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Social Networks, Social Relationships, and Their Effects on the Aging Mind and Brain

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Key Points

- Increasing evidence shows the behavioral, perceptual, and biological pathways by which social relationships and social networks positively impact health outcomes, including those for the aging mind and brain
- The facilitation of healthy aging, in turn, has been shown to increase social participation among older adults through community-based interventions and contributes to societal well-being.

“Healthy Aging” as Physical, Mental, and Social Well-Being

The World Health Organization (WHO) defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”¹ This definition emphasizes the importance of quality of life and social well-being and highlights the need to consider the impact of the social environment on human health. Public health interventions that target both the individual and his or her social environment embrace a holistic, ecological perspective that is very important for healthy aging. The ecological model posits that changes in the social environment will produce changes in the individual by addressing not only individual factors, but also interpersonal, organizational, community, and policy factors that support individual behaviors.² With respect to aging, active engagement in social settings, or the social environment, is an important factor leading to productive and “successful aging.”³ Although the process of aging is inevitable, epidemiological studies clearly show that the diseases and disabilities often associated with aging are not. Many of these “aspects of usual aging can be avoided or reversed”^{4,5} which suggests “chronological age per se is a relatively weak explanatory variable in assessing the prospects of continuing to age well in later life.”⁶ Social relationships affect human immune function,^{7–9} brain activity,¹⁰ and stress response.¹¹ Therefore, attempts have been made to enhance social integration among older adults,¹² exemplified by the inclusion of “active ageing” as a WHO goal for policy and program formulation.¹³ The WHO defines “active ageing” as “participation in social, economic, cultural, spiritual and civic affairs, not just the ability to be physically active or participate in the labour force.”¹³ By enabling older adults to remain productive and fully engaged, our society will continue to benefit from the resources this rapidly growing segment of the population provides.

The impact of the social environment and relationships on individual well-being is greater in older age versus younger.^{14,15} Support provided by family and friends becomes increasingly important especially when age-related diseases and disability occur. Nevertheless, age-related physical and functional decline can limit individuals' ability to maintain social relationships. Thus, it is important that we understand social network and relationship factors that influence, and are influenced by, the well-being of older adults. Such an understanding can enhance the development of interventions to prevent or delay the onset of major chronic conditions and to better support those experiencing physical and cognitive difficulties. As the number of older adults with moderate to severe disability continues to increase,¹⁶ consideration of social support networks and relationships becomes vital to facilitating healthy aging. In this chapter we introduce the concepts of social networks and social relationships, review the literature on their relationships to health, and present current research and programs addressing social factors and cognitive health. In addition, we discuss the implications of aging-related illness, specifically dementia, on familial social network systems and conclude with a discussion of implications for research and practice.

Toward Defining Key Terms and Concepts: Social Networks and Social Relationships

Studies investigating social relationships have evolved in many different disciplines. In the field of public health, terms such as 'social integration,' 'social networks,' 'social support,' and 'social engagement' have been introduced in studies investigating the associations between social factors and human health. *Social integration* has been defined as the existence of relationships which allow individuals to fulfill social roles either intentionally or unintentionally.^{17,18} This concept has been used to investigate individuals' social connectedness within society, and an impressive array of evidence indicating an association between social integration and health has been amassed. However, social integration has also been identified as one of the least understood constructs of social relationships¹⁷ as different studies have evaluated social integration in various ways. The *social network* has been defined as "linkages between people."¹⁹ and provides context for the exchange of social resources (e.g., support, information) and connections. Social networks can be examined by looking at their *compositional* and *functional* characteristics.

