The Relation Between Cognitive Reserve, Functionality, and Post-Mortem Cortical Structures in Adults with Alzheimer's Disease

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Background & Purpose

Cognitive Reserve
A theory that explains the discrepancy between expected lower cognitive abilities due to cerebral pathology and higher actual cognitive performance. (Reed et al., 2011)

Background Information
- It is believed that certain life experiences, such as education, social interaction, or cognitively stimulating activities, may contribute to building cognitive reserve (CR).
- CR may delay a clinical diagnosis of Alzheimer’s because it may postpone the onset of symptoms even in the face of physical pathology.
- Identifying which life experiences have the most impact on building cognitive reserve could help postpone the onset of Alzheimer’s disease for future generations and increase the number of quality years individuals may have.

Background Information
The purpose of this study is to examine how cognitive reserve influences the relation between reported brain functionality and cortical atrophy in adults with Alzheimer’s Disease. The research team will discuss clinical implications and future directions for research related to the cognitive reserve theory.

Research Question
How does cognitive reserve influence the relation between reported functionality and brain structures of adults with Alzheimer’s Disease?

Methods

Title/Abstract Review
- Researchers searched the 5 databases below using the listed search terms.

Databases
- ProQuest
- PsycInfo
- Academic Search Premier
- CINAHL

Search Terms
- “Cognitive Reserve” OR “Functional Reserve” OR “Reserve” OR “Cognitive-Planning” OR “Behavioral Brain Reserve” OR “Neurological Brain Reserve” OR “Brain Reserve”

Age
- Alzheimer’s OR “Alzheimer’s” OR “Dementia” OR “Francis” OR “Related Memory Loss” OR “Neural Degeneration”

CINAHL
- “Postmortem” OR “After Death” OR “Autopsy”

Full-Text Review
- The researchers conducted a full-text review of the remaining articles using the exclusion criteria below.

Exclusion Criteria
- If not to mention pre-mortem levels of cognitive functioning
- If not to include post-mortem brain analysis
- If not to have Alzheimer’s disease

Quality Appraisal
- Quality appraisal of the remaining 4 articles was completed using the Laurel Method: Evidence Appraisal Tool for All Domains in the areas of Descriptive Study, Epidemiologic Study, Case Series, and Cogntively Stimulating Activities.
- All of the researchers reviewed all 4 articles and were 100% reliable in their decisions.

Results

Study Quality and Participant Demographics

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</thead>
<tbody>
<tr>
<td>Quality</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Participants</td>
<td>n=31</td>
<td>n=24</td>
<td>n=9</td>
<td>n=24</td>
<td>n=20</td>
</tr>
<tr>
<td>Recruited from</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>Age</td>
<td>68.00±11.13</td>
<td>64.5±1.6</td>
<td>63.9±1.0</td>
<td>69.5±16.0</td>
<td>68.0±2.8</td>
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<tr>
<td>Education</td>
<td>13.7%</td>
<td>13.7%</td>
<td>13.7%</td>
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<tr>
<td>Gender</td>
<td>Male 53%</td>
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<td>Male 53%</td>
<td>Male 53%</td>
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<tr>
<td>Race</td>
<td>White (85.8%)</td>
<td>White (85.8%)</td>
<td>White (85.8%)</td>
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Data

Global Cognitive Reserve

<table>
<thead>
<tr>
<th>Cognitive Functionality</th>
<th>Post-Mortem Analysis</th>
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<tbody>
<tr>
<td>Wilson et al. (2013)</td>
<td>Neocortical density in specific brain areas is related to the presence of clinical manifestations of AD, and differentiates groups</td>
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<tr>
<td>Neocortical reserve in the brain is important for the manifestation of Alzheimer’s Disease</td>
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<tr>
<td>Neocortical density, post-mortem pathology (i.e., entorhinal and neocortical) had a significant association with post-mortem cognitive function</td>
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<tr>
<td>Higher neuronal density in the brain was associated with higher cognitive function and dementia severity</td>
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<tr>
<td>Neocortical density (along with the locus rubrospinalis) was the strongest predictor of reserve (mc=.52)</td>
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Social Networks

