Special series on “effects of board games on health education and promotion” board games as a promising tool for health promotion: a review of recent literature

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Abstract
Board games are played by moving game pieces in particular ways on special boards marked with patterns. To clarify the possible roles of board game use in psychosomatic medicine, the present review evaluated studies that investigated the effects of this activity on health education and treatment. A literature search conducted between January 2012 and August 2018 identified 83 relevant articles; 56 (67%) targeted education or training for health-related problems, six (7%) examined basic brain mechanisms, five (6%) evaluated preventative measures for dementia or contributions to healthy aging, and three (4%) assessed social communication or public health policies. The results of several randomized controlled trials indicated that the playing of traditional board games (e.g., chess, Go, and Shogi) helps to improve cognitive impairment and depression, and that the playing of newly developed board games is beneficial for behavioral modifications, such as the promotion of healthy eating, smoking cessation, and safe sex. Although the number of studies that have evaluated board game use in terms of mental health remains limited, many studies have provided interesting findings regarding brain function, cognitive effects, and the modification of health-related lifestyle factors.

Keywords: Board game, Chess, Dementia, Go, Lifestyle modification, Shogi

Introduction
Board games are played by moving game pieces in particular ways on special boards marked with patterns [1]. For example, one game originated in northern India in the sixth century AD and spread to Eastern as well as Western countries. In the West, it spread to Persia and then to Spain via the Moorish conquest, and then throughout Europe, where it ultimately became “chess.” In the East, this game became “Xiangqi” in China, “Shogi” in Japan, and a variety of similar games in other countries. Other popular board games that use two patterns for the game pieces include “Go” and “Othello,” also known as “Reversi.”

In the field of psychosomatic medicine, board game playing is sometimes regarded as a leisure activity, and engagement in this type of activity has been shown to protect against dementia and cognitive decline in elderly individuals [2]. For example, a 20-year prospective population-based study conducted in southwestern France investigated the relationship between the playing of board games and the risk of subsequent dementia [3]. Of the 3675 participants without dementia in that study, 1176 (32%) reported regular board game playing and 840 (23%) developed dementia during the follow-up period. The risk of dementia was 15% lower in board game players than in non-players, and board game players exhibited lesser declines in Mini-Mental State Examination (MMSE) scores and less incident depression than did non-players. Although the mechanisms underlying the reduced risk of dementia in board game players have yet to be elucidated fully, these games require players to be proactive and to anticipate, thinking several steps ahead, during play. These processes may enhance logical thinking and prevent declines in...
cognitive function. Individuals may also engage in non-verbal communication while playing board games, and players are more likely to have the opportunity to gather and participate in a fun activity with others. These factors could enhance individuals’ social networks, which also protects against cognitive decline. Furthermore, in terms of leisure activities, board game playing may also be a form of stress management [4], as the fight-or-flight response is regulated safely within the sophisticated structures of match-type games. Board game playing could also be a form of art therapy, similar to miniature garden therapy [5], facilitating infinite internal manifestations within a narrow space.

In terms of education, the playing of board games may help children learn to follow rules and stay seated for a certain amount of time, and it may increase children's concentration levels [6]. For students and trainees, board game use can enhance health education by stimulating players’ interests and motivation. A search of the Cochrane Database of Systematic Reviews [7] identified a total of 2079 unique citations related to educational games, such as board games and games based on television shows. Of these citations, 84 were potentially eligible for review based on methodological quality, number of participants, interventions, and outcomes of interest, and two randomized controlled trials (RCTs) were chosen. The first study [8] was based on the television game show “Family Feud” and focused on infection control; the group that was randomized to play the game had significantly higher scores on a knowledge test. The second study [9] compared game-based learning (using “Snakes and Ladders”) with traditional case-based learning of stroke prevention and management information. Although the two study groups did not have significantly different knowledge test scores immediately or 3 months after the intervention, the reported level of enjoyment was higher in the game-based learning group. The findings of an original review of articles published through January 2012 [7] neither confirmed nor refuted the utility of game playing as a teaching strategy for health professionals. Thus, the present study aimed to clarify the possible roles of board game use in psychosomatic medicine through a literature search for articles published after 2012 that focused on the effects of board game playing on health-related issues.

**Mind/body changes due to board game use**

Using “board game” as a PubMed search term, 83 studies published between January 2012 and August 2018 were identified; 56 (67%) articles targeted education or training for health-related problems, six (7%) examined basic brain mechanisms, five (6%) evaluated preventative measures for dementia or contributions to healthy aging, and three (4%) assessed social communication or public health policies. The major studies that investigated the effects of traditional board game use are shown in Table 1 [10–33]; some of the articles listed in the table were identified in the reference sections of the original 56 articles or other databases.

