair Health	0.18	0.01	0	1
Instrumental Activities of Daily Living	0.04	0.01	0	1
Depressive Symptomology	0.17	0.01	0	1
Social Support and Network Characteristics				
Perceived Social Support	2.39	0.02	0	3
Size	3.90	0.04	1	5
Total Communication	25.82	0.29	1	40
Average Emotional Closeness	3.08	0.02	1	4
Weighted Density	0.49	0.01	0	1

Note: Statistics are weighted to account for the multistage sampling and the probability of selection and nonresponse. Minimum and maximum reflect the full possible range. 1258 observations.

Table 3.2 Lagged Dependent Variable Linear Regressions of W3 Cognitive Function (Montreal Cognitive Assessment Score [MoCA])

Variable	Model 1	Model 2	Model 3
W2 MoCA Score	0.58***	0.50***	0.59***
	[0.51,0.65]	[0.38,0.62]	[0.45,0.73]
Sociodemographic Characteristics			
Age	-0.12***	-0.11***	-0.07*
	[-0.15,-0.09]	[-0.15,-0.07]	[-0.13,-0.01]
Female	0.47**	0.63***	0.59**
	[0.19,0.76]	[0.30,0.96]	[0.19,1.00]
Married	0.08	0.07	0.50^{+}
	[-0.36,0.52]	[-0.40,0.54]	[-0.03,1.04]
Education (Reference: Less than High School)			
High School or GED	0.5	0.47	1.51*
	[-0.19,1.19]	[-0.86,1.79]	[0.07,2.95]
Some College or Technical	0.82*	0.67	2.26***
	[0.16,1.48]	[-0.50,1.83]	[1.00,3.51]
BA or More	1.58***	1.36*	2.66***
	[0.72,2.44]	[0.11,2.61]	[1.36,3.97]
White, Non-Hispanic	0.66**	0.70^{+}	0.64
	[0.26,1.06]	[-0.03,1.43]	[-0.25,1.53]
Health Characteristics			
Poor/Fair Health	-0.60*	-0.97**	-0.61
	[-1.11,-0.09]	[-1.59,-0.35]	[-1.38,0.16]
Instrumental Activities of Daily Living	-0.87	-1	-0.18
	[-2.22,0.47]	[-2.84,0.85]	[-1.32,0.97]
Depressive Symptomology	-0.38	-0.14	-0.60^{+}
	[-0.94,0.19]	[-0.78,0.50]	[-1.20,0.00]
Social Support and Network Characteristics			
Standardized Average Social Support	-0.1	-0.17	-0.28*
	[-0.33,0.14]	[-0.42,0.09]	[-0.53,-0.02]
Size	0.48*	0.38	0.34
	[0.07,0.88]	[-0.14,0.90]	[-0.24,0.92]
Standardized Total Communication	-0.59*	-0.5	-0.46
	[-1.09,-0.10]	[-1.18,0.18]	[-1.15,0.23]
Standardized Average Closeness	0.15	0.16	0.25^{+}
	[-0.04,0.35]	[-0.05,0.37]	[-0.02,0.51]
Standardized Weighted Density	-0.02	-0.05	-0.15
	[-0.23,0.20]	[-0.31,0.20]	[-0.42,0.12]
R-Squared	0.51	0.29	0.272
Observations	1347	925	627

Note: 95% confidence intervals in brackets. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.00$

DISCUSSION

While the literature on the associations between social integration and cognitive function is immense, it is also inconclusive and relies on broad, summary measures of integration. As a result, the effects of social connectedness are frequently identified as a priority for future research, emphasizing the need for additional longitudinal studies and greater specificity in measures of social relationships, support, and engagement (Bielak 2010; Committee on Preventing Dementia and Cognitive Impairment et al. 2017:14). This study contributes to previous research by examining the cognitive enrichment and stress hypotheses using newly-available longitudinal data on the structure and composition of older adults' core discussion networks. These data offer more specific and detailed measures that are distinct from often-used summary measures of social integration and are furthermore thought to capture those relationships that are especially protective of later life health (Burt 1984; Cohen 1988; Cornwell et al. 2008; House and Khan 1985; Marsden 1987; c.f. Small 2013).

Previous research on the associations of network structure and composition with cognitive function has relied on cross-sectional data and has highlighted the need for longitudinal studies to even begin to parse the direction of identified associations. For example, density is thought to negatively associate with cognitive function because of the stimulating benefits of diverse relationships and activities introduced by structural holes. However, previous cross-sectional studies suggest density is negatively associated with cognitive function while bridging potential is positively associated with cognitive function (Cornwell 2009b, 2009a; Harling et al. 2016; Kotwal et al. 2016; Perry et al. 2017). These studies suggest these associations are the result of selection wherein lower cognitive function is associated with adaptive caregiving arrangements or inability to maintain particular networks. Using lagged dependent variables of cognitive function on lagged network measures, I attempt to attenuate some of this bias. I find that lagged density is correlated with cognitive function in the hypothesized direction, but its association is substantively small and is not statistically significant when controlling for sociodemographic or health characteristics or other measures of social support and the core discussion network.

I find limited support for my hypotheses. Consistent with the stress hypothesis, I expected perceived social support and average emotional closeness to core discussion network alters to be positively associated with cognitive function. However, I find that lagged perceived social support and lagged average emotional closeness are not statistically significantly associated with cognitive function, though the association of average emotional closeness is in the hypothesized direction. Additionally, while I find lagged network size is positively associated with cognitive function as expected, I also find that lagged total communication with core discussion network alters is moderately negatively associated with cognitive function over time. This latter finding contradicts the cognitive engagement hypothesis, which suggests that more communication with alters offers greater cognitive stimulation and is thus positively associated with cognitive function. However, I caution this may reflect one of two key limitations and is an important area for future research on egocentric networks in later life.

The first is a limitation of the core discussion network name generator more generally. Like any singular name generator, it does not capture the full range of relationships, including most especially weak or peripheral ties, which are frequent sources of both support and cognitive engagement (Small 2013). It could be that persons with relatively lower communication with core discussion network alters actively engage with others outside their core discussion network and consequently perform better on cognitive function assessments than persons who dedicate more of their time and energy to their core discussion network alters at the expense of others. The second is a limitation of egocentric network instruments in studies of cognitive function more generally. It is less cognitively demanding for respondents to recall persons with whom they communicate frequently (Marsden 2006). Thus, persons with cognitive impairment may be more likely to recognize alters with whom they communicate regularly as persons with whom they also discuss important matters, privileging those persons over others in response to the questionnaire but not necessarily in their day-to-day lives. Future research will need to identify how cognitive function affects the validity of the core discussion network instrument in population-based samples and explore alternative network methodologies, including the use of multiple reporters or sociocentric studies of aging communities (e.g., Koehly et al. 2015; Schafer 2013b).

Indeed, respondent reports of their networks are always subject to measurement error, regardless of the name generator used. This error is especially concerning for structural network measures that rely on respondent reports of connections between their alters (Marcum et al. 2017). The magnitude of bias from this measurement error and the best method of accounting for it are still being identified (Almquist 2012; Schafer 2018). However, the associations identified in these models hold when limiting the analysis to respondents with normal and normal-high cognitive function at W2—when the network measures are assessed in these models. This suggests that respondents already in decline do not drive the identified associations and mitigates measurement error concerns.

While lagged dependent variable models attenuate concerns of reverse causality, the causal interpretation of these results may be biased in ways other than the issues of measurement error described above (Finkel 1995). First, there may be omitted variables not captured by the lagged cognitive function parameter. Second, networks and cognitive function may reciprocally affect each other, causing the estimates to be biased and inconsistent. Third, and relatedly, the causal lag may be improperly measured. On the one hand, five years might not be *enough time* to assess the possibility that social network changes are a premorbid "manifestation of early dementia rather than a premorbid risk factor" (Fratiglioni 2004: 347). On the other hand, five years maybe *far too much time* to adequately identify a causal order or may underestimate the effects of exogenous predictors, including those insignificant in these models (Menard 2010). However, others find social integration is associated with cognitive function across 3-year, 6-year, or even 12-year lags (Bassuk et al. 1999; Green, Rebok, and Lyketsos 2008; Holtzman et al. 2004).

CONCLUSION

With an aging population and rising costs of dementia-related care, prevention of cognitive decline and incident dementia is an urgent public health challenge. Decades of observational research have documented associations between and social connectedness and cognitive function using composite scales and indexes, supporting the well-known cognitive enrichment and stress hypotheses of cognitive aging (Bielak 2010; Fratiglioni et al. 2000). A growing body of observational research further suggests that network composition and structure are associated with cognitive function in later life, lending insight into the mechanisms by which social resources are distributed as cognitive function begins to decline (Cornwell 2009b, 2009a; Kotwal et al. 2016; Schafer 2013b).

The results herein offer the first longitudinal examination of network composition and structure with cognitive function. The results provide modest support for the cognitive enrichment hypothesis, but also a compelling flag for several areas of future research. Future research on social networks in later life should identify measurement error in egocentric network surveys of older adults stemming from cognitive impairment and decline. Additionally, future research should further investigate potential bidirectionality in the association between networks and cognitive impairment and decline (Bielak 2010) and the appropriate etiologic period and cognitive function domains most affected by social connectedness (Fratiglioni et al. 2004; Owen et al. 2010).

Chapter Four: The Emotional Cost of Distance: Geographic Network Dispersion and Post-Traumatic Stress among Survivors of Hurricane Katrina

Hurricane Katrina caused massive destruction, loss of human life, and long-term housing displacement. Approximately 1.2 million individuals were displaced from the Gulf Coast region, and almost 80% of New Orleans evacuated before the storm (Fussell, Curtis, and DeWaard 2014). The city recovered only half its pre-Katrina population by 2006 and three-quarters of its pre-Katrina population by 2012 (Fussell and Lowe 2014). Evacuation and relocation strategies available to Hurricane Katrina survivors negatively impacted their social networks and traditional kinship care arrangements (Asad 2014; McCarthy-Brown and Waysdorf 2009). Many residents were relocated with little choice of destination and often without their close friends or family due to limited access to transportation, financial resources, and time to prepare (Eisenman et al. 2007). Households with the fewest resources were least likely to keep their families together during evacuation and relocation processes (Fussell 2006), geographically dispersing their social support networks (Hurlbert, Beggs, and Haines 2006). In this chapter, originally published as a coauthored paper in *Social Science & Medicine*, my coauthor Nicole Deterding and I examine the association between social network characteristics and post-traumatic stress disorder (PTSD) following Hurricane Katrina (Morris and Deterding 2016). We focus on network dispersion in particular, drawing from longitudinal survey data and qualitative in-depth interview data to suggest the mechanisms by which dispersion affects psychological distress.

BACKGROUND

Network Disruption after Natural Disaster

Following disaster, psychological distress is associated with both primary and secondary stressors. In the short-term, primary stressors include witnessing destruction and death, while secondary stressors are associated with long-term, indirect consequences like diminished financial resources and access to medical care. Weakened social support from network disruption is considered a key secondary stressor (Lock et al. 2012). Natural disasters harm networks due to the experience of collective trauma and mass displacement. Collective trauma refers to the shared experience of a traumatic event, which can facilitate bonding and new relationships, but often hampers reciprocal exchange when individuals are unable to offer support given their own need (Kaniasty and Norris 1993, 1995). Mass displacement disrupts networks by physically separating survivors from their communities and routine contacts (Hurlbert et al. 2006). Even those who return after relocation may find not only the physical environment of their community changed, but the composition of its members as well (Groen and Polivka 2010).

Social networks are crucial conduits of the emotional and instrumental support that buffers against psychological distress in the short-term after disaster and aids psychological recovery in the long-term (Barnshaw and Trainor 2007; Galea et al. 2005; Hurlbert et al. 2000; Reid and Reczek 2011). Research demonstrates that perceived emotional social support is protective against psychological disorders (Adeola and Picou 2014; Charuvastra and Cloitre 2008; Paxson et al. 2012; Weems et al. 2007), while network disruption and loss of support is positively associated with risk of PTSD (Fredman et al. 2010; Hall, Crowder, and Spring 2015).