Cognitive Functionality

<table>
<thead>
<tr>
<th>Cognitive Functionality</th>
<th>Social Networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bennett et al. (2006)</td>
<td>Change in cognitive function in disease pathology was greater for participants with similar social networks</td>
</tr>
<tr>
<td>Wilson et al. (2013)</td>
<td>Higher social function was found in those with higher social networks</td>
</tr>
<tr>
<td>Koeppe et al. (2008)</td>
<td>A majority of people with higher education received a low Alzheimer’s disease category for larger</td>
</tr>
<tr>
<td>Reed et al. (2013)</td>
<td>High school education, there is no statistical significance between Brain &amp; Structural Change (P = .1502)</td>
</tr>
</tbody>
</table>

Cognitively Stimulating Activities

Cognitive Functionality

<table>
<thead>
<tr>
<th>Cognitive Functionality</th>
<th>Cognitively Stimulating Activities</th>
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<tbody>
<tr>
<td>Reed et al. (2013)</td>
<td>The angular correlation (cc) between cognitive reserve and post-mortem pathology was different.</td>
</tr>
<tr>
<td>Wilson et al. (2013)</td>
<td>Participation in cognitively stimulating activities at age 35 reduced the maximum variance between neocortical density and dementia severity</td>
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Discussion

Summary
CR is significantly related to the size of a person’s social network and ongoing participation in cognitively stimulating activities. Education is not strongly correlated with CR. CR is significantly related to a reduced rate of cognitive decline. Post-mortem brain pathology provides evidence to support the theory of CR.

Clinical Application
- Recommending quality social networks and participation in cognitively stimulating activities to patients in all stages of life may have some positive impact on their cognitive abilities later in life.
- Unexpectedly, multiple studies found that education alone did not have a significant correlation with cognitive abilities.

Limitations and Recommendations
- Researchers used retrospective questionnaires to measure cognitive activity at age 40, which includes a potential for recall bias. In addition, a study of how age affects bias noted that “increased age is most often associated with under-reporting rather than over reporting” (Knopke, B. & Wittchen, 1994).
- Methods of measuring cognitive function were inconsistent throughout the research with some using the Mini Mental State Examination (MMSE) and others using composite measures from multiple cognitive tests. Therefore, research should be devoted to establishing a "gold standard" method of quantifying cognitive function in longitudinal studies of Alzheimer’s Disease.

- Of the articles analyzed, a lack of variability in demographics was noted. To make the results of these studies more generalizable, a wider variety of study participants must be included.

Cognitive Reserve
Global cognitive reserve (CGR) is significantly associated with neuroplasticity. Researchers currently use reverse analytic tools to measure GCYR by using putative cognitive reserve (CR) characteristics as a latent variable in relation to post-mortem brain analysis. Despite differences in the methodology used to obtain CR scores, CR remained significantly related to brain pathology. CGR is reported to influence neuronal density of regions associated with cognitive decline.

Conclusion

Individual Characteristics
The article also examined the strength of individual putative CR characteristics on cognitive function and brain analysis. These articles maintain that cognitive reserve can be built to some extent, by a series of lifestyle factors:
- Larger social networks were associated with reduced neurofibrillary tangles.
- Education, up to a high school diploma, was associated with a prolongation of the initial stages of Alzheimer’s Disease. Education, after a high school diploma, was not significantly related to neurofibrillary tangles (Koeppe et al., 2008).
- According to Reed et al., cognitive activities after the age of 40 resulted in the strongest relation to cognitive reserve, when controlled for education suggesting that ongoing participation in cognitively stimulating activities is the strongest predictor of the development and maintenance of cognitive reserve (2013).

- Results suggest that “cognitive activity during adulthood can compensate for low education on the outcome variable memory performance” (Lachman, Agirnaswai, Murphy, & Tu, 2009).
- No studies reported a significant relationship between socioeconomic status and CR.

References