Experimental studies investigating brain magnetic resonance imaging (MRI) or electroencephalographic (EEG) signals in professional board game players [10, 22, 26–28, 31] demonstrated that the basal ganglia play an important role in the ability to rapidly determine, or intuit, the best subsequent move in a game situation [24]. Additionally, variations in heart rate and eye movements were examined as physiological parameters during chess play [10, 14, 16]. In case studies and case-control studies, board games were shown to effectively improve symptoms in individuals who experience panic attacks [11], as well as those with attention-deficit/hyperactivity disorder (ADHD) [21] and Alzheimer’s disease (AD) [29]. On the other hand, one study revealed possible hazardous effects associated with the playing of “Go” in individuals with seizure disorders [23]. The amounts of real and virtual playing of board games have increased recently and, as a result, the number of published studies assessing the effects of board game use has also increased [12, 13, 17, 19]. The increase in game play is likely due to the prevalence of computer systems in the current age of information and communication technology (ICT) and artificial intelligence (AI).

**Recent RCTs evaluating board game use**

According to a recent meta-analysis of four studies that investigated chess play [14], age and skill have differential effects on two tasks during game play: selecting the best move for chess positions and recalling chess game positions. The authors found that age was associated negatively, whereas skill was associated positively, with performance in both tasks. Another RCT showed that an intervention using Go improved depression and increased serum levels of brain-derived neurotrophic factor (BDNF) in patients with AD [20]. Similarly, players’ depression and anxiety levels were shown to decrease significantly during a 6-week stress management intervention that utilized Shogi games [25]. Although these data have been presented only at a scientific conference, they will soon be published in this special series. The authors also reported that several patterns of negative cognitive distortion (e.g., lower levels of activity) significantly improved following completion of the Shogi program compared with those in a wait-list control group. An RCT showed that the playing of “Ska,” a traditional board game in Thailand [32], enhanced cognitive function in terms of memory and attention in elderly subjects.
### Table 1: Examples of recent studies using traditional board games

