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The relationship between the brain and spirituality with respect to aging and neurodegenerative diseases: clinical and research implications

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ABSTRACT

This article reviews and synthesizes the current data on the relationship between the brain and religion and spirituality, with regard to aging and neurodegenerative diseases. Specifically, we consider how religious and spiritual beliefs, attitudes, and practices might be affected by the aging process on the brain, particularly when neurodegenerative diseases occur. Various practices such as meditation or prayer also are associated with brain processes and such a relationship could have clinical implications for the use of these practices to help the elderly improve anxiety, depression, or cognition. Finally, we consider potential negative relationships such as religious struggle that can be part of the relationship between the brain and religious or spiritual beliefs as people age. In the end, it is hoped that this neurotheological approach, combining an understanding of brain processes with religious and spiritual phenomena, can be useful in deepening our knowledge regarding the impact of aging and neurodegenerative diseases on brain function, and concomitantly on religiousness and spirituality in the elderly population.

KEYWORDS

Aging; neurodegenerative disease; spirituality; religion; brain; neurotheology

Introduction

As the world population ages, it is important to understand and intervene on both the physical and cognitive needs of the aging individual. Recently there has been increasing interest in the interaction between disease, religiousness and spirituality. Neurodegenerative disorders have become a critical public health issue globally. According to the World Health Organization, 36 million people suffer from Alzheimer's disease alone. These disorders substantially alter brain function by affecting neuronal integrity and various neurotransmitter systems. It is also known that religious and spiritual attitudes change as people age and appear to change more in patients with various neurodegenerative disorders. Such observations imply that the integrity of neuronal pathways likely has an impact on the extent of religiosity and spirituality of

individuals. However, the exact mechanism by which aging and neurodegenerative changes affect religious and spiritual beliefs and attitudes is still being evaluated. The purpose of this paper is to review the current understanding of the relationship between aging and neurodegenerative diseases with religiosity and spirituality from a brain perspective.

At the outset, it is important to better define these terms – religion, religiousness, and spirituality. Religion typically refers to an identified group that holds a similar belief system codified in texts, rules, and practices. Thus, Judaism, Christianity, or Islam, are regarded as religions. On one hand, religiousness refers to adhering to the elements of a given religion. However, there are a variety of elements that make up religiousness that frequently overlap with spirituality. Practices such as meditation or prayer can be regarded as either a religious or spiritual practice, or a combination of the two. Thus, there is some degree of overlap between what might be referred to as religiousness and spirituality. In fact, a study of religious leaders found that they defined “religion as objective, external, and ritual or organizational practices that one performs in a group setting and that guide one’s behavior; while spirituality was defined as internal, subjective, and divine experience or direct relationship with God.” However, when asked to choose between several options, the following percentages were found: “spirituality is a broader concept than religion and includes religion (37.5%); religion is a broader concept than spirituality and includes spirituality (18%); religion and spirituality overlap but they are not the same concept (28%); religion and spirituality are the same concept and overlap completely (17%); and religion and spirituality are different and do not overlap (0%).”

In the medical field, several scholars have offered the following definitions. Astrow et al. (2001) defined religion as is a “set of beliefs, practices, and language that characterizes a community that is searching for transcendent meaning in a particular way, generally based upon belief in a deity” (Astrow et al. 2001). Although interestingly, another scholar stated that religion is “an organized system of practices and beliefs in which people engage . . . a platform for the expression of spirituality . . .” (Mohr 2006). Here we see an overlap of religion being associated with spirituality.

Several scholars have offered definitions of spirituality such as: “a quality that goes beyond religious affiliation, that strives for inspiration, reverence, awe, meaning and purpose, even in those who do not believe in God.” (Zentner & Murray, 1989, p. 259) or that it “refers to a broad set of principles that transcend all religions. Spirituality is about the relationship between ourselves and something larger.” (Kaiser 2000).

A comparison of African American and European American elderly individuals revealed that religion is typically described primarily as beliefs, while spirituality tends to be identified as a “feeling in the heart” (Nelson-Becker, 2003). However, this small study reported that African Americans were less likely distinguish between religion and spirituality in contrast to European American respondents.

Finally, a group of medical researchers (Larson et al., 1998) defined the criteria for spirituality as: “1) The subjective feelings, thoughts, experiences, and behaviors that arise from a search or quest for the sacred; 2) the “Search” refers to attempts to identify, articulate, maintain, or transform; and 3) the “Sacred” refers to what the individual perceives as a divine being, ultimate reality or ultimate truth. The criteria for religion/religiousness included 1) the criteria for spirituality and/or; 2) a search for non-sacred goals (such as identity, belonging, meaning, health, or wellness) in the context of spiritual criteria; and 3) The means and methods of the search receive general validation and support from within an identifiable group of people.”

For the purposes of this article, we will try to use religiousness and spirituality together in order to be as encompassing and inclusive as possible. However, we will also try to differentiate studies that have specifically evaluated religion or religiousness, as affiliated with a particular tradition, in contrast to the broader feelings associated with spirituality.