The *compositional* characteristics of social networks include network size, density, and homogeneity of the network members, and are expressed in terms of the network system as a whole. Some of the interactional, or dyadic, characteristics which concern the relationships between network members, including reciprocity of social exchange, frequency of contact with network ties, intensity of emotional closeness, and durability of relationships in terms of network stability,^{17,19} also give rise to the network composition. Five key *functional* characteristics of social networks have been identified in the field: social support, social engagement or companionship, social influence, social undermining, and social capital.^{17,19} Of those, social support and social engagement are most pertinent to topics of the aging mind and brain. *Social support* is defined as "aid and assistance exchanged through social relationships" that is intended by the sender to be helpful¹⁹ and further categorized into four main types: emotional ("expression of empathy, love, trust, and caring"), instrumental ("tangible aid and services"), informational ("advice, suggestions, and information"), and appraisal support ("information that is useful for self-evaluation").^{19,20} Some social relationships may not involve the exchange of social support, but exist for a "purely pleasurable interaction"²¹ that facilitates *social engagement*. The existence of these ties allows individuals to take social roles and provides them with "a sense of value, belonging, and attachment".¹⁷

The impact of social support on health and well-being has been studied to a much greater extent than the impact of social network characteristics viewed more broadly.¹⁷ In a convoy model introduced by Antonucci, personal and situational characteristics are thought to influence social

network structures and functions as well as network adequacy, and all of these factors impact individuals' well-being.²² For example, social networks are influenced by larger social contexts such as the community and neighborhood and norms of reciprocity or social trust that exist within them, sometimes referred to as *social capital*. The way social networks influence individuals can be partly determined by community resources and the network's ability to access these resources and contacts.²³ Evidence suggests that strong personal social networks consisting of family and neighbors can help reduce negative impacts of urban segregation among individuals living in poverty.²⁴ Cohen and Wills²⁵ reviewed two ways social relationships influence health: "stress-buffering" where social networks are thought to provide interpersonal resources to cope when individuals face stressful events, and "main effects" where social networks provide a context in which individuals can be socially engaged, or the degree of one's integration in a large social network.²⁵ Evidence suggests that these two pathways are likely to coexist.²⁶ In the context of the aging mind and brain, it is beneficial to consider these various types of network characteristics when investigating their associations with health in order to inform future research and practice.

Relationships between Social Networks and Health

Social relationships influence individuals' perceptions of social meanings, values, beliefs, attitudes, and actions. Changes in social relationships can create positive or negative emotional states, which may lead to changes in psychological states and symptoms of mental and physical well-being.²⁶ During the past 40 years, this topic's popularity among health professionals has been reflected in an increasing number of review articles.

All-cause mortality

Cassel introduced one of the earliest reviews of the literature on this topic, and pointed out that social relationships might impact a wide range of factors influencing well-being through improvement of generalized resistance to health-detrimental factors rather than to specific diseases.²⁷ More recently, Seeman and Crimmins also stated that evidence exists highlighting the roles of social relationships on general health.²⁸ Numerous longitudinal epidemiological studies found that social integration and social network characteristics have predictive power in relation to "all-cause mortality" after controlling for demographics and baseline health status.^{29–36} For example, in one prospective study, a 13-year mortality gradient across different social participation levels among adults ages 65 and older living in the community setting was documented.³⁷ Studies have also shown the protective effects of social engagement and support in the context of cardiovascular disease, with evidence supporting lower mortality due to cardiovascular disease among those who are socially engaged.^{38–42} Similarly, in a cohort of patients with first cases of ischemic stroke, social isolation was shown to predict a first occurrence of myocardial infarction, stroke recurrence, or death⁴³ and the mortality rate was shown to be higher among socially isolated individuals with significant coronary artery disease.⁴⁴

Physical and psychological well-being

Although the association between social network factors and mortality has been documented fairly consistently, their association with morbidity is less consistent.^{45–47} In one study, visiting friends and participating in groups for older adults was positively associated with physical functioning and general well-being.⁴⁸ A strong positive association between participation in social activities and functional status was documented in a 9-year longitudinal study with older adults in the US.⁴⁹ Another study showed that social disconnectedness and perceived isolation are independently associated with lower levels of self-rated physical health.⁵⁰ Furthermore, a strong impact of social integration on recovery from illnesses such as cardiovascular disease and stroke has been

documented.^{34,51,52} The impact of social relationships on aspects of mental health, such as psychological well-being and stress reactions, has also been well-documented.^{26,53,54} While it was initially thought that this association occurs only through the moderating effects of coping resources and coping strategies, the stress-buffering effect,⁵⁴ results of later reviews suggested the coexistence of main effects and buffering effects.²⁶

