

Cognitive Loneliness: The Impact of Social Isolation on Elderly Brain Function

A Research Paper by the All4Smiles Research Team

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Abstract

As people grow older, loneliness and social isolation become more common and begin to affect more than just emotional well-being. Studies now show that isolation can lead to physical changes in the brain, such as reduced hippocampal volume, disrupted default mode network activity, and increased inflammation. These changes are linked to memory loss, depression, and a higher risk of dementia. This paper explores how loneliness impacts brain health through biological, psychological, and social pathways. It examines how social engagement strengthens cognitive function, how culture shapes the way aging and isolation are experienced, and how issues like polypharmacy can worsen mental and neurological decline. By understanding these different factors, we can begin to find better ways to support older adults and protect their cognitive health as they age.

Table of Contents

1) Introduction to Cognitive Loneliness	4-5
2) Biological Mechanisms Behind Loneliness	6-8
3) The Role of Social Engagement in Cognitive Function	9-10
4) Mental and Physical Health Impacts of Isolation	11-12
5) Cultural Perspectives on Aging and Loneliness	13-14
6) Ways to Fight Loneliness and Protect Brain Health.....	15-16
7) Works Cited	17-19

Introduction to Cognitive Loneliness

By: Joyce Sato

An increasing number of elderly people are experiencing loneliness and decreased social participants as the global population ages. The emotional aspects of loneliness have been well established; however, new studies are beginning to show that loneliness has a very serious impact on brain function. This article will review the brain changes associated with social isolation for older adults, and what these changes mean for future cognitive decline and increased risk for neurodegenerative disease.

One of the most serious neurological effects of social isolation is the change in key structures in the brain. One such region, the hippocampus, is vital for memory consolidation, and navigation to develop experiences and memories, or to use memory to guide actions and decisions. Studies involving MRI indicated that elderly individuals who face long periods of isolation experience a loss of hippocampal volume, which correlated with lower overall memory work performance (Wilson et al., 2007). Another brain region, the prefrontal cortex (PFC), responsible for executive functions and decision-making also had noticeable decline in size and metabolic activity in socially isolated elders (Spreng et al., 2020).

Social isolation not only affects structural change, but also functional connectivity of the brain, one example is the functional connectivity of the brain default mode network (DMN) in simple terms a range of brain regions that are active at rest and when self-reflecting. Disrupted DMN functional connectivity has been a precursor to early stage Alzheimer's disease, older adults

experiencing social isolation show a reduction in activity of the DMN (Yao et al., 2021). This begs the big question: is it possible that social isolation could contribute to neural changes at the onset of cognitive conditions even before age related dementias have been diagnosed?

Social isolation is not just related to brain structure; it is associated with accelerated cognitive aging and increased risk of dementia. A long-term study showed that socially isolated people were 26% likely to develop dementia compared to those demonstrating high social engagement (Kuiper et al., 2015). Social isolation is likely to contribute to higher inflammation and states of stress; both social isolation and inflammation are contributors to β -amyloid accumulation: an important biomarker of dementia related to Alzheimer's.

Loneliness can have negative effects on neuroplasticity: the brain's ability to develop and reorganize its synaptic connections. This is concerning given larger systemic patterns that are beginning to show a decline in cognition among older adults. As such, the aging brain's performance to counter damage due to aging may be declining as well, compounding declines associated with attention, speed of processing, and working memory (Cacioppo & Hawkley, 2009).

Biological Mechanisms Behind Loneliness

By: Sri Patel

Cognitive loneliness means the personal experience of those who are poor in emotion or mind. Social isolation is, on the other hand, absence of contact or communication. Cognitive loneliness is the personal absence of rich thought-evoking relationships, as compared to social isolation. Though mostly a process of thought, loneliness does have measurable biological effects on the brain. Medical studies attest that cognitive loneliness triggers stress pathways, alters brain chemicals and composition, and leads to inflammation and cognitive impairment.

One of the intriguing biological processes involved in the brain effect of loneliness is continuous stimulation of the hypothalamic-pituitary-adrenal (HPA) axis. Chronic loneliness leads to hypersecretion of cortisol in the body, a hormone released during stress. Chronic hypercortisolemia damages segments of the brain like the hippocampus, which plays a role in learning and memory (Cacioppo et al., 2023). This disruption in the regulation of stress might lead to cognitive impairment and permanent distortion in emotional processing.

Loneliness has an adverse impact on neuroplasticity, or the way the brain is able to recover, renew itself, and adapt. In research, loneliness reduced brain-derived neurotrophic factor (BDNF) levels, a protein essential for the growth and survival of neurons (Matthews et al., 2023). Low BDNF is also linked to compromised memory, decreased learning ability, and heightened vulnerability to mental illness. Additionally, loneliness also activates the brain's immune cells, the microglia. By putting the cells into a permanent state of activation, they

increase the release of inflammation within the brain, which has been said to cause depressive behavior in addition to the development of neurodegenerative disease (Matthews et al., 2023).

Aside from these chemical changes, loneliness also affects brain structure and function.