We will explore how religious and spiritual beliefs and attitudes change with normal aging, but also focus on changes that occur in patients with various neurodegenerative disorders. We will also consider the neurophysiological mechanisms by which these changes occur and the implications for engaging religious and spiritual beliefs in the context of overall health and well-being. This analysis might also be of value for the emerging field of neurotheology that explores the relationship between the brain and religious and spiritual phenomena, rather than focusing only on the neuroscientific aspects associated with theology itself. In that sense, the term, *neurotheology*, is a misnomer since it does not refer only to theology, but typically has been expanded more broadly to include religious and spiritual practices, beliefs, attitudes, and experiences (Newberg, 2010). In fact, the theology aspects if probably the least well studied, but the term seems to be the most widely used to refer to this overall field even though other hybrid terms could be considered such as *psychospirituality* or *bioreligion* as two other examples. Further, the “neuro” side it typically expanded beyond just neuroscience to include other aspects of mental and physical health, psychology (at least as it pertains to the brain), and even sociology and anthropology. Thus, we define the field of neurotheology broadly and use the term here as a multidisciplinary approach that could have important clinical and neuroscientific implications deriving from an analysis of the aging brain.

The brain in aging and neurodegenerative diseases

Aging generally appears to be associated with reduced neuronal function which includes overall metabolic activity as well as reductions in neurotransmitter concentrations. Such changes in the brain might be expected to alter a person’s religious and spiritual attitudes, beliefs, practices, and experiences.

Thus, as the brain ages or is affected by a neurodegenerative disease, evaluating the relative changes in a person's religiosity or spirituality might have important implications for clinical management as well as for future neuroscientific research.

An important first step is to briefly describe what changes occur naturally in the brain with aging. For example, structural brain markers such as functional connectivity that are often studied in relation to neurodegeneration occur in healthy aging populations. In a study of 2878 non-demented participants who underwent resting state functional magnetic resonance imaging (MRI), Zonneveld et al. (2019), found that functional connectivity lowered significantly with aging in certain resting state networks like the sensorimotor network; however, the functional connectivity of the visual network was increased with age. A study systematically analyzing 114 studies on normal aging using fMRI also report visual networks becoming hypo-active and the frontal parietal networks becoming hyperactive in aging, along with cognitive decline in behavioral performance (Li et al., 2015). Another study of 465 participants used MRI to assess brain volume changes at age 73 and 76 (Ritchie et al., 2015). They found that the healthy white and grey matter volume decreases, and white matter hyperintensities increase. Higher initial cognitive abilities showed less healthy brain matter atrophy and were thus predictive of less change in brain volume. Findings from studies utilizing positron emission tomography (PET) in normal aging in adults have generally reported a decrease in whole brain cerebral metabolic glucose rates. A number of early studies showed diminished regional glucose metabolism in the temporal, parietal, somatosensory, and especially the frontal regions (Arnemann et al., 2017; Chawluk et al., 1987, 1985; De Leon et al., 1987; Loessner et al., 1995; Weiss et al., 1990; Yoshii et al., 1988). Other studies have found that most neurotransmitter systems such as dopamine, serotonin, and acetylcholine decrease with normal aging (Narayana et al., 2017; Segovia et al., 2001).

Cognitive aging is associated with the above mentioned changes in brain structure and function that occur with aging. A brief review indicates that a variety of cognitive functions become impaired with normal aging. There are particular cognitive functions that change more as people age. The focus on cognitive aging research includes memory processes, attention and executive processes, and affective processes (Anderson & Craik, 2017). Theories of cognitive aging typically focus on the availability of resources (associated with areas of preserved brain function), those that focus on domain-specific areas of loss (associated with areas of impaired brain function, or those that focus on compensatory strategies (utilizing alternative brain pathways from those that have deteriorated) (Salthouse, 2010). These elements of cognitive aging might also be considered from the religious and spiritual perspective. Religious and spiritual beliefs and practices might be useful in preserving brain function, preventing the reduction in brain function, or fostering

compensatory mechanisms. On the other hand, as cognitive aging occurs, it can be important to observe how various religious and spiritual beliefs and practices change for individuals. Neuropsychiatry as a field also evaluates the cognitive and affective elements of aging and dementia. In particular, neuropsychiatry can help clearly identify the neurological and psychiatric issues associated with aging, determine their interrelationship, and then bring in the religious and spiritual aspects of the person to assess those interactions. Exploring an interdisciplinary approach that combines neuropsychiatry, cognitive aging, and the study of religious and spiritual phenomena in the elderly is the basis of this paper.