Cognitive well-being

Both compositional (e.g., group membership, frequency of contact between network members, social isolation, (dis)connectedness)^{50,55} and functional characteristics of social networks, including social (dis)engagement, social support, and social conflict, have been identified as risk and/or protective factors of cognitive function, ability, and decline.⁵⁶⁻⁵⁹ More frequent participation in social activities and higher levels of perceived social support⁶⁰ as well as having close social ties⁶¹ were associated with better cognitive function among older persons without clinical signs of dementia. Findings from longitudinal studies also provide support for this relationship. In a 7.5-year longitudinal study, social support, specifically emotional support, was found to be a significant predictor of better cognitive function.⁵⁹ In terms of social engagement, higher levels of participation in social activities, maintenance of social connections, and frequency of visual contacts with relatives have been found to act as protective factors for cognitive decline among the elderly.^{57,58,62} Furthermore, in a longitudinal study of Japanese American men, those who were socially engaged at low levels during midlife and late life were at increased risk for dementia than those who were engaged at high levels, and those who dropped from high to low levels of engagement over time had the highest incidence of dementia.⁶³ Although it is difficult to disentangle the cyclic nature of the relationships between health status and social engagement (e.g., levels of engagement being influenced by the development of dementia), some of these findings suggest the influence of social engagement on cognitive decline. After reviewing the epidemiological studies, Fratiglioni and colleagues concluded that sufficient evidence supports the notion that active and socially integrated lifestyles have protective effects against dementia.⁵⁶

Relationships Between Social Networks and the Aging Mind and Brain

The pathways through which social networks and relationships influence health and well-being are very complex and difficult to uncover.^{64,65} One possible way to investigate the pathways is to look at the compositional and functional characteristics of social networks. Social interactions can influence both the compositions and functions of social networks that can alter individuals' health-related *behaviors* and *perceptions* that, in turn, impact their cognitive well-being. Berkman and colleagues postulate that social networks influence health through functional mechanisms such as social support and social engagement.⁶⁶ In terms of the behavioral pathway, it has been shown that social engagement can lead to increased physical activity levels⁶⁷ that can facilitate healthy brain aging.⁵⁶ Socially well-connected individuals are also less likely to smoke and more likely to eat a better quality diet.⁶⁸ For the perceptual pathway, participation in social activity may modify the effects of age-related health changes⁶⁹ through providing opportunity to contribute to the society and enhancing social roles and purposefulness in life.⁷⁰ It has been shown that increased opportunity for social engagement improves perception of social support availability and reduces feelings of loneliness,⁷¹ and feelings of loneliness significantly predicted IQ at age 79 in a 60-year longitudinal study.⁷² In another longitudinal study, an increased level of loneliness was associated with decreased cognitive ability, and this association was partly accounted for by symptoms of depression.⁵⁵ Given the strong evidence showing the link between depression and

dementia,^{73,74} this may represent another pathway through which social networks influence cognitive aging.

Some evidence also sheds light on the biological pathways through which social networks influence health. There is suggestive evidence for association between social relationships and human immune function.⁷⁻⁹ In animal studies, social isolation was associated with delayed immune response⁷⁵ and development of type 2 diabetes.⁷⁶ In terms of brain health, social engagement may improve synaptic activity and efficient brain recovery and repair, thus reducing individuals' risk of dementia.⁶³ One study documented an improvement in executive functioning through social engagement accompanied by positive changes in brain activity among seniors who volunteered at public schools.¹⁰ Another recent study showed that living alone and having less social support was associated with decreased processing speed.⁵⁵ Stress responses (e.g., hypothalamic-pituitary-adrenal functioning) were also shown to be modified by the presence of social support among women prior to their surgery for cancer,¹¹ and an increase in cortisol production over time led to a decline in memory performance; whereas a decrease in cortisol production led to an improvement in memory performance among community-based older women.⁷⁷ Studies reviewed here suggest the existence of multiple pathways through which social networks and relationships may influence health, thus, partly explaining why social relationships influence overall health status rather than specific disease processes such as physical and cognitive decline.¹⁴