| Authors (years)          | Countries       | Study design        | Subjects or materials                                                                 | Outcomes or variables                                                                 | Impact                                                                                   |
|-------------------------|-----------------|---------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| **Chess:**              |                 |                     |                                                                                       |                                                                                         |                                                                                           |
| Fuentes JP et al. (2018) | Spain           | Experimental, single case | Expert chess player, male, 33 years old                                                  | EEG changes, decreased heart rate variability                                            | Increased cortical arousal by critical flicker fusion threshold, decreased heart rate variability during chess play |
| Barzegar K & Barzegar S (2017) | Iran           | Clinical case       | Middle-aged man with panic attack after post-traumatic stress                           | Clinical course, including subjective physical symptoms                                 | No symptom of nausea, vomiting, or panic attack after cell-phone chess play              |
| Schairogodsky AL et al. (2016) | Argentina     | Database            | 1.4 million chess games played by humans                                               | Long-range correlations, inter-event time distributions                                | Cattuto’s model well described long-range memory used in opening chess lines             |
| Chassy P & Gobet F (2015) | UK              | Database            | 667,599 chess games played by experts from 11 civilizations                            | Conflict avoidance, risk-taking behaviors during open aggression                          | Buddhist experts used riskiest strategy nearly 35% more vs. Jewish experts              |
| Sheridan H & Reingold EM (2014) | Canada   | Experimental        | 41 chess players (17 experts, 24 novices)                                              | Eye movements in 8 chess problems                                                      | Only experts distinguished relevant and irrelevant information during early trial        |
| Moxley JH & Charness N (2013) | USA           | Meta-analysis       | 4 studies of age and skill effects in chess                                             | Age, chess skill, move selection, chess recall                                         | Best-move, recall tasks associated negatively with aging, positively with skill         |
| Leone MJ et al. (2012)   | Argentina       | Experimental        | 25 chess games played by 9 subjects                                                    | Heart rate variation                                                                   | Heart rate signals relevant cognitive episodes, e.g., objective choice correctness events |
| Go:                     |                 |                     |                                                                                       |                                                                                         |                                                                                           |
| Barradas-Bautista D et al. (2018) | Mexico | Computer simulation | Ising Hamiltonian model of black, white Go stones fighting                             | Two-player scenarios, cancer vs. immune system                                          | Go, Ising model provided elements for characterization of cancer invasion, reduction, metastasis |
| Bae J et al. (2017)      | Republic of Korea | Questionnaire survey | 63 subjects predicting outcome of AlphaGo vs. Sedol Lee match                           | Network density, game predictions                                                      | Game predictions more accurate in low-density vs. high-density group                     |
| Silver D et al. (2016)   | UK              | AI Go program       | Search algorithm of Monte Carlo simulation and networks                                | Go win rate                                                                            | AlphaGo had 99.8% win rate against other Go programs, defeated human Go champion         |
| Lin Q et al. (2015)      | China           | RCT                 | 147 patients with Alzheimer’s disease                                                  | Cognitive impairment, depression, anxiety, serum BDNF level                            | Go ameliorated Alzheimer’s disease symptoms, with BDNF up-regulation                    |
| Kim SH et al. (2014)     | Republic of Korea | Case-control study  | 17 children with ADHD, 17 age-, sex-matched controls                                   | Cognitive function, brain EEG changes during Go play–based education                   | Right theta/beta change in prefrontal cortex during study period greater in ADHD group  |
| Jung WH et al. (2013)    | Republic of Korea | Experimental        | 17 Go experts                                                                          | Structural, functional MRI during working memory tasks                                 | Experts had increased gray-matter volume, functional connectivity around amygdala       |
| Lee MK et al. (2012)     | Republic of Korea | Clinical case       | 11 patients with reflex epilepsy, including 6 male Go players                         | MRI, EEG with clinical course                                                         | Individualized strategies like game avoidance most effectively prevented seizures         |
| Shogi:                  |                 |                     |                                                                                       |                                                                                         |                                                                                           |
| Tanaka K (2018)          | Japan           | Review              | Summary of data from [26, 27, 30]                                                      | fMRI changes in game situations                                                       | Cingulate cortex essential for intuitive, strategic decision making for any given Shogi board position |
| Nakao M et al. (2017)    | Japan           | Protocol, RCT       | 65 men aged ≥65 years                                                                 | Cognitive-behavioral attitudes, depression, anxiety, well-being                        | Depression, anxiety levels lower during 6-week Shogi stress management program           |
| Wan X et al. (2016)      | China           | Experimental        | 17 professional, 17 amateur Shogi players, 19 novices                                 | fMRI signals during problem-solving tasks                                              | In professional group, rostral frontal cortex activated only in post-decision period    |
| Wan X et al. (2015)      | China           | Experimental        | 17 amateur Shogi players                                                               | fMRI signals during quick offense-vs-defense                                           | Rostral anterior, posterior cingulate cortices encoded defense, attack strategy          |
Of the 83 articles identified in the present PubMed literature search, 12 articles [34–45] report on RCTs that assessed non-traditional board games (Table 2). A variety of board games has been developed to aid in the health education of patients, children, and medical trainees; most of these games are focused on behavioral modifications, such as the promotion of healthy eating [34, 38], smoking cessation [43], and safe sex [45]. For example, in a Swiss study [43], 240 current smokers were assigned randomly to a group participating in smoking cessation program employing an educational board game (“Pick-Klop”) and a wait-list control group. Compared with those in the wait-list group, individuals in the board game group were less likely to remain smokers at the end of the program and at the 3-month follow-up assessment. The authors suggested that use of the board game would be an interesting alternative for the education of smokers in the precontemplation stage.

**Clinical applications of board games**

Based on the results of studies investigating traditional and non-traditional board games, it was hypothesized that board game use would prevent cognitive impairment in elderly individuals and illness-prone behaviors in children and adults. Board game playing also seems to be an effective, fun means of delivering medical and safety education to students and trainees. Currently, many people spend large portions of their time playing games online and offline on television monitors, personal computers, tablets, and/or smart-phones. For example, more than half of Japanese elementary and junior-high school students play video games for more than 1 h on weekdays [46]. Thus, video game–based training will become more popular in the future.

On the other hand, a series of meta-analyses [47] found only small or null effect sizes in three models examining correlations between video game skills and cognitive ability, differences in cognitive ability between game players and non-players, and the effects of video game–based training on cognitive ability, respectively. Thus, examination of the clinical effects of real or virtual training using board games may provide more appropriate information for discussion of advantages and disadvantages of each style of board game for future applications in clinical settings. A recent assessment of cognitive science research on board game playing [48] highlighted six suggestions for future studies: 1) do not forget about chess (i.e., a traditional board game for which large amounts of data have been collected), 2) look beyond action games and chess, 3) use optimal play to understand human play and players, 4) investigate social phenomena, 5) raise the standards for studies investigating game play as treatment, and 6) talk to real experts.