Jové et al. (2014) have shown that chronic neurodegeneration in aging is a result of mis-folding of proteins. The misfolded proteins spread from cell-to-cell, invading healthy brain cells, contributing to the progression of disease (Hatters, 2008). Neuroimaging has been pivotal in identifying functional and structural changes that occur in the aging brain and in those associated with neurodegenerative diseases. MRI has been very helpful in differentiating neurodegenerative diseases. Structural MRI shows atrophy of the hippocampus and entorhinal cortex in Alzheimer's Disease (Appel et al., 2009). Functional MRI-based physiological measurements are being used to identify early markers of Alzheimer's disease to help facilitate treatment (Chen, 2019). In particular, functional connectivity and network integrity appears to decrease in healthy aging, but this decrease is accelerated in patients with Alzheimer's disease. The neuronal system most affected is the default mode network including structures such as the posterior cingulate cortex/precuneus, medial prefrontal cortex, inferior parietal lobules, lateral temporal cortices, and hippocampus (Dennis & Thompson, 2014; Raichle et al., 2001). These findings are consistent with the Alzheimer's disease pattern of temporoparietal hypometabolism observed on most PET studies (A. B. Newberg & Alavi, 2010). In Alzheimer's disease, there is an accumulation of amyloid protein which is associated with neuronal death in the cerebral cortex, amygdala and hippocampus (Bloom, 2014; Wenk, 2003). Parkinson's disease is caused by a decrease in brain dopamine levels. Protein aggregates known as Lewy's bodies cause the death of dopamine producing neurons in the substantia nigra and subsequently decreased dopamine in the basal ganglia (Ottolini et al., 2017).

It is thought that systemic vascular dysfunction is an important component of neurodegenerative disease since cardiovascular and metabolic disease such as hypertension and diabetes are known major risk factors (Girouard & Iadecola, 2006). Hypertension causes vascular hypertrophy, promotes atherosclerosis leading to hypo-perfusion (Girouard & Iadecola, 2006) and an eventual increase in cellular oxidative stress (Black et al., 2009). According to De la Torre (2016), interventions which improve cerebral perfusion in the elderly may delay the onset of dementia and Alzheimer's disease. Several authors have

shown the beneficial effects of meditation on increasing cerebral perfusion in the prefrontal and parietal cortex (Newberg et al., 2010), maintenance of gray matter thickness (Pagnoni & Cekic, 2007), increasing the power of cognitive circuits (Xiong & Doraiswamy, 2009) and improving myelination of white matter tracts (Tang et al., 2010). All neurodegenerative diseases affect different regions of the brain, with different characteristics at the phenotypic level, i.e., progressive loss of sensory-motor and cognitive functions (Montero-Odasso et al., 2017; Woolley et al., 2011). However, the etiology at the cellular and molecular level is similar (Gitler et al., 2017; Hervás et al., 2012; Vadakkan, 2016). Analysis of these similarities offers the chance of addressing many diseases simultaneously (Rubinsztein, 2006; Thompson, 2008). In addition, practices such as meditation may be useful across neurodegenerative diseases as we will consider below.

Given these observations regarding the aging brain and the brain affected by neurodegenerative disorders, we also can consider which brain structures and functions might have an associated impact on religious and spiritual beliefs and attitudes. One model of “normal” spiritual development was put forth by Dr. James Fowler in his *Stages of Faith*. Building on this psychological framework, we explored how brain development throughout the lifespan might correlate with changes in spiritual development (A.B. Newberg & Newberg, 2005).

In Fowler’s model, the stages that might relate more specifically to the topic of aging and neurodegenerative diseases begins with the “Individuative-Reflective” stage. This is the fourth stage and occurs when one’s reliance on external sources of authority is interrupted. This stage is often associated with the emergence of the executive ego. This ego is defined by Fowler as the internal process that takes agency and responsibility for its choice of belief and relocation of authority within a person. Usually, this stage begins in young adulthood when one takes responsibility for their own choices independent of the sentiment of their former or present community. However, this stage can occur as late as age 30–40 years.

On a neurophysiology level, this stage is associated with significantly increased stability of cognitive and emotional process compared to previous stages, and these processes are now fully developed. New connections and pruning are limited and in balance, an individual’s cognitive functions are, for the first time, operating to their full extent during this stage. This stage is identified on imaging as a relatively stable metabolic pattern and full activity in the cortical regions that support emotional and ego/executive processes (Shamchi et al., 2018). A well-defined identity is able to be established at this time and is likely associated with enhanced affective, behavioral, and cognitive processes. These fully functioning mechanisms may prime a person in this state to reflect on his or her identity, both critically and objectively, while finding deeper meaning through the translation of symbols into concepts. According to Fowler, progression to Stage 5 is marked by disillusionment with one’s life

compromises and recognition of life's complexities that go beyond human reason and abstract thinking capabilities. This leads to turning to other traditions and belief systems to support a search for a more a multileveled approach to the truths of life.