Geographic network dispersion is a key form of network disruption linked to PTSD. For example, Bland et al. (1997) find that earthquake survivors whose displacement increased distance from their social relationships were more likely to experience psychological distress. However, increased distance does not *necessitate* disruption or dissolution, especially given social media and other new digital communication technologies (DCT) (Phan and Airoldi 2015). The association of post-disaster PTSD with network dispersion in the Internet age remains an open question. We hypothesize that network dispersion is associated with PTSD after Hurricane Katrina. We further hypothesize that this association is moderated by New Orleans residency versus continued displacement.

Geographic Network Dispersion and Social Support

While social commentators suggest the Internet reduces the effect of distance on relationship quality, research demonstrates that DCT only marginally affects how individuals maintain their relationships (Mok, Wellman, and Carrasco 2010). Even today, distance to ties remains negatively associated with the frequency and quality of social interactions. Proximity to network members "fosters frequent contact, densely knit connections, mutual awareness of problems, and easy delivery of aid" (Wellman and Wortley 1990:568), importantly predicting emotional and instrumental social support (Hurlbert et al. 2000). Proximity also increases emotional intimacy between social ties due to more frequent interaction (Lawton, Silverstein, and Bengtson 1994).

This does not mean all distant social ties are weak or all proximate social ties are intimate. Distant ties are often kin-based, representing "latent or sentimental relations" (Fischer

1982:169). Silverstein and Bengston (1997:442) find that intimate-but-distant social relationships are those “in which functional exchange is absent, but where high levels of affinity may hold the potential for future exchange.” Were distant ties not satisfying, they might be discontinued, “since local associates ‘cost’ less and distant ones ‘cost’ more, people find their distant ones *more* rewarding, on the average, than their nearer ones” (Fischer 1982:172). It follows that distance reduces access to instrumental support during periods of stress and may even exacerbate psychological distress when intimate ties are far away. We thus hypothesize the association between network dispersion and PTSD is moderated by perceived emotional support.

Mechanisms Linking Geographic Network Dispersion and Mental Health

We evaluate whether network dispersion is statistically associated with psychological distress after Katrina and aim to understand the mechanisms of this association. In doing, we extend research on the so-called “stress-buffering-hypothesis,” which suggests social ties ameliorate the effects of stress exposure on health outcomes (Cohen and Wills 1985). Researchers suggest social networks may affect physical and mental health through four categories of mechanisms: person-to-person exposure to infection or toxins; access to material resources or practical assistance; social influence and control; and emotional social support (Berkman et al. 2000). While these mechanisms are often described, they are rarely identified empirically (Thoits 2011; Uchino et al. 1996). By combining quantitative data on networks with rich qualitative interview data, we identify two mechanisms by which network dispersion affects psychological health in the wake of disaster: belonging and mattering.

Belonging occurs through shared social activities and discussions of important matters, producing feelings of acceptance and inclusion (Cutrona and Russell 1990) and protecting against loneliness (Hawkley and Cacioppo 2010). It is linked to emotional social support, defined as "sharing an emotional problem or exchanging personal life experiences" (Lin, Woelfel, and Light 1985:248; Thoits 2011). Lack of belonging is a key symptom of what Erikson (1978:131, 187) describes as disaster-related "collective trauma." Expanding from the definition of collective trauma cited above, he highlights "a gradual realization that the community no longer exists as an effective source of support and that an important part of the self has disappeared" (Erikson 1978:154). His interviewees relate loss of community and lack of deep belonging to network disruption, saying: "You don't have any friends around, people around, like we had before" and "I don't know where any of my friends are now" (Erikson 1978:196). We examine whether this mechanism persists across distance even in the Internet age.

Mattering refers to the positive feeling individuals get from fulfilling role expectations when they are relied upon for assistance, indicating they are important to others (France and Finney 2009). Mattering provides a sense of purpose, meaning in life, and self-worth (Thoits 2011:148), which is protective of PTSD following natural disaster (Feder et al. 2013). However, the strain caused by role expectations and obligations has also been referred to as the "dark side" of social networks (Kawachi and Berkman 2001:463). We examine whether the inability to fulfill obligations due to distance may lead to role strain and a lack of mattering (Rook 1990), producing psychological distress.

DATA AND METHODS

Sample

We draw data from the Resilience in Survivors of Katrina (RISK) Project, a mixed-methods, longitudinal study examining the long-term effects of natural disaster on low-income parents living in New Orleans before the storm. The study began as Opening Doors Louisiana, a randomized-controlled study of a community college scholarship intervention. When Hurricanes Katrina and Rita halted the Opening Doors evaluation, baseline data were repurposed to become RISK (Barrow et al. 2014). Given Opening Doors' eligibility criteria, the baseline sample is disproportionately female, African-American, and receiving some form of government assistance.

RISK used a nested mixed-method study design, surveying and interviewing the same individuals (Small 2011:69). Researchers conducted two post-Katrina telephone surveys of Opening Doors baseline participants and two waves of qualitative interviews with a subsample of survey respondents. Qualitative interviewees were chosen purposively to vary mental health characteristics and their post-hurricane location: New Orleans or Texas (Lowe and Rhodes 2012). Qualitative interviews were restricted to women, as the overwhelming majority of Opening Doors participants were female. The surveys and interviews measure similar concepts to facilitate mixed-methods analysis. The second post-Katrina survey (PK2) added questions to capture respondents' social connections, including their biological or adopted children, household members, and social network ties. Here, we report data from baseline and PK2 surveys and the second wave of qualitative interviews. Together, these data offer a unique opportunity to assess the association of social network characteristics and social support with the long-term psychological distress experienced following a natural disaster.

Opening Doors Louisiana collected pre-disaster data from 1,019 low-income parents in 2003 and 2005. 752 respondents from the baseline sample, including 702 women, completed the PK2 telephone survey in 2009-2010 for a total, unweighted response rate of 71%. 63 women also completed an in-depth, semi-structured qualitative interview. In order to ensure comparability between quantitative and qualitative data, we restrict our quantitative analysis to female PK2 respondents. We exclude 44 of the 702 women with missing geographic information. For all other missing data (<10%; N=48), we conducted multiple imputation by chained equations using the "mi impute" command in Stata 14, producing an analytic sample of 658 (White et al. 2011). We used item-level imputation for all scale and index measures (Gottschall, West, and Enders 2012; Shrive et al. 2006). We restrict qualitative analyses to interviews occurring within 12 months of the PK2 survey (N=43), as networks evolve with members' changing obligations and routine activities (Small, Deeds Pamphile, and McMahan 2015). We used two-sample *t*-tests to determine whether the qualitative sample differed from the quantitative sample, finding comparability across all covariates except that the qualitative sample is slightly older.

Quantitative Measures

Post-Traumatic Stress Symptomology

We measure post-traumatic stress symptomology (PTSS) using the Impact of Event Scale-Revised (IES-R), a 22-item self-report scale designed to assess distress from a specific event (Weiss 2007; Weiss and Marmar 1997). The IES-R assesses the likelihood of PTSD by asking how much distress respondents felt in the previous week due to things such as memories or nightmares about the event. The IES-R includes three subscales: avoidance; hyperarousal; and intrusion. Avoidance is characterized by emotional numbing and feeling as if the event were not real, attempts to remove the event from memory, and explicitly avoiding reminders or associated emotions. Individuals with a high avoidance score will typically avoid people, places, and situations associated with the event. Hyperarousal is characterized by feelings of irritability or anger, difficulty concentrating or sleeping, and hypervigilance, typified by feeling "watchful and on-guard." Intrusion is characterized by distracting memories or images, acting or feeling as if back at the time of the event, constant reminders of the event, or nightmares. Responses to each item range from 0 ("never") to 4 ("extremely"). We create a scale by averaging the 22 items. PTSS is coded as a dummy variable; an IES-R score of 1.5 or higher indicates a high risk of having PTSD (Creamer, Bell, and Failla 2003). Reliability of the full IES-R scale, measured using Cronbach's alpha, is 0.95; reliability of the avoidance subscale is 0.85; reliability of the hyperarousal subscale is 0.89; and reliability of the intrusion subscale is 0.91.

Social Network Measures

The RISK Project's social network module uses a *name generator* to determine the size of respondents' networks and *name interpreters* to collect information about each network member. Networks consist of the respondent (ego) and the persons (alters) directly connected to her. The name generator was adopted from the General Social Survey (GSS) "important matters" network, also called the "core discussion network," which was originally hypothesized to consist of the social ties most likely to influence opinions, provide social support, and enhance well-being (Burt 1984:317). The name generator asks respondents, "From time to time, most people discuss important matters with other people. Looking back over the last six months, who are the people with whom you discussed matters important to you?" Respondents name up to five people and the module continues with several name interpreters to elaborate the relationships.

We construct five social network measures from these interpreters: network size, ranging from 0 to 5; average frequency of communication with alters, ranging from 1 ("less than once a month") to 4 ("daily"); proportion of alters who are kin; proportion of alters the respondent knew before Katrina; and geographic network dispersion, defined as the proportion of alters living 100 kilometers or more from the respondent. This dispersion measure is consistent with previous research on social support and exchange (Fischer 1982; Hurlbert et al. 2000) and is a common threshold between every day and long-distance travel in transportation literature (Axhausen and Kowald 2015).

Covariates

We assess hurricane exposure using two measures that capture disaster-related stressors shown to be most predictive of PTSD (Chan and Rhodes 2014; Norris and Wind 2009). The first is whether the respondent had a friend or family member who died as a result of Hurricanes Katrina or Rita. The second is an exposure to hurricane trauma index using a sum of eight questions adapted from another survey of Hurricane Katrina evacuees (Brodie et al. 2006). The questions include: not having enough fresh water and food; feeling like one's life was in danger; lacking necessary medicine and medical care for self and family members; and lacking knowledge about the safety of their children and other family members. Reliability of the scale, measured using Cronbach's alpha, is 0.78.

Since poor mental health before the hurricane may increase susceptibility to post-traumatic stress, we control for baseline psychological distress. Our baseline measure is the Kessler K-6 Scale, used in several other studies of Hurricane Katrina victims (Kessler et al. 2010). The six items ask respondents whether they experienced feelings such as “hopelessness” or “nervousness” in the last 30 days. Responses range from 0 (“none of the time”) to 4 (“all of the time”). The total score is the sum of all six items. Scores of eight to 12 indicate probable mild to moderate mental illness (MMI) while scores of 13 to 24 indicate serious mental illness (SMI). We code the scale into three categories: no mental illness; MMI; and SMI. Reliability of the scale, measured using Cronbach’s alpha, is 0.78.

We measure perceived emotional social support at baseline using the Social Provisions Scale, which asks, “Do you agree with the following statements about your current relationships with family and friends…” (Cutrona and Russell 1990). The scale includes eight items such as, “there are people I know will help me if I need it.” Responses range from 1 (“strongly disagree”) to 4 (“strongly agree”). Negative items were reverse coded and items were averaged to obtain a total score. The scale ranges from to 0 to 4, with higher scores indicating higher support. Reliability of the scale, measured using Cronbach’s alpha, is 0.75.

Additionally, we control for sociodemographic covariates, including New Orleans residency. Race is coded as black (1) or non-black (0). Age is measured in years. Marital status is measured as married or cohabitating with a romantic partner (1) or not (0). Number of children is all children between the ages of 0 and 17 living in the respondent’s household at the time of the interview, top-coded at 4. Income is measured as the log of total household income last month. We also control for the number of months between when Hurricane Katrina made landfall and the day of the survey interview since time may increase the likelihood of psychological recovery.

