Numerical Quantity Estimation in the Elderly, With and Without Cognitive Impairment

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by

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Abstract

This study examined mental representation of numerical quantity in 25 elderly participants with varying degrees of cognitive impairment. An analogue number-line task has been used in research of mental representation of numerical quantity in children, but little of such research has been done in elderly populations. This research also examined the clinical utility of this number-line task as a diagnostic tool for dementia and cognitive impairment in old age.

Keywords: elderly, numerical quantity estimation, cognitive impairment, cognitive assessment, dementia

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Mental Representation of Numerical Quantity in the Elderly

Numerical quantity estimation is a cognitive process that develops in early childhood and is an everyday cognitive process throughout the lifespan. The development of the mental representation of numerical quantity has been researched in children using an analogue number scale task (Siegler & Opfer, 2003). While such number-line tasks have been in used in studies involving children and adults, these tasks have not been used to understand mental representations of numerical quantity in the elderly. In early childhood, research has shown that mental representations of numerical quantity progress from a logarithmic to a linear representation (Siegler & Booth, 2004). Of interest is whether such mental representations remain stable throughout the lifespan, or whether they digress to a logarithmic representation in old age.

Furthermore, it is of interest to know whether elderly individuals with some cognitive impairment perform significantly worse on a number-line estimation task than their cognitively healthy counterparts. Julien et al. (2010) found that individuals with semantic dementia performed more poorly on a number-line estimation task compared to cognitively healthy elderly participants, despite preserved numerical ability in general.

Currently, the diagnosis of dementia and mild cognitive impairment is dependent on neuropsychological assessments of cognitive and functional impairments. Developing methods of assessment that can detect specific cognitive impairments is useful in the diagnosis of dementia and tracking the progression of impairment over time. If individuals with some cognitive impairment score consistently worse than their cognitively healthy counterparts, then a number-line task may have clinical utility as a diagnostic tool for detecting early signs of cognitive impairment.

This study will seek to understand mental representations of numerical quantity in elderly individuals with varying degrees of cognitive impairment, and it will also examine the clinical utility of a simple number-line task as a diagnostic tool for dementia and mild cognitive impairment.

Methods

Participants

Participants for this study were recruited from assisted living facilities in Cache and Weber Counties, as well as from the Cache County Senior Citizens Center. 25 participants were recruited. Participants were all age 65 years or older.

Materials

Mini-Mental State Exam (CERAD version)

The Mini-Mental-State Examination (MMSE) is a brief 30-question test used to screen for the presence and severity of cognitive impairment. It includes questions to assess orientation to time and place, working memory, language, and other cognitive functions.

Participant Information Questionnaire

A questionnaire was developed to collect demographic information about the participant including age, education, occupation, marital status, and other relevant variables.

Numer-line Task

The number-line is a 25 cm horizontal line with "0" on the left end and "100," "1000," or "10,000" on the right end. The task was modeled after the anologue number scale developed and used by Siegler and Opfer (2003). The number-line task for this study was modified to not include the target number printed in the center for reference, to minimize confusion for individuals with cognitive impairment. The target number was only given verbally, not visually.

Dementia Severity Rating Scale

For some participants, next-of-kin were asked to complete a Dementia Severity Rating Scale survey (DSRS). The DSRS includes multiple-choice questions about severity of functional and cognitive impairments in aspects of daily living that are typically affected by Alzheimer's Disease and dementia.

Procedures

Recruited participants were asked to set up a time with a researcher when they could devote at least 30 minutes to participate in research. All participants were first administered the MMSE. Participants who scored lower than 20 of 30 on the MMSE were then told that the study required that we meet with a next-of-kin individual for further questions. Informed consent was then acquired from a next-of-kin. For participants who obtained and MMSE score of 20 or above, the researcher then asked the participant the questions from the Participant Information Survey, after which the researcher administered the number-line task.

The researcher presented a half-sheet of paper with a blank horizontal line marked with 0 at the left end and either 10, 100, 1000, or 10,000 at the right end, depending on the scale. Participants received verbal instructions to mark the position of a given value, (i.e., "If this is 0 and this is 100, where should the number 18 go?"). Participants were instructed to mark a single line crossing the number-line with a pencil indicating their estimate.

Participants were given 3 practice trials of 0 – 10 scales, during which the administrator helped the participant understand the task if there was confusion. Following the practice trials, the number-line stimuli were administered in 3 subset groups of 12 number-lines each, and subset order was randomized.

After a period of two weeks or more, a second trial was administered to each participant

to examine psychometric properties of internal consistency and test-retest reliability.

All procedures were approved by Institutional Review Board at Utah State University.

Results

Data collection is still ongoing. To date, first trial data have been collected from 24 participants, with many second visists pending. Results will be updated accordingly.

References

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