Stage 5 is referred to as "Conjunctive Faith" according to Fowler. On a neurophysiological level, the fifth stage is associated with a decrease in the overall brain metabolic activity beginning around age 40 (Newberg & Alavi, 2010). The metabolic activity continues to decline throughout the rest of the individual's life. Emotionally, this midlife stage can be associated with a readiness to encounter other faith traditions in a search for value and meaning in life. A new understanding of the individual's life and relationship to others will follow, resulting in a reclaimed and re-worked faith and identity. However, we might argue that the decreasing brain metabolic activity may, not only reflect, but also contribute to the disillusionment felt by the individual that catalyzed the fifth stage. The brain may no longer seem to be able to discover the answers it tried so hard to find when it had its full complement of functions. In other words, as the brain loses neuronal connections, unknown to the person, the reduced cognitive functions may lead to a feeling that answers are being lost and will not be found on the current path. In addition, the conception of the self may appear to fragment as a result of the diminished connections between neurons contributing to the formation of the self and the cognitive and sensory input. The ultimate result may be an apprehension that the current state of self is no longer equipped to take on the struggle to know and understand.

The "Universalizing Faith" is the last stage described by Fowler and is one that signifies the overcoming of paradoxes through actualization, both moral and ascetic, that lead to an unprecedented sense of oneness between the self and the individual's religious tradition. This union may be representative of the union between the self and an ultimate reality or with God that results from differing spiritual experiences and practices. Beyond the individual's own faith, the universalizing faith may also lead to a newfound understanding of all traditions having similar characteristics, a universalization of all faiths in addition to the union found within the individual's faith. We have hypothesized that this experience is associated with further decreases in metabolic activity in the cognitive and sensory areas in the temporal and parietal regions. In fact, several interesting brain lesion studies indicate that lesions in the parietal lobe are more likely associated with feelings of self-transcendence (Urgesi et al., 2010), an experience similar to the sense of universalizing faith.

Relationship between brain changes and spirituality in aging and neurodegeneration

In normal aging, there are brain changes that are associated with altered perspectives on religiousness and spirituality, and there are even more rapid

changes in brain function associated with neurodegenerative diseases. Regardless of aging or neurodegenerative disease, the integrity of neuronal pathways appears to determine the extent of religiosity and spirituality of individuals. The relationship between spirituality and neurophysiology or neuropathophysiology should also be regarded as a “two-way street”. As the literature below describes, being religious or spiritual may affect the brain and various neurophysiological or neuropathophysiological processes may affect one’s spirituality or religiousness. For example, one study found that the greater import that individuals put on religiousness or spirituality, the thicker their cortices throughout the occipital and superior parietal lobes (Miller et al., 2014), even in older individuals (Afonso et al., 2017). In a similar study, regional cortical thickness or volume related to the performance in a range cognitive tasks (Dickerson et al., 2008). Kapogiannis et al. (2009) validate the same relationship in the context of principle components of religiosity. Newberg (2017) discusses the activation of the right prefrontal cortex required for intense focus during spiritual practices. Brain imaging studies of volitional types of meditation show increased activity in the prefrontal cortex and anterior cingulate gyrus (Newberg et al., 2001). That these areas are affected during spiritual practices could have implications with aging and neurodegenerative processes that affect these very brain regions. In fact, there is evidence that religiousness may be protective against various aging related brain problems including both psychological and cognitive symptoms (Kraal et al., 2019; Malone & Dadswell, 2018).

The right temporal lobe has been identified as a locus for religiousness based upon brain stimulation studies (Persinger, 1983) and the finding that epilepsy in the temporal lobe has been associated with hyper-religiosity and conversion (Bear & Fedio, 1977). Kapogiannis et al. (2009) identified the cortical volume BA 21 in the right middle temporal gyrus as related to the component of religiousness reflecting on intimacy with God, a predictor of religious behavior. In their study, 40 healthy adults reported differing patterns of religiosity as reported in a survey to determine principal components of religiosity by factor analysis. Regional cortical volumes were measured via voxel-based morphometry and associated to certain components of religiosity. They also speculate that a high-volume range of the right middle temporal gyrus is associated with religious behavior, whereas a low to normal volume range is associated with non-religious behavior. The hippocampus, located in the temporal lobe, has also been identified as a region of the brain involved in religiosity and spiritual practices, especially activated during meditation (Lazar et al., 2000). Among some epilepsy patients, hyper-religiosity was found in patients with smaller hippocampal volumes religiosity (Wuerfel et al., 2004). According to Owen et al. (2011), one’s religiosity can aid in predicting the atrophy of the individual’s hippocampus. Subjects of the study who had a life-changing religious experiences, or the self-identified as “born-again”

Protestants or Catholics (meaning they experienced a conversion experience) showed greater hippocampal atrophy over time than not “born-again” Protestants (Owen et al., 2011). The atrophy was predicted by their baseline identification in the study.