Analytic Strategy

We adopt a sequential explanatory analytic design (Ivankova, Creswell, and Stick 2006), using qualitative data to elaborate statistical models. Our quantitative analyses include two steps. First, in Table 4.2, we use logistic regression models to predict the likelihood of PTSS. Model 1 is the baseline model. Model 2 adds network characteristics. Model 3 tests the hypothesis that New Orleans as residency moderates the association between network dispersion and PTSS whereas Model 4 tests the hypothesis that perceived social support moderates this association. Second, in Table 4.3, we use linear regression models to predict each of the three PTSS subscales. This is a robustness check to acquire a more detailed understanding of the association between network dispersion and PTSS. We might expect those with a high IES-R/PTSS avoidance score to have greater network dispersion due to a conscious effort to avoid distressing memories prompted by face-to-face interactions with persons they knew before the storm. If network dispersion differentially predicts the avoidance subscale compared to hyperarousal and intrusion, this could indicate that dispersion is the result rather than a cause of PTSS.

After modeling the main quantitative finding—the relationship between geographic network dispersion and likelihood of PTSS—we examined qualitative data to better understand it. We used “maximum variation” sampling, limiting ourselves to qualitative cases with the largest variation on the independent variable of interest (Caracelli and Greene 1993; Flyvbjerg 2006). Using information from the social network module, we selected interview cases belonging to two groups: those with the largest proportion of distant ties (N=7, mean distance > 500 km) and those with only proximate ties (N=24, mean distance=0 km). We then wrote respondent-level thematic memos for each interview, focusing on the interview modules where women discussed family, friends, and acquaintances. Based on preliminary inductive analysis, we focused on textual evidence of two concepts suggested by the literature: *belonging* and *mattering*. We also compared themes for respondents whose surveys indicated PTSS and those whose did not. The findings we present result from cross-case analysis of 31 cases.

RESULTS

Is Social Network Dispersion Associated with Post-Traumatic Distress? Quantitative Evidence

Table 4.1 reports descriptive statistics for the variables in our quantitative models for the full analytic sample (*N*=658) and by PTSS status. The full analytic sample has relatively small networks with an average of 2.21 alters. On average, these networks consist of kin, alters they knew before the hurricane, alters they communicate with on a daily basis, and proximate alters within 100 kilometers. The last column displays the *p*-values from two-sample *t*-tests for each variable comparing the mean among respondents without PTSS (*N*=415) to those with PTSS (*N*=243). Respondents with PTSS are older, more likely to be African-American, less likely to be married, have a lower monthly income, have a higher hurricane trauma index score, are more likely to have lost a friend or relative during the hurricane, have lower perceived social support, have fewer kin in their network and have a greater proportion distant alters.

Table 4.1 Descriptive Statistics for Variables in Regression Models

		Full Sample		Without PTSS		With PTSS		
Variables	Range	Mean	*SD*	Mean	*SD*	Mean	*SD*	*p*
Dependent Variables								
Post-Traumatic Stress Scale	0,1	0.369	0.483					
Avoidance Sub-scale	0,4	1.340	0.984					
Hyperarousal Sub-scale	0,4	0.964	1.044					
Intrusion Sub-scale	0,4	1.374	1.106					
Sociodemographic Characteristics								
Age at Baseline Years	18,35	25.129	4.402	24.723	4.374	25.823	4.372	0.002
African-American	0,1	0.860	0.347	0.810	0.393	0.947	0.225	0.000
Married / Cohabiting	0,1	0.448	0.498	0.499	0.501	0.362	0.482	0.001
# Children, Ages 0-17	0,4	1.778	0.984	1.769	0.978	1.794	0.995	0.748
Log of Monthly Income	4.605,9.833	7.594	0.775	7.646	0.780	7.505	0.759	0.053
Hurricane Experience and Recovery								
Baseline Psychological Distress								
Mild to Moderate	0,1	0.173	0.379	0.152	0.360	0.210	0.408	0.058
Serious	0,1	0.061	0.239	0.039	0.193	0.100	0.299	0.002
Hurricane Trauma Index	0,8	3.070	2.246	2.513	2.018	4.021	2.301	0.000
Death of Friend/Relative	0,1	0.413	0.493	0.337	0.473	0.543	0.499	0.000
Time to Follow-Up Months	43.32,55.78	46.045	2.805	46.107	2.796	45.940	2.821	0.461
Living in New Orleans	0,1	0.705	0.456	0.728	0.446	0.667	0.472	0.098
Social Network and Support Characteristics								
Perceived Social Support	1.286,4	3.210	0.442	3.252	0.419	3.136	0.472	0.002
Network Size	1,5	2.214	1.184	2.260	1.165	2.136	1.214	0.193
Average Communication	1,4	3.736	0.463	3.726	0.481	3.753	0.432	0.478
Proportion Kin	0,1	0.675	0.383	0.695	0.368	0.640	0.406	0.078
Proportion Knew Before	0,1	0.876	0.264	0.878	0.261	0.875	0.268	0.888
Proportion ≥ 100 km	0,1	0.230	0.349	0.203	0.326	0.275	0.383	0.012
Observations		658		415		243		

Note: Descriptive statistics were calculated using the first imputation data set. Unless otherwise noted, all variables are measured at PK2, approximately five years after the storm. The last column displays the p-values from two-sample t-tests for each variable comparing the mean among respondents without probable post-traumatic stress (N = 415) to the mean among respondents with probable post-traumatic stress (N = 243)

Table 4.2 shows results from logistic regression models predicting PTSS. Model 1 includes individual-level sociodemographic characteristics, exposure to hurricane-related traumas, and baseline psychological distress. Consistent with previous research, age, race, baseline psychological distress, exposure to hurricane-related traumas, and death of a friend or relative significantly predict the likelihood of PTSS. Model 2 adds perceived social support and structural and compositional social network characteristics. A standard deviation increase in the proportion of distant alters is associated with a 21.9% increase in the log odds of PTSS in this model. As seen in Table 4.1, the standard deviation of proportion distant alters is 0.35. For a network of three, the difference of 0.35 units is approximately the difference of one distant alter versus all alters living nearby. This model confirms that network dispersion significantly predicts the likelihood of PTSS when controlling for sociodemographic characteristics and classic factors associated with hurricane experience and recovery (Chan and Rhodes 2014; Paxson et al. 2012). Additionally, we find that network dispersion predicts the likelihood of PTSS above and beyond perceived social support. Models 3 and 4 demonstrate the association is not moderated by living in New Orleans or perceived social support. While this contradicts previous theory suggesting perceived social support moderates the effect of network characteristics on mental health (House 1987), it is consistent with empirical research on Hurricane Katrina (Lowe, Chan, and Rhodes 2010; McLaughlin et al. 2011; Paxson et al. 2012).

Table 4.3 shows that the network dispersion coefficient is similar in the correct direction but not significantly associated with any of the three PTSS subscales. This suggests the relationship cannot be explained by a differential association with the avoidance subscale.

Table 4.2 Odds Ratios from Logistic Regression Models Predicting Post-Traumatic Stress

Variables	Model 1	Model 2	Model 3	Model 4
Sociodemographic Characteristics				
Age at Baseline	1.053**	1.051**	1.051**	1.050**
	(1.010-1.097)	(1.008-1.096)	(1.008-1.096)	(1.007-1.095)
African-American	3.044***	2.698***	2.699***	2.672***
	(1.562-5.931)	(1.378-5.285)	(1.378-5.287)	(1.364-5.237)
Married/Cohabiting	0.618**	0.644**	0.644**	0.648**
	(0.421-0.907)	(0.434-0.956)	(0.434-0.955)	(0.437-0.962)
# Children, Ages 0-17	0.992	0.994	0.993	0.992
	(0.828-1.188)	(0.828-1.193)	(0.828-1.193)	(0.826-1.191)
Log of Monthly Income	0.974	0.976	0.975	0.966
	(0.760-1.247)	(0.760-1.254)	(0.759-1.253)	(0.752-1.242)
Hurricane Experience and Recovery				
Baseline Psychological Distress				
Mild to Moderate	1.541*	1.534*	1.538*	1.539*
	(0.968-2.452)	(0.962-2.447)	(0.964-2.455)	(0.966-2.452)
Serious	2.776***	2.796***	2.795***	2.778***
	(1.312-5.870)	(1.304-5.998)	(1.302-5.999)	(1.292-5.973)
Hurricane Trauma Index	1.276***	1.285***	1.284***	1.284***
	(1.175-1.387)	(1.181-1.397)	(1.181-1.396)	(1.181-1.396)
Death of Friend/Relative	1.490**	1.521**	1.520**	1.522**
	(1.038-2.139)	(1.056-2.190)	(1.055-2.189)	(1.057-2.194)
Living in New Orleans	0.808	0.915	0.907	0.919
	(0.549-1.187)	(0.603-1.387)	(0.592-1.391)	(0.606-1.395)
Time to Follow-up	0.977	0.977	0.977	0.974
	(0.916-1.042)	(0.915-1.042)	(0.915-1.042)	(0.913-1.040)
Social Network and Support Characteristics				
Perceived Social Support	0.813	0.817	0.817	0.817
	(0.542-1.221)	(0.536-1.246)	(0.536-1.245)	(0.535-1.248)
Network Size		0.972	0.972	0.970
		(0.833-1.134)	(0.833-1.135)	(0.831-1.132)
Standardized Average Communication		1.152	1.151	1.146
		(0.951-1.396)	(0.950-1.395)	(0.947-1.388)
Standardized Proportion Kin		0.908	0.907	0.910
		(0.743-1.110)	(0.741-1.109)	(0.744-1.112)
Standardized Proportion Knew Before		1.056	1.059	1.052
		(0.867-1.287)	(0.867-1.294)	(0.864-1.282)
Standardized Proportion ≥ 100 km		1.219**	1.198	0.642
		(1.007-1.477)	(0.898-1.597)	(0.172-2.402)
Interactions				
Living in New Orleans × Standardized Proportion ≥ 100 km			1.032	
			(0.709-1.502)	
Perceived Support × Standardized Proportion ≥ 100 km				1.227
				(0.809-1.861)
Constant	0.195	0.207	0.209	0.261
	(0.00319-11.88)	(0.00331-12.93)	(0.00333-13.10)	(0.00406-16.73)
Observations	658	658	658	658

Note: 95% confidence intervals are in parentheses. * p < 0.05, ** p < 0.01; *** p < 0.001

Table 4.3 Linear Regression Models Predicting Post-traumatic Stress Subscales

Variables	Model 1 Avoidance	Model 2 Hyperarousal	Model 3 Intrusion
Sociodemographic Characteristics			
Age at Baseline	1.014	1.019**	1.016*
	(0.997-1.030)	(1.002-1.037)	(0.998-1.035)
African-American	1.656***	1.280**	1.442***
	(1.331-2.060)	(1.026-1.598)	(1.134-1.832)
Married/Cohabiting	0.857*	0.906	0.882
	(0.733-1.001)	(0.773-1.063)	(0.741-1.050)
# Children, Ages 0-17	0.987	1.009	0.983
	(0.918-1.061)	(0.937-1.087)	(0.907-1.066)
Log of Monthly Income	0.984	0.931	0.993
	(0.890-1.088)	(0.840-1.031)	(0.889-1.110)
Hurricane Experience and Recovery			
Baseline Psychological Distress			
Mild to Moderate	1.250**	1.177*	1.153
	(1.034-1.511)	(0.971-1.426)	(0.936-1.421)
Serious	1.477**	1.662***	1.897***
	(1.093-1.996)	(1.218-2.268)	(1.358-2.651)
Hurricane Trauma Index	1.102***	1.157***	1.142***
	(1.065-1.140)	(1.118-1.198)	(1.100-1.186)
Death of Friend/Relative	1.234***	1.356***	1.353***
	(1.063-1.433)	(1.163-1.580)	(1.146-1.597)
Living in New Orleans	0.980	1.041	0.938
	(0.831-1.156)	(0.878-1.233)	(0.780-1.127)
Time to Follow-up	1.007	0.998	0.988
	(0.982-1.032)	(0.972-1.024)	(0.961-1.016)
Social Network and Support Characteristics			
Perceived Social Support	0.971	0.923	1.023
	(0.821-1.147)	(0.778-1.095)	(0.850-1.232)
Network Size	0.992	0.983	0.976
	(0.933-1.054)	(0.924-1.047)	(0.912-1.044)
Standardized Average Communication	1.058	1.076*	1.049
	(0.982-1.140)	(0.997-1.162)	(0.966-1.140)
Standardized Proportion Kin	1.007	0.991	0.987
	(0.929-1.092)	(0.912-1.077)	(0.902-1.080)
Standardized Proportion Knew Before	0.973	1.002	0.994
	(0.899-1.052)	(0.925-1.086)	(0.911-1.085)
Standardized Proportion ≥ 100 km	1.059	1.039	1.061
	(0.981-1.144)	(0.961-1.124)	(0.974-1.155)
Constant	1.170	1.799	2.169
	(0.231-5.918)	(0.343-9.434)	(0.359-13.08)
Observations	658	658	658

Note: 95% confidence intervals are in parentheses. * p < 0.05, ** p < 0.01; *** p < 0.001

Why Does Network Dispersion Predict Post-Traumatic Distress? Qualitative Evidence

Survey data indicate that the geographic dispersion of significant social relationships is associated with PTSS after natural disaster. Our analysis also ruled out return to New Orleans, perceived social support, or reverse causality due to avoidance symptoms as explanations for this association. We now turn to interview data for suggestions of mechanisms linking distant alters to psychological distress. How does distance shape social relationships key to psychological recovery?

