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REVIEW ARTICLE

Chess Training for the Elderly: Insights and Prospects as a Dementia Preventive Treatment

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Abstract

This article reviews research on chess training as a treatment to promote cognitive fitness and to delay the onset of dementia among the elderly. Alternative treatments are needed to address the widespread problem of dementia among the elderly, primarily because all drug treatments developed thus far to cure or delay dementia have been deemed either unsuccessful or unsafe. Chess training augmented by artificial intelligence is presented as an alternative treatment to address the dementia crisis. Computer-based technology and open-source chess software such as Stockfish 14 with the artificial intelligence component NNUE have the capacity to enhance chess training programs for the elderly. Although research on chess training for the elderly is sparse when compared to research on drug treatments for dementia, one pilot study, as an example, provided evidence that chess training is a viable intervention to improve cognitive fitness among the elderly. The elderly participants in the study enjoyed the chess lessons and looked forward to the challenge and the camaraderie in the group games against artificial opponents available on websites such as chess.com. Chess instruction is a safe, practical, and efficient intervention that should be implemented in community senior centers and retirement villages. Also, chess instruction in community senior centers and retirement villages provides a potentially highly generative and interesting setting for the scientific study of chess and its utility in addressing the enormous public health problem of Alzheimer's Disease and other forms of dementia. Chess training should be seriously considered as an intervention to be used in research in the quest to promote brain health among the elderly and to protect the elderly from the ravages of Alzheimer's Disease and other forms of dementia.

Keywords: Dementia prevention. Chess training, Stockfish, Artificial intelligence

Introduction

A debilitating medical condition that afflicts many elderly individuals is dementia. Prominent among the various forms of dementia is Alzheimer's Disease that accounts for approximately 80% of all cases of dementia. Dementia inexorably leads to cognitive decline that affects more than 35 million people worldwide. For example, Alzheimer's Disease is a progressive condition marked by memory loss and then death.

In *The Scientific American Healthy Aging Brain,* Horstmann[1] provided an excellent review of basic research on Alzheimer's Disease. That book is a vital source for much of the basic information on Alzheimer's Disease and other forms of dementia cited in this article. In that book and throughout this article, the expression "the elderly" refers to people who are at least 65 years of age.

Alzheimer's Disease is the fifth leading cause of death for people over 65 years of age in the U.S.A. Approximately 5.4 million Americans, i.e., approximately 13% of Americans over 65 years of age, have Alzheimer's Disease. Approximately 44% of Americans over 85 years of age have Alzheimer's Disease.[1(p.91)]

Dementia is lethal in most cases. For example, people diagnosed with Alzheimer's Disease tend to die between 4 and 8 years after the diagnosis. Physiologically, Alzheimer's Disease is marked by the formation of tau tangles within neurons and the abnormal accumulation of beta-amyloid plaque covering neurons. As a result of these two abnormal neurological changes, neurons die and cognitive and physical deterioration results. Once Alzheimer's Disease is established in a person, the person will inevitably die.[1(p.91)]

However, many older people do not have any other form of dementia. In fact, many elderly citizens die from conditions other than dementia.

The medical costs of dementia are enormous, well over 100 billion dollars worldwide annually. As a result, there has been an intense search for medical cures for various forms of dementia. Governmental agencies and pharmaceutical firms have spent billions of dollars on research to find medical cures for different forms of dementia.

Drug Treatments

This massive expenditure of research funds resulted in the drug Aduhelm being given accelerated approval by the U.S. Food and Drug Administration in 2021 to slow the cognitive decline for persons with the disease.[2,3,4] The Aduhelm treatment is given intravenously by infusion over a one-hour period once a month for an indefinite period of time. Biogen, the pharmaceutical firm owning Aduhelm, indicated that the list price for the medication is $28,000 per year. Common side effects of this treatment are painful brain swelling, headaches, and confusion. The Cleveland Clinic among other clinics chose not to prescribe Aduhelm. Aduhelm has not been a financial success for Biogen, which stopped its production.[4]

In addition to Aduhelm, other drugs have been developed to resolve dementia, especially Alzheimer's Disease. Lecanemab[5] and Donanemab[6] are noteworthy drugs

developed to treat Alzheimer's Disease and other forms of dementia. Although these drugs did result in decreases in cognitive declines among many participants, there were some negative side effects.

Among dementia patients receiving Donanemab, there were instances of swelling and bleeding in the brain. Some dementia patients experienced dizziness, headache, or fainting. Most adverse events were mild-to-moderate, but some patients experienced extreme brain swelling.[7] Future drugs that treat dementia by reducing neuronal beta-amyloid plaque need to produce greater cognitive outcomes and markedly fewer negative side effects.