The atrophy of the hippocampus is of particular interest in studying religiosity in Alzheimer’s patients because of the characteristic atrophy of the brain in the disease, and particularly the hippocampus. For example, Gosche et al. (2002) found that the hippocampal volume may help identify individuals in early preclinical stages of Alzheimer’s. In their study of the brains of older nuns (age range between the late 80’s and early 90’s), Gosche et al. (2002) found that individuals with dementia who met neuropathologic criteria for Alzheimer’s showed significantly smaller left hippocampal volumes. Individuals without dementia and Alzheimer’s disease had significantly larger hippocampal volumes. Roher et al. (2012) quantified cerebral blood flow and hippocampal volumes using magnetic resonance imaging techniques in eight patients suffering from mild to moderate Alzheimer’s Disease and their age-matched controls. They found a 20% reduction in cerebral blood flow in the Alzheimer’s patients as well as a statistically significant reduction in hippocampal volume in these patients. The hippocampal volume has a high predictive value of differentiating individuals in stage II from stage I or lower disease (Gosche et al., 2002). Therefore, the atrophy of the hippocampus may be a useful index in identifying Alzheimer’s because it is expressed in a clinical setting (Gosche et al., 2002). Because Alzheimer’s disease has been strongly tied to the atrophy of the hippocampus, the studies referenced above on the connections between the hippocampus and the religious centers of the brain can be applied here. Results regarding changes in religiosity due to hippocampal atrophy can be extended to encompass the study of Alzheimer’s disease and change in religiosity.

Religious experiences and practices have also been tied to neurotransmitters, both excitatory and inhibitory. Such neurotransmitters include dopamine, serotonin, and acetylcholine which may play a role in religious experiences (Newberg, 2017). Using 11 C raclopride PET scans, dopamine specifically has been found to be released during spiritual practices such as Yoga Nidra meditation (Kjaer et al., 2002). As a primary neurotransmitter, dopamine is involved in the brain’s reward system and associated with positive emotions (Newberg, 2017). Newberg (2017) also found that after a one-week spiritual retreat of intense meditation and prayer, participants showed a change in the dopaminergic system. This suggests that spiritual experiences affect, and are maybe prime by, the dopamine system. The effect of dopamine on religious is of particular importance when looking at Parkinson’s disease which is marked by death of dopamine producing neurons in the substantia nigra (Ottolini et al., 2017). For example, one study suggested that people with Parkinson’s disease have reduced religious beliefs and

practices. McNamara et al. (2006) used the Brief Multidimensional Measure of Religiousness/Spirituality (BMMRS; Fetzer Institute 1999) to demonstrate that Parkinson's patients were more likely to report that religion was less important to them compared to age matched controls. However, Redfern and Coles (2015) hypothesizing that these results may be partly explained by reduced mobility and social isolation associated with Parkinson's disease showed that through the course of a year even though the Parkinson's group showed greater decline in mobility and cognition compared to control their religiosity scores were unchanged. No aspect of faith was reduced by degeneration of the basal ganglia pathways. This was recently published in an abstract form and further randomized controlled trials will be needed to sort this out.

Conversely, in a well conducted pilot study with age matched controls Butler et al. (2011) had shown that Parkinson's disease patients consistently scored lower in religiosity and that this mechanism is organic and hemisphere dependent. The study consisted of 71 patients with midstage Parkinson's Disease with 75 age matched controls as well as a parallel pilot study with 21 patients suffering from Parkinson's Disease, and it used the Brief Multidimensional Measure of Religiousness/Spirituality as a measure of religiosity. The main study of 71 patients found that patients suffering from Parkinson's Disease scored lower in five of the six dimensions of religiosity. Religiosity was shown to be related to disease stage, male gender, and asymmetry. Patients in the control study who demonstrated greater right than left forebrain dopamine dysfunction showed a more pronounced decrease in religiousness. These findings indicate that aspects of religious/spiritual cognition appear related to specific cerebral structures. In 2015, Redfern and Coles published a review of literature on Parkinson's disease and spirituality and concluded that the different conclusions are related to contrasting methodological approaches. Case control studies have shown a decrease in religious beliefs and qualitative studies found that religious faith remains important to patients with Parkinson's disease.

Use of religion and spirituality for coping in the elderly

A number of studies have found patients using religion and spirituality as an approach to coping with various illnesses including neurodegenerative diseases. In its broadest context, spirituality in the elderly cannot only help with existential questions of life, but have a practical aspect helping people reevaluation life, rethink meaningful engagement in life, and redefine the fundamental constituents of identity (Janhsen et al., 2019). And as we have described, spirituality and religion, particularly when associated with specific practices, appear to slow cognitive decline, and help provide coping strategies to deal various diseases and improve quality of life (Agli et al., 2015).

Disease related agitation can be reduced by involving adults with neurodegenerative disorders in meaningful activities. Even though some activities may be difficult because of memory loss and physical disability, many spiritual and religious activities which rely on procedural memory and limbic system aspects of attachment may be more easily performed. This form of intervention, called Procedural and Emotional Religious Activity Therapy, can be applied successfully in many different religious traditions (Vance, 2005). An elegant longitudinal study in 2007 by Kaufman et al. also demonstrated that higher levels of spirituality and private religious practices slowed the cognitive decline in patients suffering from Alzheimer's disease.