Developing a "New Family"

Empirical work linking social networks to mental health typically frames social support as proffered by *significant* others, though Thoits (2011) theorizes that *secondary* others may also matter. Among interviewees with dispersed core networks, we do find evidence of new, proximate social connections made after Katrina. For example, 39-year-old Melissa, a divorced mother of two, lived in Houston at the time of interview. She described "being away from family, and not having that support system, having to develop a new family out here" as the hardest thing about life in the year after Katrina. By the interview—four years after the hurricane—she described a set of Houston friends as "very, very close, like extended family." Yet, despite success in building fulfilling relationships, she yearned for return to New Orleans, where her mother, grandmother, and best friend, identified on the name generator, lived.

Like Melissa, the majority of interviewees developed new supportive and reciprocal relationships following the hurricane. Regarding a new friend in Houston, Tasha, a 36-year old mother of four, reported: "If I need her for something, I can go to her. If she needs me for something, she can come to me. No matter what it is." 32-year-old Nancy described a new neighbor as "like a sister" with whom she exchanged childcare when needed. These new relationships were largely not mentioned on the network name generator during survey administration, but appeared to offer respondents important day-to-day instrumental and emotional support.

Perhaps particularly for this sample of low-income mothers, respondents rely on nearby instrumental support such as picking-up children from school. Even women indicating a proximate network in the survey described the importance of new friends and loose connections as they dealt with the disaster and adjusted to life that followed. Interviews also suggest that respondents receive emotional support, like listening and offering advice about how to navigate interpersonal issues at home or at work, from these new relationships. These data are consistent with Model 4 in Table 4.2 indicating perceived social support does not attenuate the relationship between geographic network distance and PTSS, since respondents appear to draw instrumental and emotional support from secondary others.

The Emotional Cost of Distance

While interview respondents clearly value these new relationships, they discuss ties to distant alters in qualitatively different terms, highlighting the emotional cost of distance. Qualitative data suggests that psychological strain associated with geographically dispersed networks is most closely tied to two mechanisms from the social support literature: *belonging* and *mattering*.

Belonging—emotional comfort and acceptance within longtime relationships—is hypothesized to link social support and mental health even during settled times. Following Katrina, interviewees vividly described the emotional strain they felt when removed from the comfort of their closest friends and family. While Melissa, above, built new relationships "like family" in Houston, she also described continuing issues with sleep, unusual aches and pains, and anxiety, linking these symptoms to being away from her closest social ties, reporting "I think I still suffer some anxiety about what happened. I find myself at moments feeling sad or angry, and [do] not really know why. But I would say it would probably be linked to that tearing away from family and what happened in the storm."

Like the "tearing away" Melissa describes, a common metaphor for this mechanism was "uprooting." Kristin, a 30-year-old mother of two, lived in New Orleans at the time of interview, but highlighted the emotional strain she felt when far from her community for the three months she was displaced to San Antonio: "You're just being pulled out of your natural roots, like a tree. You pull a tree out at the natural roots, and how is it going to grow? And that's basically all you're thinking about when you're out there, and you're scared that you're going to have to do it again." Kristin's survey indicates she continues to suffer from PTSS, and in the interview, she reports that thoughts of future hurricanes—and future uprooting—continue to cause emotional distress.

Similarly, Tasha, a 36-year-old mother of four living in Houston, described the lingering effects of distance from those returning to New Orleans: "My mom is depressed. I suffer with it. I mean, basically everybody who went through that shit is suffering with it." Tasha's survey indicates she continues to experience PTSS, and she reported that she thinks about the hurricane "Every day. I think about what I left and the change that it brought on my family and friends, the memories you'll never get back, the people you never get back." In short, a lack of deep belonging appears to continue to affect those with distant primary networks.

Interview data also suggest role strain was a key experience of distance from primary ties. *Mattering* results when we meet others' expectations of us and successfully perform the social roles with which we identify. These women mothered their children every day, but the social roles of daughter and granddaughter also appeared particularly salient. When distance prevented fulfilling the caring obligations associated with these roles, respondents reported psychological stress.

For instance, the main reason Melissa is "determined to get back home" to New Orleans is to help her mother care for her grandmother, who lost both legs following diabetes complications. Melissa speaks to her mother on the phone frequently and her grandmother sends postcards, but she reports that, as a good daughter, "I just don't want the burden to be solely on my mom." From Houston, Melissa is physically unable to relieve her mother's burden.

Network dispersion also produced the strain of conflicting role obligations. Thirty-six-year-old Anna returned to New Orleans under pressure from her mother and aunt "to help out with the family," but regretted not choosing St. Louis with her father: "I'm the only one that really talks to my dad, the closest one to my father. The only time [my little brother] calls is when he needs something. I call my daddy for advice. I call my daddy just to say hello. I just call my dad." Anna's father was the one person mentioned on her network name generator, and as he struggled with depression and isolation, their distance weighed heavily on her as well.

Finally, qualitative data indicate that role strain emanated both from significant others' stated expectations and respondents' own expectations of themselves. Even in the absence of explicit pressure, many women described feeling guilt and regret when they were unable to meet distant others' needs. If social obligations are the "dark side" of social networks, it appears distance only emphasizes the strain obligations can produce.

DISCUSSION

This chapter answers the question: “What difference does the spatial distribution of ties make?” (Fischer 1982:173) We find that geographic dispersion is positively associated with risk of PTSS. This association is not moderated by perceived social support as suggested by literature on social structure and support (House 1987) and literature on the stress-buffering-hypothesis (Weems et al. 2007). Further, we do not find the main association is moderated by living in New Orleans, despite previous research indicating post-Katrina relocation negatively predicts mental health (Lowe, Willis, and Rhodes 2014). Based on analysis of interview data, we suggest two potential mechanisms for the association between network dispersion and psychological distress: belonging and mattering.

Echoing Erikson’s *Everything in Its Path* (1978:233), we find that “when one’s communal surround disappears, and with it a feeling of belonging and identity, one tends to feel less intact personally.” Interviewees reporting dispersed core discussion networks do not lack proximate social ties. Instead, they describe their proximate and distant ties in qualitatively different terms. They report material support and companionship from secondary others—new friendships and even “new family” built since the hurricane—yet they long for the deep belonging they felt when embedded among significant others pre-Katrina. Interviewees with dispersed networks also report emotional strain from an inability to meet obligations toward distant ties, especially kin. These data suggest that distance to significant others named to the core discussion network decreases feelings of belonging and mattering and increases feelings of longing and burden in the wake of disaster.

By capitalizing on the RISK project's unique data, we build on growing attention to integrating qualitative and quantitative data in social network research (Bellotti 2014; Domínguez and Hollstein 2014). Contextualizing statistical models with qualitative data, we illustrate how individuals "perceive and define their friends, the nature and content of their relationships, and the opportunities and constraints offered by local networks" in the wake of a disaster (Bellotti 2014:77). An important contribution of this work is that respondents derive instrumental and emotional social support from individuals who go unmentioned on the GSS "important matters" network name generator. However, we find both quantitative and qualitative evidence that those mentioned on the name generator constitute an intimate group of significant others who continue to shape individuals' emotional recovery from disaster. This combination of data also suggests that new and latent secondary ties are essential immediately following a crisis, but that continued recovery and distinct support is provided by an intimate group of core ties (Perry and Pescosolido 2012).

While we contribute to understanding the relationship between social networks and psychological distress, our work is not without limitations. First, the RISK sample is not representative of New Orleans residents at the time of the storm. Generalizing from this sample is problematic, particularly given that low-income women in urban areas have smaller, denser networks than average (Domínguez and Hollstein 2014; Fischer 1982). However, understanding the recovery trajectories of this population is particularly important. Young, low-income, mothers of color are especially vulnerable to disasters and their sequelae (Bolin and Kurtz 2018; Fothergill and Peek 2004). They were also most likely to have been displaced by damage from Hurricanes Katrina and Rita (Groen and Polivka 2010), and thus may be most likely to suffer the effects of network dispersion.

Second, we cannot establish causality using the survey data alone. The network name generator was not administered pre-Katrina, so we cannot control for baseline network characteristics to establish that network dispersion resulted from the storm. We also cannot firmly establish whether network dispersion was a cause of PTSD, as we argue, or a result of it. For example, negative social interactions, asymmetrical resource exchange, and residential instability may result in the loss of proximate alters, and this loss rather than distance to remaining alters may increase the likelihood of PTSD (Fredman et al. 2010; King et al. 2006). However, our qualitative analysis supports the directional argument we suggest, as does prior research on network dispersion following a disaster (Bland et al. 1997).

Third, RISK uses the GSS “important matters” name generator, which is susceptible to question-ordering effects (Pustejovsky and Spillane 2009) and topic-alter dependency (Bearman and Parigi 2004). The protocol records respondents’ networks halfway through the survey, immediately after soliciting their experiences during the hurricane and “opinions about life in New Orleans these days.” It could be that respondents interpreted the hurricane or life in New Orleans as “important matters,” and were thus emphasized alters currently residing there. However, there is little support for this in the data. In interviews, respondents are asked “Is there anyone you talk to about the storm?” and often describe persons who do not appear to be alters mentioned on the name generator.

Finally, this and other research suggests the name generator does not capture a full range of relationships. The question solicits small, homogenous, kin-centered networks with strong ties and relatively high density (Marsden 1987), which are hypothesized to provide key emotional support (Burt 1984). It does not capture other weak or peripheral ties that also convey support (Small 2013). Additionally, given the six-month time frame specified in the name generator, we may not capture ties that previously provided support or continue to provide companionship. However, the six-month time frame is intended to increase respondent accuracy and capture ties most essential for stress-buffering in times of crisis, the focus of this chapter (Marin and Hampton 2007:189; Poel 1993:52).

CONCLUSION

Despite limitations, our work builds upon previous research on social relationships and mental health in the post-disaster context by drawing from a unique, longitudinal source of quantitative and qualitative data. We argue that distance to core discussion network members is associated with PTSS five years after Katrina because it decreases feelings of belonging and mattering. While respondents appear to receive social support from post-Katrina relationships, proximity to the intimate ties solicited by the “important matters” name generator facilitates deep ties that buffer against distress. Our work reinforces the need to distinguish between material and emotional dimensions of social support and the importance of elucidating varied and nuanced mechanisms of emotional support inadequately captured by perceived quantitative emotional support scales alone. We also underscore how network characteristics both promote and impair health and highlight the value of mixed methods in studies of social networks and health.