Neuroimaging research acknowledges the fact that lonely people exhibit increased activity in the anterior cingulate cortex and amygdala—brain areas that handle threat detection and pain of emotion (Lyu et al., 2021). What this indicates is that with time, the brain becomes increasingly sensitive to social threats. Conversely, brain regions that are involved in reward, such as the ventral striatum, are less activated by social touch among lonely individuals and would leave them with fewer resources to find pleasure in affiliation (Lyu et al., 2021). Such changes would lead to withdrawal rather than escape from loneliness.

Variations in the default mode network, DMN, a group of brain networks active during relaxation and self-referential thinking, have been proposed by research. People with a long history of experiencing alienation are also going to have disruption in a network at both the structural and functional levels, namely those areas activated by self-reflection and memory (Spreng et al., 2020). This is also in accordance with evidence that has shown loneliness to be linked to decreased attention, memory, and social reasoning. Social isolation and loneliness have also been strongly associated with cognitive decline in older age. A systematic review of longitudinal evidence proposed that lonely people were at risk of decreased cognitive function across the long term through both emotional stress and absence of mental stimulation (Wang et al., 2023). In short, loneliness's biological processes and effects on brain health are dysregulated stress hormones, impaired neuroplasticity, increased inflammation, and alteration of brain reward and

memory circuitry. These processes begin with feelings of isolation and progress to somatic impacts on the brain that weaken cognition and cause aging. Identification of these biological processes stresses that loneliness has to be treated as a neurological and psychological illness.

The Role of Social Engagement in Preserving Cognitive Function

By: Aria Fernandes

Maintaining cognitive health becomes increasingly challenging with age, with around ⅓ of Americans experiencing various forms of cognitive decline by age 70. Of the population of those 85 or older, around 50% are estimated to be living with Alzheimer's, and the risk of developing a similar condition increases over time. Signs of cognitive decline can include a loss of executive function, memory, or language. While losing function may seem inevitable with age, social engagement can help to lower the risk of cognitive impairment.

Brain size decreases as we age due to a loss of volume in grey and white matter within the brain.

The deterioration of grey matter causes damage to the frontal cortex of the brain, and the degeneration of white matter results in a loss of speech. Additionally, deterioration of the frontal cortex has negative impacts on memory, judgement, and executive functions such as: emotional regulation, reasoning, and task initiation. The loss of these functions is often one of the defining signals of cognitive decline.

As individuals age, they lose neurons, but participating in socially engaging activities can result in longer living neurons. These longer lasting neurons are crucial in maintaining cognitive function, because many of them make up important neural pathways. Engaging in social activities has been found to reduce the risk of neurodegenerative diseases by 30-50%. This is recognized by many senior resident care centers, activities such as wood painting, music events and walk in classes, can help older individuals have time to engage in social activities.

Having thoughtful or even casual conversations with other people makes sure that one's mind is active. This interaction stimulates actions, memory, problem solving, and causes people to become focused, which exercises one's brain. Sharing experiences, meeting family, reading and furthering education are all ways to stimulate the mind. These simple actions end up strengthening neural pathways in the brain which assists in processing sensory input, overall adding up to more cognitive control and function.

Cognitive decline can also occur due to neurodegenerative diseases, including Alzheimers, ALS and Parkinson's disease which have become increasingly common in the past 5 years. Reducing dementia cases in patients has been linked to volunteering in a group, participating in a music ensemble, and community arts and crafts. These activities are rich opportunities for social interaction.

Ultimately, it is important to try and recognize the signs of cognitive impairment, whether it be in a loved one or oneself. This way, preventative care, such as increased social engagement, can be issued accordingly. Social engagement should also not be forced upon the individual. Instead, finding a preferred way for them to interact with others will cause less overall stress and therefore will be more effective.

Mental and Physical Health Impacts of Isolation

By: Evelyn Yao

As people transition from adults into seniors, an inevitable fact that they face is loneliness. As their children grow up and start their own families, these seniors must combat the harsh reality that they have less company. Accompanying loneliness is cognitive decline. As seniors enter social isolation, their brain function slowly starts to deteriorate as a result. The profound emotional impacts of loneliness lead to various mental disorders that impede the seniors' abilities to function in working society.

Social connection is necessary for all humans to maintain strong mental health systems. Not only does interacting with other people bring a sense of belonging and being cared for, it reduces the risk of developing diseases like heart disease, stroke, dementia, type 2 diabetes, depression, anxiety, and premature mortality. When sources of social connection become limited or cut off, seniors are at a higher risk of contracting negative mental and physical liabilities. For instance, loneliness is strongly linked to depression. Seniors face increasingly negative self beliefs, suicidal thoughts, and decreased life satisfaction, according to Mental Health America. Additionally, social isolation can worsen already existing social anxiety or even develop it. Seniors may find it harder to regulate their emotions due to a lack of social support. Some seniors may even face psychosis, accompanied by increased hallucinations and paranoid thinking. The cycle may develop into loneliness and hallucinations propelling each other. A combination of these factors makes it easier for seniors to self-harm and commit suicide, as their mental health greatly suffers due to loneliness.