Spirituality is closely tied to bereavement in an aging population coping with conjugal loss or in the face of disease. Koenig et al. (1988) found elevated well-being in older populations hospitalized for serious illnesses was predicted by religious variables used for positive coping including seeking a relationship with God and clergy members. Literature regarding the biopsychosocial benefit of religion and spirituality on patients suffering from chronic diseases show that religiosity and spirituality function as buffering one from stressors (Vance et al., 2011). Vance (2006) found that 72% of older adults with HIV reported a change in spirituality catalyzed by their diagnosis. In a separate study, the change in spirituality was positive; from four different clinics, 75% of patients indicated a greater level of spirituality having diagnosis with HIV (Cotton et al., 2006). The results indicate an inverse relationship between spirituality and physical and psychological functioning, suggesting that poorer diagnosis leads to patients turning to spirituality to cope (Cuevas et al., 2010). Spiritual coping after a diagnosis includes increased self-esteem, life satisfaction, optimism, and decreases alcohol use.

Spirituality in adults with HIV was also changed by a death of a loved one. Bower et al. (1998) found that the decline of CD4 T cells was slowed when HIV-positive men who suffered from an AIDS-related loss of a loved one to AIDS-related disease reported finding meaning. Finding meaning is a key component of spirituality in coping (Michael et al., 2003). CD4 T cell decline is a marker of progressing disease, so spirituality suggests less mortality. Loss of a loved one affects women disproportionately in the United States with almost of women 65 years and older are widows, and nearly 70% of this population lives alone (U.S. Census Bureau, 2003). Michael et al. (2003) identified six aspects that impact the widowhood experience and how spirituality may affect coping with loss: 1. Age and timing of death, 2. Caregiving, 3. Psychological wellbeing, 4. Physical health, 5. Social support, 6. Use of terminal care services.

Older adults have shown to demonstrate more religiosity and spirituality than other cohorts (McFadden, 1996) which may prepare widows better for loss of a loved one by supplying an already established explanation for the death, saving the widow the trouble of embarking on a search of meaning and

increasing the sense of well-being and comfort (Michael et al., 2003). In fact, one study found that such religious beliefs prior to loss predicted sense-making later on (Davis et al., 1998). Bahr and Harvey (1979) compared 44 widows of the Sunshine Mine fire who had religious beliefs and those who did not in a longitudinal study of a homogenous population assessing quality of life and bereavement. They found that five years post-loss, widows with religious beliefs and church involvement reported more stable qualities of life than widows who did not participate in religious beliefs of church involvement. 63% of widows who were church members were reported stable quality of life compared to the 29% of unaffiliated widows. Moreover, the study found that widows who identified as religious and attended church frequently (at least once a month) reported a higher percentage of the population (64%) as well-adjusted than those who attended church less than monthly (25%). Loss of a spouse may also come with loss of a social support system that religion and spirituality can compensate for. Pargament (2001) expands the benefit of religious support to evidence showing that support from and collaborative coping with God lead to positive adjustment. Religious engagement not only is useful for coping, but has quantitative benefits in terms of overall mortality and disability. Ofstedal et al. (2019) used data from the Health and Retirement Study (1998–2014 waves) and found that attendance at religious services at least once a week was associated with a 1.5 to 5.2 years longer total life expectancy and between 1.1 and 4.0 years longer disability free life expectancy compared to those who attend less frequently or never attend services.

Use of spiritual practices in the elderly

Evidence suggests that participation in religious practices and activities is important to many older individuals and is associated with slower progression of Alzheimer's disease (Kaufman et al., 2007), decelerated cognitive aging, (Corsentino et al., 2009), and enhanced quality of life in the healthy elderly (Ellison & Levin, 1998). Studies have suggested that the elderly believe that their personal spirituality was important in their acceptance of losses, finding hope and relief from fear (Beuscher & Beck, 2008), their faith allowing them to be more positive and enjoy day to day life.

Prayer as a coping mechanism is most common and helps with emotional healing and reassurance in all elders (Narayanasamy & Narayanasamy, 2008). Narayanasamy and Narayanasamy (2008) cite that in face of cardiac surgery, 96% of patients pray, and 97% reported the act as being helpful. Furthermore, of Americans, 82% believe in the healing power of personal prayer and 77% believe that serious illness can be cured with God's intervention. Numerous research studies have shown that spirituality is an important coping mechanism for individuals with debilitating and chronic illnesses (Beuscher & Grando, 2009). Participating in church activities fulfills their need to be useful and productive

(Beuscher & Grando, 2009). It is especially important in Alzheimer's patients because it provides a sense of control over their progressive cognitive impairment. Effect of faith in those suffering from Parkinson's disease remains controversial. In a study of 22 patients suffering from Parkinson's Disease with age-matched controls, McNamara et al. (2006) suggest that patients with Parkinson's are less likely to consider religion as an extremely important life goal. Since they show little emotion, the inference is that Parkinson's patients have low interest in faith. The resulting lower scores in religiosity measures demonstrated by Parkinson's patients were correlated with prefrontal dopaminergic network function. However, Giaquinto et al. (2011) found that for the most part patients with Parkinson's disease do maintain their faith although differences were found between right and left onset of Parkinson's disease in their study of 83 patients with Parkinson's Disease. Using the Royal Free Index as a measure of evaluating beliefs, patients with left onset Parkinson's Disease reported statistically higher RFI scores than the controls, indicating stronger beliefs that their faith aided in coping with and explaining their illness.