Chapter Five: Conclusion

This dissertation demonstrates that the structure and composition of the core discussion network are associated with health-related resources and outcomes, often independent of summary measures of social integration, support, or engagement. Detailed and rigorously validated summary measures have been the hallmark of research on the importance of relationships for health across the life course, and they continue to lend valuable insights (Berkman et al. 2000; House, Umberson, et al. 1988; Yang et al. 2016). The empirical studies in this dissertation, however, are part of a larger shift toward research on personal networks (Cornwell et al. 2008; Cornwell and Schafer 2016; Smith and Christakis 2008). These data allow researchers to examine more specific measures of individuals' interpersonal environments that are uniquely consequential for their physical and mental health (House 1987; Suzman 2009; York Cornwell and Waite 2009). For example, these data allow researchers not only to understand the effects of network composition such as the availability of kin, but to further understand the effects of network structure and the extent to which alters know and communicate with one another. These data further allow researchers to better understand the mechanisms underlying observed associations, both by making more specific connections to sociological theory and by empirically identifying those mechanisms either through statistical models or mixed method data on specific alters.

The main contributions of this dissertation stem from the investigation of three empirical questions that are central to functional and cognitive health in older age and psychological health after a natural disaster. The first empirical chapter investigates the network dynamics of informal care among older Americans with functional disabilities. There is overwhelming evidence that the population of older Americans with functional disabilities will increase over the next several decades, along with demand for informal care (Ankuda and Levine 2016; Freedman et al. 2013; Freedman and Spillman 2014; He and Larsen 2014; Schulz et al. 2016). The literature on the social determinants of who receives assistance with functional disabilities largely argues that care is a function of the availability of family or household members such as a spouse or adult child, but this research does not explain variation in the likelihood of help within different family or household arrangements (Allen et al. 2014; Choi et al. 2015; Desai et al. 2001; LaPlante et al. 2004). Living alone, for example, is frequently identified as one of the strongest risk factors for unmet need for assistance (Allen et al. 2014; Desai et al. 2001), and this might be due to differences in the personal networks of those living alone, not just differences in access to proximate household members (Klinenberg 2016; Knipscheer et al. 1995). This study shows that while living alone is indeed strongly associated with lower odds of help with both household tasks and personal care, help is also a function of the broader interpersonal environment that is captured by the core discussion network.

This study extends the literature on functional specificity and shows that in order to understand *who gets help and why*, you need to first understand *with what they need help.* However, while much of the research on functional specificity suggests that particular alters are optimally matched to particular forms of support (Perry and Pescosolido 2010; Wellman and Wortley 1990), this study draws only early research to suggest that particular network configurations too are optimally matched to particular forms of support (Burt 2001). Emotional closeness to alters is associated with higher odds of help with personal care tasks like bathing, which requires physical immediacy, intimacy, and trust. However, network density is associated with higher odds of help with more casual household tasks like shopping for groceries, which does not require physical immediacy but may require increased coordination among multiple helpers. While focused on help with functional disabilities, this is also one of the first nationally-representative studies to examine the associations of detailed network measures with routine instrumental support (c.f., Haines et al. 1996; Hurlbert et al. 2000).

The second empirical chapter investigates the association of network composition and structure with cognitive function using newly-available longitudinal data. The number of cognitively impaired people worldwide will triple from 35 million to 115 million by 2050, but already the economic and social costs of mild cognitive impairment and dementia are immense (Hurd et al. 2013; Kim and Schulz 2008; Langa 2015). Social integration is frequently hypothesized to promote cognitive function and prevent mild cognitive impairment and dementia, thus allowing socially integrated older adults to maintain their functional abilities and productive activities (Fratiglioni et al. 2004; Hertzog et al. 2008; Institute of Medicine et al. 2015; Plassman 2010).

This study finds mixed support for the two prevailing theories linking social integration and cognitive function: the cognitive enrichment hypothesis and the stress hypothesis. The cognitive enrichment hypothesis argues that social engagement and the exposure to new ideas and situations that comes with social interactions and activities is directly associated with cognitive function by increasing cognitive reserve (Salthouse 2006; Scarmeas and Stern 2003). The stress hypothesis argues social support and cohesion indirectly affect cognitive function through neuroendocrine and cardiometabolic stress responses (Cacioppo and Hawkley 2009; Fratiglioni et al. 2004). Numerous studies find support for these two hypotheses using summary indexes or scales that collapse multiple measures to capture the broad concepts of social integration, engagement, or support. In this study, I use more specific measures of social engagement and support derived from the core discussion network. I find that network size is positively associated with cognitive function, total communication with alters is negatively associated with cognitive function. These results both confirm and contradict the enrichment hypothesis. I also find average emotional closeness to network alters is positively associated with cognitive function. While the direction of the correlation is consistent with the stress hypothesis, it is not statistically significant and I cannot reject the null hypothesis of no association. These are puzzling findings, and they raise new questions about how best to measure the specific features of relationships that are most crucial for later life cognitive function. For example, it is possible that the "important matters" name generator does not capture the relationships with whom communication is most beneficial for cognitive health, and it is further possible that what matters for cognitive health is not frequency of communication but the quality and content of social interactions and shared activities (Green et al. 2008).

The third empirical chapter addresses a related problem in survey research on relationships and health: the ability to identify substantive mechanisms of observed associations. This chapter draws from collaborative work with Nicole Deterding using mixed method data from the Resilience in Survivors of Katrina (RISK) Project. We investigate the likelihood of post-traumatic stress among women who were living in New Orleans at the time of Hurricane Katrina (Morris and Deterding 2016). This chapter draws from previous work which demonstrates that while networks are crucial conduits of support that buffer against psychological distress after a disaster (Aldrich and Meyer 2015; Barnshaw and Trainor 2007; Galea et al. 2005; Hurlbert et al. 2000; Kaniasty and Norris 1995; Reid and Reczek 2011), network deterioration is common after disasters (Lock et al. 2012). Using survey data on respondents' core discussion networks, we find that the proportion of alters who live far away is associated with the odds of post-traumatic stress. Qualitative interviews reveal that those with distant alters have emotional and instrumental support from alters not named to the core discussion network, which echoes well-known studies by Small and colleagues (2010, 2017; 2016). However, qualitative interviews also reveal that distance to core discussion alters does not undermine access to local ties who provide crucial forms of instrument support, but is rather associated with decreased feelings of belonging and mattering, which are crucial social-psychological resources rarely measured in surveys (Thoits 2011). This finding echoes previous research on the “dark side” of networks and the burden imposed by the expectations of role relationships (Berkman et al. 2000).

The three empirical chapters collectively draw form four theoretical propositions to answer these questions. The first is that network composition is independently associated with health-promoting resources and outcomes. Despite puzzling findings on cognitive function, this proposition is supported by each of the empirical chapters. The second is that relationships are both positively and negatively associated with health through multiple mechanisms, and third is that these mechanisms are not always captured by surveys alone. These two propositions are most directly supported by the findings on post-traumatic stress after Hurricane Katrina. In this study, we are only able to determine that distant core discussion network alters hurt psychological health by decreasing both feelings of role-based mattering and local belonging after examining qualitative interview data merged with the survey-based network measures. The second proposition also undergirds the other two empirical chapters, each of which draws from different mechanisms among those previously outlined in the literature (Berkman et al. 2000; Smith and Christakis 2008; Thoits 2011; Uchino et al. 1996). The fourth proposition extends research on the functional specificity of alters and merges this theoretical tradition with research on the sociology of the body (Perry and Pescosolido 2010; Timmermans and Haas 2008; Wellman and Wortley 1990), stating that network composition and structure matter in ways specific to the outcome or population. This proposition is most clearly supported by the chapter on informal care, which finds that particular network configurations—not just particular alters—are associated with different types of help in ways that theoretically reflect the natures of difficulty and help. The chapter on cognitive function also draws attention to the need for greater research on the *specific biological mechanisms* linking cognitive function to *specific measures of relationships* as captured by different name generators.

Beyond their answers to three important empirical questions and their support for the four motivating propositions, these three empirical chapters of this dissertation also lend insight to two contexts when relationships are more likely to be disrupted but may be especially needed: older adulthood and recovery from a natural disaster. For example, older adults may experience relationship change through a variety of mechanisms, including residential mobility, bereavement such as the loss of their spouse or friends, and transitions into new social roles such as retiree or grandparent (Coe and Zamarro 2008; Cornwell et al. 2009, 2008; Cornwell, Marcum, and Silverstein 2014; Klein Ikkink and Van Tilburg 1999). However, the first two empirical chapters show older adults also need their relationships when coping with their later life transitions, if experiencing a chronic condition or adverse health event for which they are at higher risk, or to prevent such an event (Alwin, Felmlee, and Kreager 2018; Waite et al. 2014). In comparison, individuals exposed to a natural disaster experience relationship change primarily through forced displacement and heterogeneous relocation and return strategies (Aldrich and Meyer 2015). Similarly though, this disruption occurs despite high levels of need. The third empirical chapter demonstrates two ways in which relationships are crucial when psychologically recovering from a disaster: belonging and mattering. However, relationships are also crucial for preparation and more immediate recovery. They provide resources such as information, financial loans, physical assistance preparing or repairing personal property, and transportation during evacuation and return (Haines et al. 1996; Hurlbert et al. 2006; Kaniasty and Norris 1993).

LIMITATIONS AND FUTURE DIRECTIONS FOR RESEARCH

The three empirical chapters call attention to several methodological advances needed to further current understandings of the connections between social relationships and health. In the space below, I highlight five such innovations: (a) additional validity studies of the core discussion network, particularly to understand age differences in its content and predictive value; (b) additional mixed method studies of the core discussion network; (c) network data collected using multiple name generator questions to elicit a wider range of alter types and with multiple name interpreter questions to elicit alter qualities specific to the outcome of interest; (d) network data collected using multiple reporters; and (e) network and health data collected longitudinally over shorter intervals to better understand reciprocal causality.

In recent years, evidence shows measures derived from the core discussion network instrument are associated with health and well-being (e.g., Cornwell 2009a; Cornwell and Laumann 2015; Goldman and Cornwell 2015; Schafer and Koltai 2015a, 2015b; York Cornwell and Waite 2012) and may even be especially predictive of particular health outcomes (Zelner et al. 2012). However, while core discussion network survey instruments attempt to measure more specific and detailed features of relationships compared to summary measures of social integration, they too are critiqued for conceptual ambiguity and for concerns about reliability and validity. At the time of its inception, the "important matters" name generator was thought to solicit intimate relationships most important for well-being (Burt 1984) and to even solicit those relationships particularly important for well-being at older ages specially (Cornwell et al. 2009, 2008). Some studies have found that respondents often name alters to the "important matters" name generator to whom they are not particularly close (Small 2013, 2017), but the question of whether this alleged invalidity of the instrument varies across age groups has yet to be answered empirically. We know that—across cultures and contexts—core discussion networks are smaller at older ages (Cornwell et al. 2008; Harling et al. n.d.; Kalmijn 2012; Marsden 1987; McDonald and Mair 2010), but is this difference due to true differences in the interpersonal environment or due to differences in response styles?

Following from proposition four on functional specificity, additional research is also needed on whether the core discussion network appropriately samples the relationships most crucial to the outcome of interest. The puzzling finding that total communication is negatively associated with change in cognitive function, for example, might be explained by a boundary specification problem: those alters with whom communication is engaging and protective are not captured by the "important matters" name generator. However, to empirically assess whether this is the reason for these puzzling findings, we need to understand what this name generator truly captures in this population.

Mixed method studies incorporating core discussion network data could lend additional insight to both the validity of the name generator and the substantive mechanisms by which identified associations operate. Mixed method studies are those that incorporate at least two kinds of data or at least two means of collecting data. This dissertation demonstrates the value of mixed method research for identifying the particular ways in which seemingly ambiguous measures of network composition or structure matter for health, particularly mixed method research using survey and qualitative interview data. These data allow researchers to understand the meaning respondents ascribe to their relationships and to particular types of interactions or supports (Bellotti 2014; Crossley 2010; Domínguez and Hollstein 2014). For example, in-depth interviews sequential to NSHAP could uncover why older adults do not receive help with particular tasks and whether communication among alters (i.e., density) is associated with the odds of help because of coordination, as emphasized here, or some other reasons. However, another valuable future direction is mixed method research combining network survey instruments with behavioral data from technology use, time diary studies, and mobile sensors or mobile phone administered momentary assessments (Cornwell, Marcum, et al. 2014).