**Conclusions**

Although the number of studies investigating board game use remains limited, interesting findings have recently been obtained in terms of brain function, cognitive effects, and health-related lifestyle modification. Board games may also be applicable as educational tools.
Thus, it is time to re-evaluate the usefulness of games and gamifications following technological advances made in modern society. Clinical medicine is closely linked to a public health approach, and medical practices should be undertaken within the limited human, time, and financial resources available [49]. In this sense, appropriate health education programs with a board game component would be useful for both preventive and therapeutic intervention for cognitive-behavioral problems.

**Table 2 Examples of recent RCTs using board games**

| Authors (years) | Countries | Subjects | Board games | Control setting | Outcomes or variables | Impact |
|----------------|-----------|----------|-------------|----------------|-----------------------|--------|
| Nederkoorn C et al. (2018) [34] | The Netherlands | 66 children aged 3–10 years | Age-appropriate memory-related board game | Play with large bowl filled with colorless, odorless jelly (Jelly group) | Acceptance of a food with a specific texture | Jelly group ate significantly more jelly dessert |
| Fancourt D et al. (2016) [35] | UK | 352 subjects aged > 16 years without surgical training | Board game requiring removal of 3 organs from Cavity Sam (experimental tool) | Operating theater sound, classical music, or rock as background music | Surgical speed, accuracy, and perceived distraction | Rock music impared men’s performance of complex surgical procedures in board game |
| Karbownik MS et al. (2016) [36] | Poland | 124 medical students | AntimicroGAME to learn bacteriology, antimicrobial drug actions | Lecture-based seminar | Short-term knowledge retention about pharmacology of antimicrobial drugs | Long-term knowledge retention greater in board game participants vs. controls |
| Sharps M & Robinson E (2016) [37] | UK | 143 children aged 6–11 years | Board game with descriptive social norm–based or health message | Board game with animal images | Children’s fruit and vegetable intake | Health and social norm–based messages increased fruit and vegetable intake vs. controls |
| Viggiano A et al. (2015) [38] | Italy | 3110 subjects aged 9–19 years | Kaleido board game to promote nutrition education, improve dietary behavior | No board game during study period | Adolescent food habits and body mass index | Treatment group showed improved nutrition knowledge, healthy diet, food habits, physical activity |
| Fernandes SC et al. (2014) [39] | Sweden | 125 children aged 8–12 years | Educational board game, video, or booklet with surgery and hospitalization information | Entertaining tools with same formats (comparison group), no tool (control group) | Children’s preoperative worries and parental anxiety | Educational group less worried about surgery, hospital procedures vs. other two groups |
| Laski EV & Siegler RS (2014) [40] | USA | 42 kindergartners, mean age 5.8 years | Numerical board game, counting on from current number on board | Same game, standard count-from-1 procedure | Children’s knowledge of numbers in the 0–100 range | Number line estimates, numeral identification, count-on skill improved more in count-on group |
| Charlier N & De Fraine B (2013) [41] | Belgium | 120 students | Board game to obtain first-aid knowledge | Traditional lecture | Students’ Knowledge of first aids | Game condition was preferred, but lecture more effectively increased knowledge |
| Swiderska N et al. (2013) [42] | UK | 67 medical students | Educational board game in neonatology | Normally provided teaching | Students’ test scores in neonatology | Neonatology test scores higher in game vs. control group (p = 0.00) |
| Khazaal Y et al. (2013) [43] | Switzerland | 240 current smokers aged 18–65 years | Pick-Klop game, cards with smoking-related questions, response options | Psychoeducation to stop smoking, wait-list control | Smoking-related attitudes and behaviors | Game group less likely to remain smokers vs. wait-list group |
| Cho KH et al. (2012) [44] | Republic of Korea | 24 stroke patients | Virtual reality training with balance-board game system | Standard rehabilitation program only | Statics balance of chronic stroke patients | Significant improvement in dynamic balance in chronic stroke patients with virtual-reality balance training |
| Wanyama JN et al. (2012) [45] | Uganda | 180 HIV-positive participants | Educational board game to impart health knowledge | Standardized health talk | Uptake of knowledge to HIV and sexually transmitted infections | Educational game improved uptake of HIV, sexually transmitted infection knowledge |
functioning (e.g., ADHD and dementia), psychological conditions (e.g., depression and anxiety disorders), and life-style diseases (e.g., metabolic syndromes and smoking-related diseases).

Abbreviations
fMRl (functional) Magnetic resonance imaging; AD: Anno Domini; ADHD: Attention-deficit/hyperactivity disorder; AI: Artificial intelligence; BDNF: Brain-derived neurotrophic factor; EEG: Electroencephalographic; HIV: Human immunodeficiency virus; ICT: Information and communication technology; RCT: Randomized controlled trial

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