Despite the enormous expenditure of governmental and private funds, there remains no biomedical cure for any other form of dementia. The return on investment for those billions of dollars has been meager at best. The quest for a successful biomedical cure for any form of dementia has been unsuccessful.[8(p.3-6)]

Chess Training for the Elderly

Alternative approaches to addressing the bane of dementia are thus warranted. One source for such alternative approaches is the domain of lifestyle factors that play a major role in delaying dementia. Among the lifestyle factors that are related to the occurrence of dementia are diet, sleep, exercise, and cognitive stimulation. Improper diet, lack of sleep, lack of exercise, and the lack of cognitive challenge appear to be related to the emergence of dementia. Among the forms of cognitive activities that appear to be helpful in maintaining cognitive vitality among the elderly is chess. However, research on the efficacy of chess training as a means to maintain brain health among elderly citizens and to protect the elderly against the ravages of dementia is limited.

There is evidence in support of chess as a cognitively healthy lifestyle factor for the elderly. There are many elderly individuals who are active chess players. There are chess tournaments limited to elderly individuals over 65 years of age.[9] The famous Russian chess trainer and chess grandmaster, Yuri Averbakh, attained 100 years of age before he passed away from natural causes.[10]

Chess is a complex game that requires usage of practically all higher-order thinking skills including skills at critical thinking, decision making, planning, and problem solving. Chess can also require creativity in play. Playing chess requires the comprehension of board positions and the formulation of viable moves.[11]

Chess training is not intended to cure dementia afflicting elderly individuals. Chess training is meant to improve mental fitness so that elderly individuals are less apt to experience dementia. Chess training is intended to increase the capacity of an elderly individual to prevent the onset of dementia. Chess training and chess play have the potential to contribute to the cognitive reserve of an elderly individual.

Chess training for the elderly is not well developed. Chess instruction is usually oriented toward school-aged children.[12-19] No books could be located that are specifically

for teaching chess to elderly people. Also, no books could be identified specifically for elderly people to learn chess.

An important term used in chess is the Elo rating, the international metric of chess competency.[20] Elo ratings can range from 0 that indicates the absence of chess skill to 2853 that is the Elo rating of Magnus Carlsen, the highest rated human player, and even beyond the Elo rating of the highest rated player.[21] Contemporary chess engines such as AlphaZero and Stockfish 14 tend to have Elo ratings higher than 3200 [22] and can evaluate chess positions that result from sequences of more than five moves.

Research Background for Chess Training

Lille-Crespo et al.[23] reviewed existing research on the effects of chess training among the elderly. They determined that the research to support chess training as a protective against dementia is inconclusive, despite some of the research being supportive of the protective role of chess training. They argued that much more research is needed and with larger samples.

Cibeira et al.[24] engaged in a pilot study to determine how effective a chess-training program would be among the elderly. They found that the program had positive effects among the elderly participants including gains in attention, executive function, processing speed, and quality of life. It is anticipated that research on chess training among the elderly that uses contemporary technological tools will also engender worthwhile results.

Neurological research on chess has produced some interesting findings. As individuals advance in their chess skills, individuals tend to make greater use of their frontal and temporal lobes. Amidzic et al.[25] and Atherton et al.[26] determined that amateur chess players tended to formulate chess moves and to analyze new moves in chess with increased activation in the medial temporal lobe; whereas, highly skilled chess grandmasters had increased activation in the frontal and parietal lobes. That indicated that chess grandmasters were accessing knowledge chunks from expert long-term memory by using neural circuits outside the medial temporal lobe. Advances in chess competency is associated with greater usage and coordination of various brain regions including the frontal lobe that is implicated in general intelligence.

Pilot Study of Chess Training

The motivation for this inquiry is the belief that chess training has the potential to be very useful in the care of older people by preventing the onset of Alzheimer's Disease and other forms of dementia and by helping elderly individuals to maintain cognitive vitality. Having Alzheimer's Disease or any other form of dementia is incompatible with playing chess at even a moderate level of chess competency. To explore how elderly citizens react to chess training that uses computer-related technology, a pilot study was implemented and examined to determine how elderly citizens respond to such chess training.[27]

The sample size was small in the pilot study with the participants being 7 men and 5 women. All 12 participants were over 65 years of age. They had little or no experience with chess.

The Saint Louis University Mental Status (SLUMS) Examination was administered individually to each participant prior to the chess training.[28] The SLUMS test has 11 test items and was used to detect mild cognitive impairment and dementia. Test scores for the SLUMS test can range from 0 to 30. Two of the male participants had SLUMS scores in the 21 to 26 range that indicated that they each had mild cognitive disorder. The other 10 participants had SLUMS scores in the normal range between 27 and 30. The SLUMS testing occurred prior to the chess training. There was no post-intervention testing, because the purpose of the pilot study was to explore how seniors would react to chess training.