There is a growing literature on the effects of information and communication technologies (ICTs) on both the content of particular relationships and the composition and structure of face-to-face networks (Rainie and Wellman 2014; Wellman 2004). Social media and internet usage, for example, is associated with larger core discussion networks and with a greater likelihood of network turnover (Hampton, Sessions, and Her 2011; Vriens and van Ingen 2018). However, the extent to which social media or other digital networks proxy the interpersonal environments of their members is an open question (Schober et al. 2016), as are the effects social media or other digital networks on health and well-being. By contrast, the effects of these digital networks on taste formation or product adoption are well-identified (Lewis et al. 2008). If representative of interpersonal environments, behavioral data captured from new media could be combined with surveys of users' health. This combination would offer the ability to understand day-to-day fluctuations in social relationships and their association with health-related behaviors, health-promoting resources, and physical and emotional health outcomes. For example, does a short-term increase in communication among alters precede—as theorized in the first empirical chapter—or follow instrumental social support and informal care? Or, expanding from the second empirical chapter: what kinds of daily social interactions in-person and online promote or impair short- and long-term performance on cognitive function instruments?

The incorporation of multiple name generators could add further insight to the types of relationships and network features associated with health behaviors, resources, and outcomes and could further be used to test for cohort differences in the types of alters named to the core discussion network as opposed to other name generators. Recognition of the empirical value of multiple name generators dates to the midcentury (Bott 1957:61), and since then a large number of name generators have been implemented in network survey instruments (Marsden 2006, 2011). The popularization of the core discussion network as a single-item name generator in household surveys is largely driven by time constraints (Burt 1984:294; Cornwell et al. 2009; Marsden 2011). However, works suggests that the core discussion network elicits 40% of total alters named to multiple name generator instruments. This work also suggests that the addition of a few or even one name generator to the core discussion network question substantially decreases bias from the boundary specification problem (Marin and Hampton 2007; Poel 1993). Marin and Hampton (2007) find, for example, that the addition to the question, “Who are the people you really enjoy socializing with?” significantly improves the representativeness of the network. And, early work by Kadushin (1983) and contemporary work by Perry and colleagues (2010; 2018) on the functional specificity hypothesis suggests the addition of just one or two name generators specific to the outcome of interest improves the predictive value of network data for that outcome.

The incorporation of additional name *interpreters*, however, may also contribute to research on the associations between network composition and health. Alter-level information on forms of communication and exchange, for example, would allow for hierarchical models that parse the effects of network characteristics from more classic individual-level measures of particular alters and their relationship to the ego. This would allow researchers to better distinguish between the effects of availability versus the effects of the composition and structure of the network as a whole. This would then allow for stronger claims about the functional specificity of network configurations relative to the functional specificity of alters (Pescosolido, Perry, and Borgatti 2018; Snijders, Spreen, and Zwaagstra 1995; Wellman and Frank 2001).

There is also great value in using multiple reporters to solicit networks (see Marsden 1990:450–53). Forgetting is a frequent problem in survey-based network instruments, even for intimate relations like those thought to be solicited by the core discussion network (Bell, Belli-McQueen, and Haider 2007; Brewer 2000; Marsden 2011). This is especially problematic in samples of older adults where a significant minority have mild cognitive impairment or dementia and in studies following trauma where distress might impede recall. Some studies suggest methods for improving recall by a single reporter, such as encouraging the respondent to check their phone or social media to jog their memory (Hsieh 2015). However, beyond their methodological benefits, multiple reporters in egocentric or sociocentric studies add greater nuance to understandings of asymmetrical exchange, such as that received when coping with functional, cognitive, or psychological health problems. For example, a study using multiple reporters to capture the networks of community-residing older adults with Alzheimer's disease and related dementia finds that the multiple reporters capture a much larger network of informal caregivers and even medical decision-makers than those reporters by the focal adult (Koehly et al. 2015).

Finally, there are urgent needs for greater understanding of the specific biological through which relationships and their mechanisms associate with health and greater understanding of the directions of these associations. Both these needs would be served by data collected more frequently. For as long as researchers have posited that relationships affect health, researchers have also posited the reverse: that relationships change in response to health (Haas, Schaefer, and Kornienko 2010; House, Landis, and Umberson 1988; Schafer 2013b; Shaw et al. 2007; Smith and Christakis 2008; Wong and Hsieh 2017). In truth, there is likely a great deal of reciprocal causality (Thomas 2011), which is difficult to capture in longitudinal studies with multi-year time lags. For example, Cornwell and Laumann (2015) find that core discussion network growth over five-years is associated with health, but Small et al. (2015) find core discussion networks change on a monthly rather than a yearly basis. This is also problematic when trying to establish etiologic periods, which is essential for understanding biological pathways (Bielak 2010; Cohen 1988). How do you establish either causal order or etiologic period if the process you hope to observe has occurred multiple times in between observation periods?

PRACTICAL IMPLICATIONS

It follows from this dissertation and the literature to which it contributes that population health can be improved by introducing practices, programs, and policies that promote and protect the benefits of social relationships while also reducing strain stemming from those relationships.

However, researchers are only beginning to understand the effectiveness of interventions for social relationships, despite decades of research. I briefly outline four approaches to interventions on social relationships: (1) local, state, and national policies; (2) professional or peer-led psychological treatment; (3) physician-led interventions; and (4) digital nudges.

Umberson and Montez (2010) outline several principles policy-makers should adhere to in order to improve population health, including: (a) publicly promote the benefits of social relationships; (b) support programs that reduce social isolation; (c) avoid programs and policies that increase family caregiving burden; and (d) prioritize public support for populations most at risk for social isolation or caregiving burden. Several policies and programs have been lauded for adhering to these principles and for their positive effects on both relationships and health inequalities. For example, Meals on Wheels America aims to simultaneously address social isolation and hunger among older adults living in the community by partnering with volunteers to visit and deliver nutritious meals. However, other policies and programs adhere to some of these principles while failing to adhere to others. The U.S. Family and Medical Leave Act (FMLA), for example, has been lauded for easing family caregiving burdens but has been criticized for not benefiting those who most in need. FMLA allows eligible employees to take unpaid, protected leave for family and medical reasons such as the birth of a child or a serious health condition for which the employee or their spouse, parent, or child requires care (U.S. Department of Labor). However, FMLA is often inaccessible to lower wage workers due to employment eligibility rules. There is clearly more work to be done, not only in identifying effective policies that meet the principles outlined by Umberson and Montez (2010), but also measuring their effects on network composition and structure. There is, after all, some evidence that suggests more generous policies undermine support by easing normative obligations (Djundeva, Dykstra, and Fokkema 2019; Dykstra 2018).

While policies with positive externalities are the broadest approach and the fastest growing area of research, the most common intervention approach in the scientific literature currently is support groups, workshops, or personal and family sessions with professional psychologists or social workers. This approach aims to build personal social skills and self-efficacy in addition to team-based problem solving. This approach theorizes that these psychological treatments both directly and indirectly increase instrumental and emotional social support and consequently improve health. However, randomized control trials have found mixed effects, demonstrating that while some populations experience beneficial effects, others experience none or even detrimental effects (Berkman et al. 2003; Ertel, Glymour, and Berkman 2009; Helgeson et al. 2000; Hogan, Linden, and Najarian 2002). Meta-analyses show similar findings to those from analyses of the associations between summary measures of social integration and health: it appears to help, but *what exactly* is helping *what* remains unclear (Hogan et al. 2002).

There are two fledging but promising areas of research on relationship interventions for health promotion and recovery: digital nudges and physician-administered surveys. Numerous information and communication technologies (ICTs) ease barriers to the formation of social relationships and fulfillment of social roles, including but not limited to social media. For example, several web and mobile products are designed to disseminate information and coordinate informal care among network members of a person coping with a health problem. These products use digital nudges to lower barriers to asking for and receiving assistance and web-based tools to reinforce obligations (Goyer 2017). Additionally, other ICTs such as community email newsletters and group forums on social media web and mobile products have also been to found to successfully provide “digital nudges” to encourage more general prosocial behaviors, including more frequent social interactions, participation in formal group activities, and accepting of assistance (Grates et al. 2019).

The last intervention approach is less broad than the others, but likely highly effective. Physicians increasingly recognize the important of network structure and composition for health. Dhand et al. (2016) find patients with higher density networks after stroke had better recovery, and they advise physicians to administer network surveys to understand potential deterrents to recovery. Aside from informing the physician about potential social risk factors though, these surveys could further facilitate doctor-patient communication about how relationships might help or even hurt and how to make a support plan for recovery or disease management (Street et al. 2009). However, additional research on the treatment effects of these questionnaires and the conversations that follow is needed.

Supplementary Material

APPENDIX A: WHO GETS HELP?: LIVING ARRANGEMENTS, SOCIAL NETWORK STRUCTURE, AND HELP WITH ACTIVITIES OF DAILY LIVING IN LATER LIFE

The two supplementary analyses presented here are intended as additional robustness checks and to contextualize the main results. The first supplementary analysis includes logistic regression models for each activity separately, rather than as two indexes. This is a robustness check of whether the main findings hold across activities. The second supplementary analysis examines who helps respondents most often with any of the activities with which they report difficulty and help. I first examine the role relationships of helpers to the respondents by whether or not the respondents are living alone. I then estimate alter-level conditional logistic regressions predicting, among respondents receiving some help, which alter helps. This model is a robustness check to determine whether degree centrality is associated with caregiving above and beyond role relationship and residence.

Collectively, these supplementary analyses confirm that social network measures are associated with the likelihood of help and that position in the network is associated with providing help above and beyond role-relationship and quality of relationship with the recipient. These supplementary analyses also suggest that further research is needed to better understand help with different activities and to understand the relative contribution of particular relationships compared to the network as a whole.

Supplementary Analysis of Help with Each Activity

Table A.1 displays the odds ratios from the logistic regressions of help with each IADL. Controlling for the level of difficulty the respondent has with the activity, this table shows that living alone is strongly associated with not receiving help preparing meals (*OR*=0.07 [*CI*=0.02,0.22]), shopping for food (*OR*=0.11 [*CI*=0.03,0.46]), or using the telephone (*OR*=0.14 [*CI*=0.03,0.65]). This suggests that help with these tasks is in part a matter of convenience and availability of potential helpers in the household. Help managing money is very strongly positively associated with being married or living with a partner with whom the respondent shares household finances (*OR*=5.67 [*CI*=1.62,19.85]).

Consistent with the main results in Table 2.4, a standard deviation change in social network density is strongly positively associated with the odds of help with almost all tasks, including: managing money (*OR*=1.48 [*CI*=0.97,2.28]); preparing meals (*OR*=1.50 [*CI*=1.04,2.16]); light housework (*OR*=1.51 [*CI*=1.00,2.29]); taking medications (*OR*=2.45 [*CI*=0.90,6.65]); and shopping for food (*OR*=2.99 [*CI*=1.64,5.42])**.** Additionally, increases in the proportion with whom egos discuss health matters is associated with a statistically significant increase in the odds of help with: shopping for food (*OR*=1.63 [*CI*=0.98,2.69]); taking medications (*OR*=1.88 [*CI*=1.03,3.42]); preparing meals (*OR*=2.05 *CI*=1.17,3.59]); and using the telephone (*OR*=2.23 [*CI*=1.17,4.23]).

Table A.2 displays the odds ratios from the logistic regressions of help with each ADL. This table shows that the odds of help are largely driven by the level of difficulty the respondent has with the activity and their overall physical health. This is unsurprising given the community-dwelling population for whom independence is dependent on the ability to accomplish these fundamental personal care activities. However, even controlling for the level of difficulty with the activity, living alone is strongly negatively associated with the odds of help eating (*OR*=0.03 [*CI*=0.00,0.27]) and transferring (*OR*=0.16 [*CI*=0.04,0.63]) and being married or living with a partner is strongly positively associated with the odds of help dressing (*OR*=2.71 [*CI*=1.15,6.40]). Average closeness is only statistically significantly associated with the odds of receiving help bathing once controlling for the overall level of difficulty the respondent has with bathing (*OR*=1.51 [*CI*=1.02,2.23]). This may be driven by the uniquely intimate nature of the activity, which is the only activity in the index for which help by definition requires full nudity on the part of the recipient and likely bodily contact between recipient and provider. Asking for and receiving help with this task may thus be especially dependent on intimacy of the network.