Characteristics of Social Networks and Social Relationships among Older Adults

In early years, Kahn and Riley posited that individuals are influenced by social networks and these networks continuously change as individuals move through various life stages.⁷⁸ Antonucci later noted through a review of evidence that the characteristics of the social network do change as individuals age and that these changing characteristics influence how older adults maintain their levels of activity in later life. Bowling also noted the changing nature of social networks as well as the unique network characteristics for older adults and their impact on health status and ability to adapt to the physical, mental, and social changes related to aging. Although there are some inconsistencies in the findings across studies, stronger evidence exists for changes in social network characteristics as people age such as a decrease in the size of social networks, frequency of contacts with social ties, number of ties in close proximity, and level of reciprocity in support exchanges.¹⁵ This emphasizes the importance of not only considering social network characteristics of older adults but also the changes that occur in these systems over time to examine their impacts on health outcomes in later life. Older individuals in the developed society have become especially vulnerable to social isolation due to longer postretirement years, widowhood, loss of friends, illness, residential relocation, and increasing geographic dispersion of family members and friends.⁷⁹ In general, older individuals spend less time on social activities compared to younger individuals,⁸⁰ partly due to age-related physical, cognitive, and social changes that influence individuals' ability to remain socially engaged.

Older adults are increasingly using electronic tools to stay connected with their family and friends. For example, in the United States in 2012, more than half of older adults were online and 70% of the internet users were online every day to do things like check email (86%) or social network sites (34%)⁸¹ and search for health information (47%).⁸² In addition, nearly 70% of older adults own a cell phone⁸¹ and 20% reported having a smartphone that also allows them to stay electronically connected with family and friends^{83,84} who may live away from them. How such changes in the way older adults interact with others and the influence of technology on social engagement and well-being outcomes remain underexplored. Additionally, concerns about economically disadvantaged older adults not having the access to or not knowing how to use such

electronic tools, and their increased risk for social isolation due to not being able to adjust to changing nature of interpersonal communication and interaction have been raised.⁸³

Compositional features of social network characteristics

Some studies have shown that the *sizes* of social networks of older people are smaller compared to those of younger individuals⁷⁸ due to mortality among members and life changes such as retirement and relocation. However, other studies showed that the size of the social network does not change over the life course⁸⁵ because lost ties are replaced with new social ties by older adults.⁸⁶ Together, these studies imply that individual variations defy simple overall trends. Likewise, while some studies have shown the importance of larger social network size on health,^{30,87} other studies show that one or two people in the network can provide the optimal support needed to maintain health and well-being.^{33,88} Generally, larger networks provide more instrumental and emotional support,⁸⁹ and provide greater opportunity for social interactions and engagement whereas smaller networks may be able to provide more organized support that meets the needs of the individual as network members tend to know and interact with each other. Older adults also have more *homogeneous* networks mainly consisting of family and relatives than younger adults,^{15,90} and homogeneous networks bring more emotional and instrumental supports to the members compared to less homogeneous networks.¹⁷ Because of the homogeneous nature, older adults' networks also tend to be *denser* with network members knowing and interacting with each other.¹⁹ Denser networks can lead to higher levels of instrumental support available to members; however, older adults may also experience decreased opportunities for making new social contacts.¹⁹

Because social networks increasingly contain more family ties and fewer friends as individuals age, the *proximity* to network ties tends to increase,⁸⁵ especially when individuals relocate or family members move away. Older adults consider geographic proximity when developing companionships⁹¹ and proximity also influences their access to readily available support.¹⁹ In addition, the *frequency* of contacts with social network ties appears to decrease with age,⁹² and the decreased frequency is associated with increased risk for mortality.⁹³⁻⁹⁵ Finally, asymmetries in social relationships increase as people get older, resulting in fewer opportunities for the older adults to give support to others.⁷⁸ The *ability to reciprocate* received support was found to be the only structural network characteristic that predicted overall well-being among older adults.⁸⁵