The chess training lasted approximately three months. It was limited to three months due to funding limits and time constraints on the principal investigator. The chess training made extensive use of chess-related websites available on the Internet such as chess.com[29] and lichess.org.[30] The instruction involved the projection of a chess-related website projected onto a large classroom screen with the use of an instructor's computer connected to the projector.

The chess sessions were typically 90 minutes in length with later sessions lasting up to two hours. In later sessions, the participants became so engaged in the games that they wanted to continue past the regularly scheduled 90 minutes per lesson to complete the games being played.

Results of Pilot Study

Bart[31] used a similar computer-based approach to teaching chess to university undergraduates. The elderly participants tended to differ from university undergraduates in the chess training in two ways. One, elderly participants were neither as competitive nor as quick to learn as university undergraduates. The training had to proceed at a slower rate with the elderly. Two, the elderly participants tended to be timid and afraid to make mistakes.

Elderly participants enjoyed playing as a group against an artificial opponent such as level 1 or level 2 on chess.com, which were the lowest opponent levels available on chess.com at the time. The elderly took turns making a move with other elderly offering advice to the elderly participant making the move. The investigator entered the move recently played into a computer and displayed the move on either a physical chessboard or a computer-connected display screen or both the physical chessboard and the display screen. If the elderly participants defeated an artificial opponent playing both White and then Black, the elderly participants would then play an artificial opponent at the next level on chess.com.

The investigator served as the neutral referee and commented periodically on the game positions. The instructor lauded and celebrated good moves informing the participants why the moves were viewed as good moves. Care was taken to have the artificial opponent be at a chess skill level that was similar to the chess skill levels of the elderly participants. The elderly enjoyed playing chess as a group and they enjoyed making good moves and winning at chess. The elderly became competent enough to

compete well as a group against a level 3 opponent at chess.com, but not well enough to defeat a level 4 opponent at chess.com. An estimate of the group's chess ratings would be Elo ratings in the 1100-1300 range.

Discussion

Several conclusions can be made from this pilot study. One, the two participants with mild cognitive impairment did not make much progress at playing chess. They often needed help from other participants in making moves. The cognitive benefits of chess training for elderly with mild cognitive impairment may be very limited. Two, the other participants in the normal cognitive range made definite progress at playing chess. It is uncertain how much progress that they could have made if the chess training continued.

Group-based instruction.

Several recommendations emanate from this pilot study. One, chess training for the elderly should involve group-based chess lessons. Elderly participants seemed to be very social, enjoying the camaraderie of playing as a group. Also, elderly individuals seemed to enjoy learning from each other.

Technology-based Chess Training.

Chess instruction for elderly individuals should make extensive usage of computer technology and chess-based websites. Elderly participants seemed to be very savvy with cell phones and enjoyed the usage of computers and chess-related websites freely available on the Internet. Bart[27] performed the first chess research study involving the elderly that made use of computer-based technology. However, the technology was just a small portion of computer-based technology that could be used to promote chess learning among the elderly. Websites such as lichess.org and chess.com along with the open-source software Stockfish 14 with NNUE[32] could provide the basis for chess training programs that offer chess lessons, opportunities to play artificial opponents at different skill levels, mechanisms to diagnose errors in play, and mechanisms to prescribe corrective feedback. All of this can be done at relatively low costs, primarily because lichess.org, Stockfish 14, and segments of chess.com are available at no cost. Bart[27,31,33-36] provided illustrations how various computer-based technology, chess-related websites, and chess software can be used in chess training and chess research. Online chess instruction could prove to be very useful in providing chess training to the elderly inexpensively.

Cognitively normal participants.

Chess training programs for the elderly are likely best suited for cognitively normal individuals. The SLUMS test is an example of a test that could be used to identify cognitively normal elderly individuals. Individuals with dementia or with mild cognitive disorder would likely not benefit from chess training programs that make substantial use of relevant technology.

Participant Elo Rating as a Factor in the Protection against Dementia.

As an elderly individual attains more skill at chess, the individual will activate more regions in the brain and do so in a coordinated

manner when playing chess and will attain more cognitive reserve. It is hypothesized that as an individual attains a higher Elo rating, that individual will be less likely to experience dementia than that individual would have with a lower Elo rating.

In summary, chess training for the elderly has definite potential to contribute to the scientific study of brain health and to efforts to address the crisis of dementia among the elderly.

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