Taken together, these models largely support those analyzing the I/ADL indexes. However, I caution that the sample sizes for these analyses are quite small, limiting the statistical power of the analyses, which is reflected in the size of many of the confidence intervals. I also caution that more research is needed using alternative survey data on the type of help received with each task and from whom, not only whether help is received. This type of data would allow for greater understanding of the distribution of help among those who are unmarried or are living alone and whether there are particular tasks with which egos receive help from outside their core discussion network.

Table A.1 Odds Ratios from Logistic Regressions of Help with 6 Instrumental Activities of Daily Living (IADLs)

Variable	Prepare Meals	Take Medications	Manage Money	Shopping for Food	Light Housework	Using the Telephone
Family and Household Characteristics						
Married or Living with a Partner	0.7	2.36	5.67**	0.6	1.04	1.01
	[0.18,2.64]	[0.36,15.33]	[1.62,19.85]	[0.13,2.81]	[0.32,3.45]	[0.19,5.36]
Living Alone	0.07***	0.23	0.99	0.11**	0.4	0.14*
	[0.02,0.22]	[0.04,1.45]	[0.32,3.06]	[0.03,0.46]	[0.13,1.24]	[0.03,0.65]
Social Network Characteristics						
Size	1.13	1.46	0.76^{+}	0.85	1.21	1.33
	[0.77,1.67]	[0.93,2.31]	[0.55,1.05]	[0.56,1.27]	[0.95,1.54]	[0.84,2.12]
Standardized Proportion Kin	0.97	0.76	1.12	0.32**	0.93	1.45
	[0.56,1.67]	[0.31,1.83]	[0.66,1.89]	[0.16,0.66]	[0.61,1.42]	[0.49,4.24]
Standardized Average Closeness	1.08	0.86	1.39	0.71	0.9	0.61
	[0.70,1.68]	[0.48,1.54]	[0.80,2.39]	[0.34,1.46]	[0.57,1.42]	[0.26,1.43]
Standardized Proportion Discuss Health	2.05*	1.88*	0.84	1.63^{+}	1.36	2.23*
	[1.17,3.59]	[1.03,3.42]	[0.47,1.52]	[0.98,2.69]	[0.93,2.01]	[1.17,4.23]
Standardized Density	1.50*	2.45^{+}	1.48^{+}	2.99***	1.51*	1.59
	[1.04,2.16]	[0.90,6.65]	[0.97,2.28]	[1.64,5.42]	[1.00,2.29]	[0.86,2.94]
Health Characteristics						
Level of Difficulty ((Reference: Some)						
Much Difficulty with Activity	3.16*	8.36*	3.95*	6.46^{+}	1.28	5.73^{+}
	[1.11,8.96]	[1.39,50.34]	[1.26,12.38]	[0.85,49.01]	[0.41,3.99]	[0.80,40.90]
Unable to Do Activity	6.35**	4.08	76.85**		8.11**	
	[2.10,19.18]	[0.48,34.80]	[4.95,1193.16]		[1.76,37.39]	
Observations	291	112	219	237	369	111

Note: Models control for age, gender, education, self-rated physical health, use of walking equipment, and a depression score above the cutoff. 95% confidence intervals are in brackets. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.00$

Table A.2 Odds Ratios from Logistic Regressions of Help with 5 Activities of Daily Living (ADLs)

Variable	Bathing	Dressing	Eating	Transferring	Toileting
Family and Household Characteristics					
Married or Living with a Partner	1.71	2.71*	0.23	1.74	1.27
	[0.65,4.51]	[1.15,6.40]	[0.02,2.43]	[0.42,7.25]	[0.38,4.21]
Living Alone	0.46	0.47	0.03**	0.16*	0.21
	[0.16,1.31]	[0.17,1.30]	[0.00,0.27]	[0.04,0.63]	[0.03,1.50]
Social Network Characteristics					
Size	1.04	0.93	0.85	0.86	0.86
	[0.83,1.30]	[0.70,1.23]	[0.51,1.41]	[0.66,1.13]	[0.61,1.21]
Standardized Proportion Kin	1.26	1.05	1.44	1.43	1.28
	[0.75,2.13]	[0.73,1.50]	[0.56,3.75]	[0.85,2.40]	[0.78,2.12]
Standardized Average Closeness	1.51*	1.16	0.8	0.9	1.28
	[1.02,2.23]	[0.70,1.92]	[0.31,2.07]	[0.53,1.52]	[0.78,2.12]
Standardized Proportion Discuss Health	1.29	1.04	2.12^{+}	1.34	1.22
	[0.74,2.26]	[0.74,1.45]	[0.93,4.87]	[0.86,2.10]	[0.68,2.17]
Standardized Density	0.92	1.08	1.48	0.77	0.81
	[0.66,1.29]	[0.73,1.60]	[0.54,4.01]	[0.43,1.36]	[0.44,1.48]
Health Characteristics					
Level of Difficulty (Reference: Some)					
Much Difficulty with Activity	6.29*	5.90***	14.34**	2.27	10.73***
	[1.53,25.96]	[2.59,13.44]	[2.72,75.61]	[0.66,7.78]	[2.97,38.80]
Unable to Do Activity	25.50***	7.10***		4.56	
	[5.10,127.56]	[2.37,21.28]		[0.43,48.01]	
Observations	227	346	88	229	222

Note: Models control for age, gender, education, self-rated physical health, use of walking equipment, and a depression score above the cutoff. 95% confidence intervals are in brackets. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.00$

Supplementary Analysis of Who Helps

I also conduct a secondary analysis of who helps respondents among those who report any difficulty and any help with I/ADLs. After the I/ADL indexes, the interviewers asked respondents to name one person who helps most often with *any or all* of the activities with which they have difficulty. Interviewers then asked about the respondent's relationship to the person who helps most often and if they named them to their network. The large majority of helpers were named to the network (95.5%, *N*=450), allowing me to examine additional characteristics of those helpers and their relationship with the respondent relative to other alters in the network.

I use the network name interpreters to identify the individual-level properties of each alter in addition to the properties of their relationship to the respondent and their structural position in the network. Individual-level alter properties include gender, whether they live with the respondent, and role relationship to the respondent. Alter- respondent tie-level properties include whether each alter communicates with the respondent every day and how emotionally close he or she is to the respondent. I measure the structural position of each alter in the network using normalized degree centrality. I calculate normalized degree centrality as the number of ties between an alter and the other alters in the network divided by the number of possible ties to other alters in the network (k-1). Normalized degree centrality was standardized for ease of interpretation.

I use an alter-level conditional logistic regression model predicting *which* alter provides help most often with either IADLs or ADLs among respondents with reported difficulty on either index. I use cluster-robust standard errors at the respondent-level and again use person-level weights to adjust for differential selection and non-response. As already noted, this is a robustness check that examines whether relationship quality and structural position in the network, measured using normalized degree centrality, are associated with being the person who helps above and beyond their role relationship with the respondent. However, because respondents could only name one primary helper for all activities, these supplementary analyses cannot sufficiently test the overarching hypotheses that the particular network characteristics associated with help differ for IADLs versus ADLs, or the hypothesis that network characteristics moderate the effect of living alone.

Table A.3 displays the tabulation of the role relationships of the persons who help most often with I/ADLs by whether the respondent lives with others or alone. Confirming previous research, this table shows that regardless of living arrangement, respondents get help most often from a close relative. However, respondents living with others typically live with and receive help most often from a spouse while respondents living alone are more likely to receive help from a child, friend, or paid housekeeper or home health provider. I confirm these differences using a chi-square test.

Table A.4 shows the results from the conditional logistic regression model predicting the odds an alter is the person in the network who helps most often. This model supports previous findings that the person who provides help most with I/ADLs is more likely to be female, to live with the respondent, to be a spouse or other family member, and to frequently communicate with the respondent, and to be emotionally close to the respondent. This model further confirms that helpers have a higher normalized degree centrality (*OR*=2.80, *CI*=1.82,4.31), all else held constant. Because the question is asked as who helps with any activity, I cannot parse whether IADL helpers differ from ADL helpers.

Table A.3 Descriptive Statistics of Persons Who Help Most Often among Respondents Receiving Help with either ≥ 1 Household Tasks (Instrumental Activities of Daily Living [IADLs]) or ≥ 1 Personal Care (Activities of Daily Living [ADLs])

	With Others		Alone		Total	
	%	No.	%	No.	%	No.
Spouse or Romantic Partner	59.17	229	2.19	3	44.27	232
Child or Step-Child	26.36	102	48.91	67	32.25	169
Grandchild	2.84	11	3.65	5	3.05	16
Sibling	2.07	8	3.65	5	2.48	13
Other Family	3.62	14	5.84	8	4.20	22
Friend	1.55	6	13.14	18	4.58	24
Housekeeper or Health Provider	1.55	6	13.14	18	4.58	24
Other Relation	2.84	11	9.49	13	4.58	24
Total	100.00	387	100.00	137	100.00	524

Table A.4 Odds Ratios from Conditional Logistic Regression of the Alter Who Provides Help Most Often among Egos Receiving Help with either ≥ 1 Instrumental Activities of Daily Living (IADLs) or ≥ 1 Activities of Daily Living (ADLs)

Variable	Model 1
Female (Reference: Male)	2.22^{***}
	[1.48,3.35]
Lives with Ego (Reference: Lives Elsewhere)	3.97^{***}
	[1.94,8.12]
Relationship to Ego (Reference: Spouse)	
Child or Step-Child	0.66
	[0.35,1.25]
Grandchild	0.22^{**}
	[0.07,0.66]
Sibling	0.16^{***}
	[0.05,0.47]
Other Family	0.5
	[0.18,1.40]
Friend	0.34^{*}
	[0.12,0.98]
Housekeeper or Home Health Provider	2.52
	[0.51,12.58]
Other	0.74
	[0.22,2.49]
Talks to Ego at Least Every Day (Reference: Talks to Ego Less than Every Day)	6.20^{***}
	[3.52,10.94]
Emotional Closeness (Reference: Not Close)	
Somewhat Close	0.26
	[0.02,3.20]
Very Close	0.7
	[0.05,9.31]
Extremely Close	1.31
	[0.11,16.38]
Standardized Normalized Degree	2.80^{***}
	[1.82,4.31]
Pseudo *R*-Squared	0.65
Alters	2065
Egos	465

Note: Results use cluster robust errors adjusted at the ego-level. 95% confidence intervals are in brackets. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

APPENDIX B: DO SOCIAL NETWORKS "GET INTO THE HEAD"?: SOCIAL NETWORKS AND COGNITIVE FUNCTION IN LATER LIFE

This appendix provides additional information on the NSHAP cognitive function measure. For even greater detail, see Shega et al. (2014), Kotwal et al. (2015), or Dale et al. (2018). I also present the results from lagged dependent variable models for three of the eight cognitive domains included in the composite measure: memory; executive function; and attention.

Description of the Survey-Based Adaptation of the Montreal Cognitive Assessment

As noted in the main text, NSHAP investigators developed a survey-based adaptation of the Montreal Cognitive Assessment (MoCA-SA). Using a pilot test, NSHAP investigators optimized the MoCA-SA for administration by non-medical personnel in a time-limited national survey. They selected specific items and revised the order and wording to minimize respondent burden (Kotwal et al. 2015; Shega et al. 2014).