Functional features of social relationships

As discussed earlier, older adults may be at increased risk for losing sources of social support or becoming socially disengaged due to possible changes in their social network composition. Older individuals seem to spend less time engaging in social activities compared to younger individuals.⁸⁰ Levels of productive activity also tend to decrease with age, mainly due to a decline in paid work and social participation related to raising children,⁹⁶ and this decrease is associated with poorer health status.⁹⁷ However, some older adults remain as active as younger people in unpaid work and volunteerism⁹⁶ and those individuals tend to show less physical and cognitive decline as reviewed in the earlier section of this chapter. Evidence shows that merely being in a social context was more strongly associated with health than the actual participation in social activity.⁹⁸ It is likely that being in the social context not only helps individuals maintain social roles but also provides them with access to potential sources of support when it becomes necessary. Although the evidence points to strong associations between higher levels of social support and better health among older adults,^{9,15,46,54,71,99-101} the amount of support received decreases as people get older.¹⁰² Studies showed that perceived levels of social support was a strong predictor of 30-month mortality among older adults in a community, and its predictive value was higher than that of the observable exchange of support.^{6,93} Another study also showed a positive impact of perceived support on

well-being without any explicit changes in the actual support exchanged.¹⁰³ Because objective indicators of social support (e.g., frequency of support provision) would not reflect individual differences in the needs,¹⁵ it is important to consider subjective measures (e.g., perceived levels of available or received support) in determining what aspects of networks should be enhanced to achieve better health outcomes.

Addressing the Links Between Social Relationships and Cognitive Aging

Interest in promoting social engagement among older adults to facilitate healthy aging is growing. Social engagement not only positively influences the physical, mental, and cognitive well-being of older adults but also allows socially integrated individuals to remain independent longer in community settings.^{104,105} As an increasing amount of evidence becomes available in the field, researchers have attempted to translate the knowledge gained into effective intervention efforts.

Although efforts are being made, only a limited number of interventions have been implemented to enhance social engagement among older adults and results have not been consistently positive.¹⁰⁶ Interventions that led to the enhancement of social relationships and integration have involved, for example, providing support in times of crisis,^{107,108} organizing support groups,^{109,110} promoting community organization among older adults,²³ and facilitating volunteering.¹¹¹ Volunteering has been shown to serve as a protective factor for mental illnesses during spousal bereavement,¹¹² and has a positive impact on self-reported health among older adults.¹¹³ Another study, a randomized trial of a volunteer program for older adults, The Experience Corps®, showed that participation in this program led to increases in social, physical, and cognitive activity among the participants compared to the control group.¹¹⁴ Furthermore, Carlson and colleagues documented significant intervention effects of this senior volunteer program in increasing brain activity among African American participants who were at increased risk for developing cognitive impairment.¹⁰

Social Networks of Families Caring for the Aging Mind and Brain

Social networks both influence and are influenced by individuals. The studies introduced above show the potential influence of social networks on individual health; however, social networks are also influenced by individual members including those who may be experiencing age-related decline in physical and cognitive functioning. In this section, the impacts of having an individual affected by dementia on familial social networks are discussed.

In 2013, about 5.2 million people were affected by Alzheimer's disease and related dementias in the US, and this rate is projected to increase to 13.8 million in 2050.¹¹⁵ Most individuals with dementia (80%) live in the community and are cared for by family and other informal caregivers.¹¹⁵ Because of the nature of dementia symptoms, family caregivers often face physical, emotional,^{116,117} social,¹¹⁸ and financial strains.¹¹⁹ For example, informal caregivers are less likely to engage in preventive health behaviors,¹²⁰ show lower immune functioning¹²¹ and are at increased risk of mortality.¹²² The severity of patients' cognitive and behavioral symptoms influences caregiver well-being,¹²³⁻¹²⁵ and caregiver well-being, in turn, influences patients' well-being^{126,127} generating a symbiotic relationship. However, a recent report suggests that more hours spent on caregiving is not necessarily associated with higher mortality and that active participation in caregiving may have positive impacts on caregiver well-being.¹²⁸ It is likely that interpersonal relationships and other social network elements also determine how caregiving impacts the health of the patient and family members.