Prayer has often been compared to meditation in that it is a private spiritual practice that focuses attention on an individual's inner experiences. Therefore, prayer should be associated with measurable changes in brain activation (McNamara et al., 2003). Electroencephalographic and neuroimaging studies of people engaged in meditation have demonstrated increased level of frontal brain function (Andresen, 2000). It was shown by McNamara et al. (2003) that those individuals with higher neuropsychological function and higher prayer frequency had the better health scores.

Rowe and Kahn (1997) created a model for understanding health throughout the lifespan of an individual and suggested possible interventions for the aging population. However, Crowther et al. (2002) have successfully argued that the spiritual dimension of older adults has not consistently been integrated into models for successful aging. They developed an enhanced Rowe and Kahn's model for successful aging with the addition of a fourth factor, positive spirituality, to the three interdependent pillars of biological, psychological and social processes. Measures of religiosity such as frequency of prayer and attendance at religious services have been shown to have a beneficial effect on both physical and mental health (Beit-Hallami & Argyle, 1997). Lawton (2001) states that there are 11 universal human needs, which include meaningful activity and spiritual wellbeing. Specific religious activities may fulfill both needs in the elderly. Prayer and related spiritual practices may help to reduce unhealthy levels of stress (Koenig, 2001). A study review by Marciniak et al. (2014) explored the effect of meditation on attention, memory and cognition. Overall these studies suggest a positive effect of meditation. A study by Pagnoni and Cekic (2007) showed that age did not affect gray matter thickness in those that practiced meditation regularly. Vihangam yoga meditation has shown improvement in attention span and speed of processing (Prakash et al., 2012).

With regard to studies specifically evaluating the effects of spiritual practices on brain function in the elderly, several meditation techniques such as mindfulness and transcendental meditation are used by psychologists as part of their therapeutic armamentarium. Meditation can delay the onset of dementia in Alzheimer's disease (Horrigan, 2007) by affecting the traditional risk factors as well as by impacting cerebral blood flow (Roher et al., 2012). Several studies have examined the effects of a meditation technique – Kirtan Kriya – on seniors with cognitive impairment (Innes et al., 2012; Moss et al., 2012; Newberg et al., 2010) and demonstrated a significant improvement in cerebral blood flow, particularly in memory related regions of the prefrontal cortex, superior frontal gyrus, and superior parietal cortices. These changes in brain function were associated with comparable improvements in memory, stress, mood and quality of sleep. Khalsa et al. (2009) studied changes in brain physiology in eleven healthy patients during Kirtan Kriya meditation using cerebral blood flow single-photon emission computed tomography. Compared to baseline condition, significant increase in cerebral blood flow was observed in the posterior cingulate gyrus, one of the first brain regions to show decline in function in patients diagnosed with Alzheimer's disease (Horrigan, 2007).

Two other studies exploring the impact of spiritual practices on the elderly brain demonstrated that practices such as Vipassna and Zen Buddhist meditation result in improved cortical thickness with aging, particularly in the frontal lobes (Lazar et al., 2005; Pagnoni & Cekic, 2007). Elderly Yoga practitioners with over eight years of experience were similarly found to have increased cortical thickness that appears improved as compared to similarly aged people who do not practice yoga (Afonso et al., 2017). And a systematic review of eleven studies described significant improvements in elderly subjects' cortical thickness, functional connectivity, and executive network neural function after practicing Tai Chi as a therapeutic intervention (Pan et al., 2018). Thus, spiritual practices appear to have both clinical and neurobiological effects on the elderly.

Religious struggle and the elderly

Despite all the obvious and proven benefits of religion and spirituality, it is important to know the religious history of the individual before propounding these techniques. Techniques that require high cognitive functioning like bible study, storytelling etc., or for individuals that have left a particular religious ideology for various reasons, may cause more frustration and agitation as cognitive decline progresses. Additionally, individuals who have not been very religious during their lifetime may not gain as much benefit (Vance, 2005). And it goes without saying that individuals should not be asked to perform practices that are inconsistent with their beliefs. Furthermore, there are a number of circumstances in which religious attitudes can become

problematic leading to heightened anxiety, depression, and even mortality. Religious struggle, which can occur for a number of reasons in the elderly (see below) becomes more problematic for health at successively older ages (Krause et al., 2017). And incorporating spiritual elements into therapeutic approaches can be very beneficial to help elderly patients better manage anxiety, depression, and even personal trauma (Bowland et al., 2013).