In terms of physical health, seniors who are lonely are more likely to abuse substances. They may turn to drugs or alcohol as a method of ignoring their sadness or loneliness, and be stuck in an endless pattern of abuse. As mentioned previously, seniors are also at a higher risk of developing heart disease, stroke, type 2 diabetes, and dementia because of their negative mental health. Finally, the ultimate negative feedback loop can be created by the seniors who experience social isolation and find it harder to connect with others, resulting in further negative emotions and withdrawals.

Ultimately, as seniors grow older and spend less time interacting with others, they must make it a priority to form new connections or rekindle old ones. For the sake of their health, both mental and physical, being with others allows seniors to feel supported and secure. The family of seniors should recognize the severe negative emotional consequences of loneliness and thus make an effort to connect with their seniors.

Cultural Perspectives on Aging and Loneliness

By: Sue Nguyen

People experience aging and loneliness differently depending on the culture they grow up in. In some places, getting older means gaining wisdom and respect, while in others, it can feel more like being pushed aside. By comparing societies that value close family ties with those that encourage independence, we can examine how cultural attitudes can either protect people from loneliness or make it worse. The way older adults experience aging and loneliness isn't the same everywhere around the world because communities don't always offer a strong support system.

These differences can affect not just how others treat elders, but how elders feel about themselves. Understanding these cultural perspectives is key to finding better ways to support emotional well-being as people age.

Western cultures view aging as an unfortunate aspect of life and focus on preserving youth for as long as possible. Many seniors rely on retirement communities and nursing homes for long-term care. Western society often embraces individualism which prioritizes the well-being of the individual. Pursuing and following one's passion is encouraged at a young age. People focus on themselves rather than those around them. By placing an importance on independence, younger generations concentrate on raising their own families and achieving personal goals. This often leads to feelings of isolation among the elderly.

Eastern cultures, on the other hand, place a high value on caring for and respecting elders. This is because many Asian countries have collectivist societies, where family and community are

prioritized over individual needs. It's common for multiple generations to live in one household.

A multi-generational home benefits from increased emotional support, shared expenses, and more even distribution of caregiving responsibilities. Showing respect to elders is considered very essential in eastern cultures. Older adults are included in important family decisions, given roles in religious ceremonies to reflect their seniority, and treated with courtesy in everyday interactions. In these cultures, aging is not something to fear, but a stage of life that brings increased honor and connection.

In the end, different cultures shape the way people experience aging and loneliness. Sometimes older adults are at the center of family life, while in other cultures, more independence is expected, which can lead to isolation. These differences help explain why some seniors feel more supported than others. Through the cultural patterns, we can find practical ways to improve the lives of older adults across different communities.

Ways to Fight Loneliness and Protect Brain Health

By: Hiya Patel

As people age, the risk of them experiencing loneliness increases due to factors such as retirement, reduced mobility, and the death of loved ones. While loneliness is often perceived as a feeling or emotion, such isolation negatively affects both cognitive and physical health. Fortunately, this cognitive decline is preventable through utilizing evidence-based strategies to combat loneliness.

Building and Maintaining Connections With Peers

Strong social connections have been shown to mitigate cognitive decline. According to the National Institute on Aging, seniors who interact with others in meaningful and productive ways show improved cognitive resilience as they age. In addition, these activities help maintain older adults' well-being and may contribute to a longer life (Social Isolation). Community centers and senior groups are programs that can help seniors stay engaged in their communities and feel a sense of purpose. Even during times where in-person connection is difficult, video call platforms such as Zoom and FaceTime can help reduce feelings of loneliness. It has been proven that having a feeling of purpose in life lessens the pathologic impact of Alzheimer's Disease on cognitive function, thus creating meaningful connections with others is a way to protect brain health (Buchman).

Technological Advancements Helping to Combat Isolation

For older adults battling severe isolation and chronic loneliness, psychological interventions may be effective. Telehealth options have made these services more accessible for seniors who may be homebound or have mobility issues. Seniors are able to receive help from specialists who they may not otherwise be able to connect with. An emerging development in this field is socially assistive robot technology, which can deliver high-quality health and social care to the elderly in the comfort of their own homes. These robots are designed to provide companionship, as well as stimulate the brain in order to stop the loss of cognitive health. In the future, these technological advancements can help older adults fight back against chronic loneliness (Abdi et al., 2018).

While chronic loneliness and isolation is a complex emotional issue affecting many older adults, it has physical implications; feelings of isolation can contribute to increased risk of neurodegenerative diseases such as Alzheimer's disease. Numerous changes to biomechanisms such as cortisol secretion and proportions of gray and white brain matter have been observed, showing that an emotional issue such as chronic isolation can affect older adults' health beyond worse mental health. However, there are many existing and new strategies to combat loneliness, and thus protect senior citizens' brain health. With these strategies, older adults' brain health can be maintained and protected through meaningful connections with others (Guarnera et al., 2023).

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