Caregiving creates changes in family relationships and functioning^{129,130} that can act as stressors for some family members as they accommodate to provide support and care to the affected

individual.¹³¹ Caregiving impacts each family member differently,¹²⁵ and family members engage in caregiving in various ways at various levels (i.e., direct care, providing support to caregivers, sharing household chores, organizing services). Caregiving responsibilities tend to be shared by multiple family members such as adult children, spouses, and grandchildren.¹³² Caregivers may also change over time within the family, for example, from spouse to adult children or among multiple adult children.¹³³ The process of negotiating caregiving responsibilities, or lack of this process, within the family can go on for many years, and family members often experience conflicts as caregiving responsibilities and family roles change,¹³⁴ sometimes leading to feelings of anger, resentment, and guilt among family members.¹³⁵ Perceptions about inequitable distribution of caregiving tasks within the family has been identified as one of the main causes of caregiver distress¹³⁵ and biological family members may especially be at higher risk for caregiving distress as they are often expected to provide higher levels of care within the family.¹³⁶ Feelings of anger, resentment, guilt, and distress may influence family members' ability to cope, and can lead to increased depressive symptoms among them.^{137,138}

At the same time, social networks provide the context in which family caregivers gain access to support and resources.¹³⁹ Dementia caregiving research has predominantly employed the stress process framework¹⁴⁰ and showed that financial resources, social support, and perceived efficacy in care provision are important coping resources for caregivers.^{141,142} Caregiving interventions, therefore, have focused on reducing caregiving burden through education, support, and skills training of primary caregivers.¹⁴³ However, due to the modest effectiveness of such interventions,^{144,145} caregiving researchers are suggesting the need to consider family-level approaches.^{146,147} For example, the family's ability to adapt to changes has been associated with continued support provision¹⁴⁸ and the ability to resolve conflicts has been associated with more care provision,¹⁴⁹ thus can be the targets of interventions.

The compositional characteristics of familial networks (i.e., size, demographic compositions) have implications on how families provide care and adapt to the changing needs of family members. For example, women are more likely to provide direct care than men,¹⁵⁰ thus family networks with more females may be more resilient than others in caregiving situations. Similarly, networks with more biological family members may possess more caregiving resources because of a feeling of filial obligation among them.¹⁵¹ A study showed that proportion of kin and network size were negatively associated with caregivers' family-related distress, and that support availability weakly mediated these associations.¹⁵² The characteristics of network functions such as exchange of support and resources among members have also been examined extensively and shown to be important in caregiver well-being.²⁰ Network-level interventions such as identifying and activating potential support sources that are on hold¹⁵³ or restructuring interaction patterns to facilitate negotiations and to optimize caregiving processes can greatly enhance the well-being of entire family systems including affected relatives and primary caregivers.

Concluding Thoughts: Healthy Aging of our Mind and Brain – Where are we Headed?

Available evidence suggests that social networks and social relationships may have implications on how individuals' mind and brain age through behavioral, perceptual, and biological pathways (Figure 2.1). On the other hand, the way individuals' mind and brain age has implications on the social contexts that surround them. In some cases, challenges associated with providing care to those affected by dementia result in changes in family relationships that determine the outcomes of family caregiving processes and the well-being of the affected individuals and their family. Positive aging of the mind and brain (AMB) can lead to more participation in generative activities among older adults that contribute to the well-being of the society and younger generations.