The MoCA-SA assesses eight domains of function using 18 items, which are summarized in Table B.1 (Dale et al. 2018; Kotwal et al. 2016; Shega et al. 2014). *Orientation* is measured using month and day (1 point each). *Naming* is measured using ability to identify a picture of a rhinoceros (1 point). *Executive function* is measured using Trails-B (1 point). *Visuospatial skills* are measured using a clock draw (3 points total). *Memory* is measured using delayed recall (5 points total). *Attention* is measured using three activities: forward digits (1 point), backward digits (1 point), and serial 7s (3 points). *Language* is measured using sentence repetition (1 point) and phonemic fluency (1 point). *Abstraction* is measured using similarity between a watch and ruler (1 point).

Table B.1 displays unweighted descriptive statistics for the MoCA-SA and converted MoCA scores, as well as for each of the items. The sample performs well on the MoCA at W2 with a mean of 23.06 (*SD*=4.17), which decreases to 22.08 (*SD*=4.61) at W3. The largest change between the waves is within the visuo-construction, executive function, and language domains, decreasing from 56% of the sample to 47% of the sample scoring correctly for drawing the hands of the clock, from 62% of the sample to 54% of the sample scoring correctly on the Trails-B activity, and from 66% of the sample to 58% of the sample scoring correctly on the phonemic fluency task.

To illustrate sample change in cognitive function between waves, Table B.2 displays the cross-tabulation of cognitive function at W2 and W3. This tables shows that the sample is more likely to have dementia at W3 and that while many improve their cognitive function status between waves, more decline, and many more stay the same, with nearly half classified as having normal function at either wave. Figure B.1 visualizes the growth in cognitive impairment over time, displaying the weighted percentages of persons screening for MCI or dementia at W2 compared to W3.

Table B.1 Unweighted Montreal Cognitive Assessment (MoCA) Scores in Analytic Sample

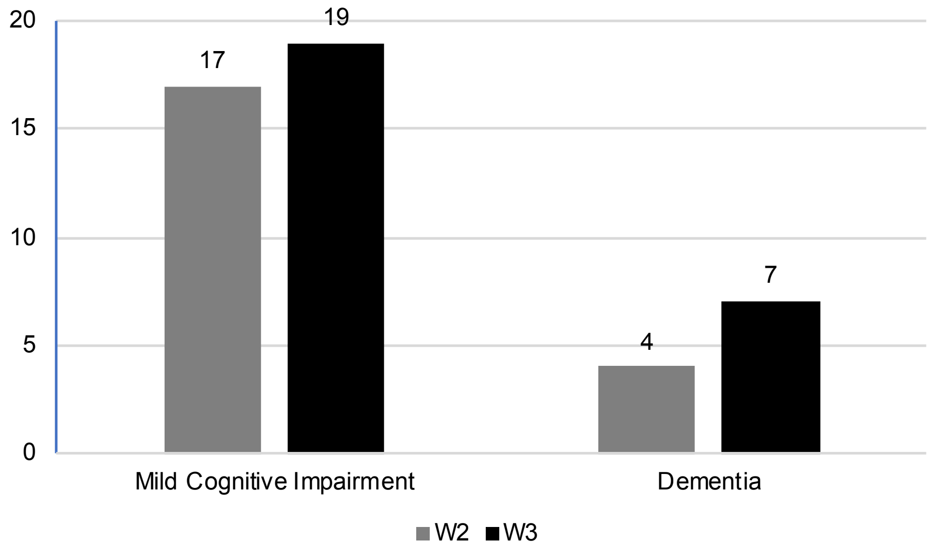
Item	Description	W2 Mean	W3 Mean
Summary Scores			
MoCA-SA	See main text.	14.66	13.85
MoCA	6.83+(1.14×MoCA-SA)	23.55	22.62
MoCA Change Score	MoCA W3 – MoCA W2		-0.92
Orientation			
Month	"Tell me the date today. First, tell me the month." Proportion correct.	0.99	0.98
Date	"Now, tell me the exact date." Proportion correct.	0.94	0.89
Naming			
Rhinoceros	"Now, I want you to name this animal." [Rhinoceros] Proportion correct.	0.85	0.84
Visuo-construction			
Clock Contour	"Now, I'd like you to draw a clock. Put in all the numbers and set the time to 10 after 11." Proportion correctly drew circular watch face.	0.98	0.95
Clock Numbers	Proportion correctly placed the numbers on the clock.	0.80	0.84
Clock Hands	Proportion drew minute and hour hands at the correct time and proportionate length.	0.58	0.49
Executive Function			
Trails-B	"Please draw a line, going from a number to a letter in increasing order." Proportion correct.	0.65	0.56
Attention			
Forward Sequence (5 Numbers)	"Now, I am going to say some numbers and when I am through, repeat them to me exactly as I said them." Proportion correct.	0.89	0.89
Backward Sequence (3 Numbers)	"Now I am going to say some more numbers, but when I am through, I want you to repeat them to me in the backwards order." Proportion correct.	0.82	0.80
Serial 7s, 0 Correct	"Now, starting with 100, I would like you to subtract 7 and then keep counting down by 7." Proportion scoring 0 correct.	0.07	0.10
Serial 7s, 1 Correct	Proportion scoring 1 correct.	0.10	0.11
Serial 7s, 2-3 Correct	Proportion scoring 2-3 correct.	0.22	0.23
Serial 7s, 4-5 Correct	Proportion scoring 4-5 correct.	0.62	0.56
Language			
Sentence Repetition	"I am going to read you a sentence. Repeat it after me, exactly as I say it." Proportion correct.	0.65	0.63
Phonemic Fluency	"Now, tell me as many words as you can think of that begin with the letter F." Proportion naming > 10 words in 1 minute.	0.52	0.47
Abstraction			
Similarity between Watch/Ruler	"For this exercise, tell me how a ruler and a watch are alike?" [Measuring instruments.] Proportion correct.	0.61	0.58
Memory			
Delayed Recall, "Face"	"I read a list of words to you earlier, which I asked you to repeat and remember. Tell me as many of those words as you can remember." Proportion repeated "face."	0.57	0.52
Delayed Recall, "Velvet"	Proportion repeated "velvet."	0.68	0.60
Delayed Recall, "Church"	Proportion repeated "church."	0.65	0.61
Delayed Recall, "Daisy"	Proportion repeated "daisy."	0.46	0.39
Delayed Recall, "Red"	Proportion repeated "red."	0.64	0.56

Table B.2 Unweighted Cross-Tabulation of Cognitive Function Classification using Montreal Cognitive Assessment (MoCA) Score Cut-points in Analytic Sample

	W3 Cognitive Function				
W2 Cognitive Function	Normal	Mild Cognitive Impairment	Dementia	Total	Statistic
Normal	675	164	34	873	*Frequency*
	77.32	18.79	3.89	100.00	*Row %*
	88.01	51.57	19.43	69.29	*Column %*
Mild Cognitive Impairment	86	123	66	276	*Frequency*
	31.16	44.93	23.91	100.00	*Row %*
	11.21	38.99	37.71	21.90	*Column %*
Dementia	6	30	74	111	*Frequency*
	5.41	27.03	67.57	100.00	*Row %*
	0.78	9.43	42.86	8.81	*Column %*
Total	767	318	175	1,258	*Frequency*
	60.87	25.24	13.89	100.00	*Row %*
	100.00	100.00	100.00	100.00	*Column %*

Note: $\chi^2 = 500.50$; $p < 0.000$

Figure B.1 Weighted Percentages Screening for Mild Cognitive Impairment (Montreal Cognitive Assessment [MoCA] Score 18-22) or Dementia (MoCA Score < 18), by Wave



Note: $\chi^2 = 554.51$; $p < 0.000$

Lagged Dependent Variable Model across Domains

Research suggests that the association of social engagement with function and decline holds for some cognitive domains—including speed of processing, attention, and memory (Hughes et al. 2008)—but does not hold across all (Brown et al. 2012; Gow, Bielak, and Gerstorf 2012; Sörman et al. 2017). However, the NSHAP investigators and their collaborators caution that the individual items in the cognitive function measure were designed and evaluated for their performance within the full evaluation and not as individual items and so domain-specific results should be interpreted with due caution (Shega et al. 2014:S174).

Table B.3 displays the results from four models: the main lagged dependent linear regression model of cognitive function from the main text, which is included here for ease of comparison; a lagged dependent Poisson regression model of delayed recall of five words; a lagged dependent logistic regression model of scoring correctly on the Trails B measure (coefficients displayed), and a lagged dependent logistic regression model of scoring the highest possible score on the serial 7s exercise (coefficients displayed). The results are mixed, but the findings for the serial 7s exercise, which is part of the attention domain, are similar to the those for the full cognitive function measure. This is consistent with prior research of which domains are associated with social integration (Hughes et al. 2008).

Table B.3 Lagged Dependent Variable Regressions of W3 Cognitive Function (Montreal Cognitive Assessment Score [MoCA]), W3 Memory (5-Word Delayed Recall), W3 Executive Function (Trails B Test Correct), and W3 Attention (4-5 Serial 7s Correct)

W3 Cognitive Function Measure	MoCA	Memory	Executive Function	Attention
Model	OLS	Poisson	Logit	Logit
W2 Cognitive Function Measure	0.58^{***}	0.14^{***}	1.20^{***}	1.20^{***}
	[0.51,0.65]	[0.10,0.17]	[0.84,1.56]	[0.87,1.53]
Sociodemographic Characteristics				
Age	-0.12^{***}	-0.02^{***}	-0.05^{**}	-0.03^{*}
	[-0.15,-0.09]	[-0.03,-0.01]	[-0.08,-0.02]	[-0.05,-0.01]
Female	0.47^{**}	0.14^{***}	0.34^{+}	-0.29
	[0.19,0.76]	[0.08,0.19]	[-0.06,0.74]	[-0.72,0.15]
Married	0.08	0.03	0.13	0.03
	[-0.36,0.52]	[-0.04,0.10]	[-0.26,0.52]	[-0.40,0.46]
Education (Reference: Less than High School)				
High School or GED	0.5	0.02	0.59	1.04^{*}
	[-0.19,1.19]	[-0.14,0.19]	[-0.41,1.59]	[0.19,1.88]
Some College or Technical	0.82^{*}	0.11	0.95^{*}	1.33^{***}
	[0.16,1.48]	[-0.07,0.29]	[0.11,1.80]	[0.65,2.01]
BA or More	1.58^{***}	0.19^{+}	1.45^{**}	1.51^{***}
	[0.72,2.44]	[-0.01,0.38]	[0.56,2.35]	[0.82,2.20]
White, Non-Hispanic	0.66^{**}	0.06	0.77^{***}	0.49^{*}
	[0.26,1.06]	[-0.02,0.14]	[0.39,1.16]	[0.01,0.96]
Health Characteristics				
Poor/Fair Health	-0.60^{*}	-0.1	-0.24	-0.32^{+}
	[-1.11,-0.09]	[-0.22,0.03]	[-0.62,0.13]	[-0.69,0.06]
Instrumental Activities of Daily Living	-0.87	-0.15	0.24	-0.49
	[-2.22,0.47]	[-0.38,0.07]	[-0.48,0.96]	[-1.36,0.38]
Depressive Symptomology	-0.38	-0.01	-0.34	0.12
	[-0.94,0.19]	[-0.12,0.10]	[-0.90,0.22]	[-0.37,0.61]
Social Support and Network Characteristics				
Standardized Average Social Support	-0.1	-0.01	-0.09	-0.05
	[-0.33,0.14]	[-0.05,0.03]	[-0.31,0.12]	[-0.26,0.16]
Size	0.48^{*}	0.04	-0.11	0.49^{*}
	[0.07,0.88]	[-0.05,0.12]	[-0.75,0.54]	[0.06,0.92]
Standardized Average Communication	-0.59^{*}	-0.07	0.17	-0.60^{*}
	[-1.09,-0.10]	[-0.17,0.03]	[-0.54,0.88]	[-1.14,-0.05]
Standardized Average Closeness	0.15	0.01	0.04	0.05
	[-0.04,0.35]	[-0.02,0.04]	[-0.20,0.27]	[-0.19,0.28]

Note: 1258 observations. Models are adjusted for multistage sampling and weights account for the probability of selection and non-response at W2 as well as the inverse probability of attrition between W2 and W3. 95% confidence intervals in brackets. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.000$

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