In the literature, when looking at long-term health trajectories in light of religiosity, the relationship to frequency of religious service attendance is often studied (Koenig et al., 2012). Functional disabilities may have an impact on service attendance. Benjamins et al. (2003) conjectured that older adults may minimize their social activity after the onset of disease, but that this limitation in religious attendance may increase private forms of religious engagement. The onset of disease has been studied by others as contributing to decrease in religious attendance due to physical limitations (Benjamins et al., 2003). In one study, adults that suffered from functional impairments attended religious services less frequently than unimpaired adults (Idler & Kasl, 1997). Another study found a similar relationship stating that lower levels of service attendance was associated with higher impairment levels (Hays et al., 1998).

Benjamins et al. (2003) discuss chronic impairments such as broken hip, cancer, or stroke as major determinants in the decline of service attendance, and Hybels et al. (2012) also found that fewer mobility impairments at baseline was associated with more frequent service attendance. Benjamins et al. (2003) suggest that the compounding effects of more than one impairment affecting one's health may also lead to a decline in religious attendance. The inverse relationship between levels of baseline impairment and service attendance observed by Hybels et al. (2012) was corroborated and may be explained by reverse causation according to Fitchett et al. (2013). The physical disability that accompanies illness may be the factor that limits religious service attendance in the elderly (Benjamins et al., 2003).

Other factors such as stigma also affect religious attendance. Both age-related, and disease related, such as HIV stigma are experienced by aging adults (Vance et al., 2011). In a study by Cotton et al. (2006), 10% of people diagnosed with HIV changed congregations and 25% of people reported feeling alienated for their HIV/AIDS status. This ostracization leads to a change in religious engagement shown by 15% of the older decreasing their service attendance following diagnosis (Vance et al., 2011). The stigma that may be associated with other conditions in aging populations can potentially contribute to a change in service attendance.

Other religious struggles in the elderly may arise from ideological challenges to their beliefs in the face of disease or end of life. Certain forms of religiosity were found to increase mortality in the elderly ill population (Pargament et al., 2001). Pargament and colleagues reported that patients who reported of feeling "alienated from or unloved by God" or "attributed their illness to the

devil” were more likely to increase their mortality rates in the following two years. Another study of hospitalized older adults showed that religious struggle, marked by feelings of being punished by God, the work of the devil, or anger towards God, was associated with poorer health (Koenig et al., 1998). In their study of 577 patients over the age of 55 admitted to general medicine inpatient services, religious coping (21 types) and nonreligious coping behaviors were analyzed. Positive religious coping behaviors related to better mental health, and over half of the religious coping behaviors positively related to greater spiritual growth, cooperativeness, and stress related growth. The study found that religious coping behaviors were as strongly, if not more strongly, associated with better health status than nonreligious coping behaviors. However, negative religious coping methods, such as questioning God’s love or disagreement with the church, were positively related to depression and negatively related to quality of life. The relationship between religious coping methods and growth, cooperativeness, and stress related growth were weaker with the negative methods than in the positive ones. Pargament et al. (2001) found a slight but significant correlation with greater religious struggle discussed in the studies above and decrease in church attendance frequency.

Interestingly, a large study by Strawbridge et al., (1998) based on the 1994 Alameda County Study survey of 2,537 subjects found that while both organizational and non-organizational religiosity buffered against depression in the elderly for non-family stressors such as financial or health problems, non-organizational religiosity exacerbated depression associated with child problems, and organizational religiosity exacerbated depression associated with marital problems, abuse, and caregiving (non-organizational religiosity was defined as prayer and religious and spiritual beliefs while organizational religiosity was defined as attendance at services and other religious activities).

Conclusion

Further work needs to be done to understand the effect of religiosity and spirituality in healthy aging as well as in those patients with neurodegenerative disorders. Emerging evidence in this exciting, hitherto untapped field of neurotheology has shown that spirituality and religious beliefs may be altered because of organic brain issues. And conversely, religious and spiritual beliefs can alter and potentially support brain function in positive, but sometimes negative ways. That the brain and religious/spiritual phenomena may reciprocally interact has broader implications for trying to ascertain any causal relationship – e.g., does the brain cause religious beliefs? Such a question lies at the heart of neurotheology and the study of aging and neurodegenerative disorders may provide some fascinating opportunities for elucidating any causal relationships. However, great care must be taken regarding interpretation of study results before concluding that a clear causal arrow exists.

More practically, a better understanding of these relationships may allow individualized therapies incorporating spirituality to impact the rate of disease progression. Going forward, it will be interesting and necessary to continue to expand future research to include individuals from different ethnic, cultural, and religious belief systems, especially with those populations that may define religion and spirituality differently. Expanding this entire area of research would ultimately have implications for a deeper understanding of the relationship between the brain and spirituality/religion, and how that relationship changes with aging and neurodegenerative diseases. Further, such information might be useful for guiding older individuals through that life stage with respect to their religious and spiritual beliefs and practices.

Disclosure statement

All authors fully contributed to this paper. No authors have any financial conflict of interest related to the study. All authors have seen and approved the manuscript.

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