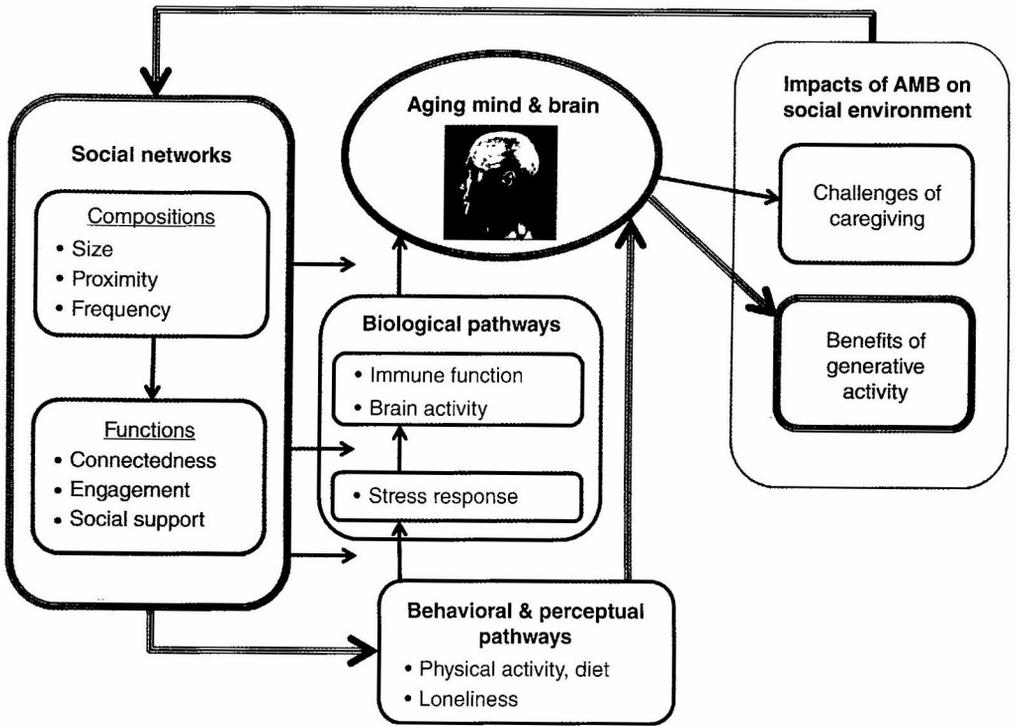


Figure 2.1 Overview of the literature on social networks, social relationships, and their effects on the aging mind and brain.

Any of these associations can be intervened upon to foster social engagement and achieve better health outcomes. The pathways indicated with enhanced lines in Figure 2.1 (the link from social networks to generative activity through aging mind and brain that lead back to enhanced social networks) represent the efforts being made through current community-based interventions.

Attempts to enhance social networks have not always been successful or have not achieved desired levels of change in health outcomes.¹⁵⁴ It is likely that this is due to a lack of understanding of the mechanisms through which these factors influence health and well-being. Traditionally, epidemiological studies evaluated social relationships using such indicators as marital status and number of friends and/or relatives. Using social network size in these studies assumes that the support and influence from each member of the network are all equally effective. However, studies show that the existence of social network ties does not guarantee the availability of social resources such as support, information, and context in which individuals can maintain social engagement.¹⁵⁵ Social network literature clearly indicates that a more detailed examination of social networks, through evaluating compositional and functional characteristics as well as interaction patterns among network members, can greatly enhance our understanding about the way social contexts influence physical and cognitive health.¹⁹ Furthermore, understanding the mediating roles of functional characteristics of social networks will enhance our knowledge about the mechanisms of influence and improve future intervention efforts. Through enhanced understanding of social networks, interventions move beyond opportunities for social participation to identifying specific social relationships that can be influenced, or interaction patterns that can be restructured, to facilitate optimal social network functioning.

There have been dramatic shifts in the structure of social networks in our society as family compositions change due to the extending of life expectancy, fewer numbers of or no children per

household, and increasing rates of divorce, remarriage, cohabitation, and never-married individuals.¹⁵⁶ The geographic proximity between older adults and their family also continues to increase as adult children move away to pursue their career or older adults relocate after retirement. The traditional nuclear family model that includes parents and children or a three-generation household model in which parents live with their adult children and their grandchildren is seen less frequently in industrialized societies. Considering that family members continue to be the most important network members to older individuals, such changes in family systems can put older adults at increased risk for limited social support and resources. Although emotional and informational support may be provided through electronic communication, instrumental support such as helping with shopping and transportation may not be easily provided by the family members living farther away. With such changes, older individuals are increasingly considering their close friends as family or “fictive kin,” and these friends function as providers of important social resources such as accompaniment to medical visits, helping in decision-making, and providing instrumental support when family members are not readily available.¹⁵⁷ Therefore, future research of older adults needs to employ an expanded definition of social contexts and family social networks to gain a comprehensive understanding of social relationships.

Similarly, considerations about the role of the internet in social relationships are also necessary. Having access to the Internet allows older individuals to stay connected with family and friends who may not live close to them.^{158,159} However, research also shows that having access to the internet and using cell phones reduced the connectedness among older adults with their local neighbors¹⁶⁰ implying a potential trade-off that requires further investigation. More research is needed to increase our understanding about how technology influences social relationships and how it may be useful in facilitating perceived social engagement among older adults. In order to take advantage of technology to facilitate social well-being of older adults, we need to identify potential alternative sources of social support that require in-person contacts such as instrumental support, and ways to ensure access to such technology among all older adults, including those who may be economically disadvantaged and especially vulnerable.

Facilitating social participation through volunteerism appears to be one of the promising intervention approaches to enhance social networks and to facilitate healthy aging. In order to make public health impacts, it is important to involve individuals who have limited social interactions, or are at risk for social isolation. Health promotion programs offered in the community to facilitate healthy brain aging, such as physical exercise or cognitive stimulation activities,^{62,161,162} often attract those who are already socially engaged. However, the opportunity to contribute to society through volunteering was effective in motivating participation among those older individuals who normally do not participate in such programs.¹¹⁴

The concept of generativity, interest in contributing to the development and well-being of others such as younger generations and the society,^{163,164} has been increasingly considered in research concerning the health and well-being of older adults. Many older adults express their desire to be useful and valuable to the society and feel that it is their moral responsibility to provide for others and future generations.^{165–167} Those with generative desire tend to engage in more social and productive activities to sustain self-esteem and well-being.^{165,166} On the other hand, those who feel low levels of social usefulness experience higher levels of the activities of daily living (ADLs) impairment¹⁶⁸ and mortality, and lower self-rated health.¹⁶⁹ The findings from an inter-generational mentoring program documented the enhancement of academic skills in students along with decreased levels of disability and loss of executive function among older volunteer mentors.¹⁷⁰ Older adults, including those who are dependent on others for care, desire to¹⁷¹ and are able to participate in volunteer activities to help.¹⁷² Future public health efforts to facilitate healthy aging through social engagement can consider using this concept of generativity to motivate and engage older adults in social activities. For example, asking older adults to share life stories creates an opportunity for generative activity¹⁷³ and facilitates the preservation of historical information that benefits future generations.¹⁷⁴ Older generations also have more knowledge about their

family's health history¹⁷⁵ that can facilitate risk assessment and disease prevention among family members.^{176,177} Thus, creating opportunity for older adults to share such information can help enhance social engagement among them while bringing benefits to the society and future generations.

As reviewed here, participation in social interactions among older adults is likely to be influenced by the complex interaction of many elements, including physiological, psychological, and social factors. While studies have looked at the influence of physical, psychological, and macro-level sociodemographic factors on participation in social activities among older adults, more studies are needed to investigate the impact of individual social network characteristics and functions on the level of social participation and engagement. Investigating the mediating mechanisms through which social participation may influence cognitive aging will assist health professionals in developing social programs that can effectively and appropriately enhance or maintain the cognitive functioning of older adults. Furthermore, a better mechanistic understanding through which social networks and social relationships influence cognitive aging is needed. Developing a social network framework that will facilitate the identification of biological-, individual-, interpersonal-, and community-level factors that most prominently influence, and are influenced by, cognitive aging will be useful. Once such an understanding is gained, social network assessment tools to help identify the strategies to facilitate optimal aging of the mind and brain through enhancement of social networks and relationships among older adults can be developed.

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