Playing to Focus: A Systematic Review of Reveal-and-React Board and Card Games for Executive Function Development in Children

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ABSTRACT: Analog board and card games featuring reveal-and-react mechanics, characterized by immediate player responses to newly disclosed game elements, have emerged as promising tools for enhancing executive functions (EF), attention, memory, and problem-solving skills in children. This systematic review synthesizes findings from 13 studies, assessing the cognitive impact of reveal-and-react gameplay in participants aged 3–18, with particular emphasis on children aged ≤12 years. Results consistently indicate improvements across core EF domains such as inhibitory control, cognitive flexibility, and working memory. Notable games identified include Ghost Blitz, Dobble, Bee Alert, and Speed Cups, which provide structured yet engaging environments for cognitive training. The review underscores reveal-and-react mechanics as potent catalysts for developing rapid decision-making, attention control, and working memory updating. Moreover, these games hold significant educational and clinical potential, offering scalable, cost-effective interventions adaptable across diverse settings, including classrooms and therapeutic contexts. Despite limitations in study heterogeneity and longitudinal data scarcity, the collective evidence supports integrating these games into child-focused cognitive enhancement programs.

INTRODUCTION

Board and card games have long been a staple of childhood play and informal learning environments. Beyond entertainment, many of these games offer embedded cognitive challenges that can support children's executive function, memory, attention, and problem-solving abilities (Diamond & Lee, 2011; Noda et al., 2019). In particular, the category of analogue games with "reveal-and-react" mechanics where players must respond quickly or strategically to newly revealed game elements have garnered interest for its potential to train rapid decision-making, attention control, and working memory updating (Moya-Higueras et al., 2023; Vita-Barrull, Guzmán, et al., 2022).

Reveal-and-react games include familiar formats such as memory-matching cards, reflex-based reaction games (e.g., Dobble, Ghost Blitz), and visual search challenges that require players to act under time pressure or rule-based inhibition. For example, in *Dobble* (also marketed as *Spot It!*), players must scan circular cards to quickly identify a matching symbol, training visual attention, inhibition, and processing speed (McRobbie, 2018). In *Ghost Blitz*, players must rapidly apply abstract rule-based matching to grab the correct object, challenging cognitive flexibility and impulse

control (Dyson, 2024). These mechanics closely resemble elements of cognitive training paradigms used in psychological research, such as go/no-go tasks and n-back memory challenges (Sousa et al., 2023; Vita-Barrull, Guzmán, et al., 2022). Importantly, board and card games provide these experiences in a motivating, low-stress format that encourages repetition and engagement, factors essential for cognitive skill development (Alotaibi, 2024).

The relevance of executive function (EF) in child development and academic success has been well documented. Core EF components working memory, inhibitory control, and cognitive flexibility are foundational to attention, learning, and emotion regulation (Diamond & Lee, 2011; Zelazo et al., 2016). Multiple studies suggest that these domains can be positively influenced by cognitively engaging games, particularly those that involve real-time responses to unpredictable stimuli (Benzing et al., 2019; Martinez et al., 2023). Compared to video games, analogue board and card games often promote more deliberate thinking, turn-taking, and social interaction, which may uniquely support self-regulation and cognitive flexibility (Gashaj et al., 2021).

While previous reviews have explored game-based learning in broad terms (Alotaibi, 2024), few have systematically focused on reveal-and-react mechanics specifically within analogue games and their impact on cognitive outcomes. The present review addresses this gap by synthesizing evidence from experimental and observational studies on children aged 3–18, with a focus on those aged ≤12.

We examine how reveal-and-react board and card games relate to improvements in executive function, attention, memory, and problem-solving. This review includes both English and Bahasa Indonesia literature and incorporates Gray literature to reduce publication bias. Our goal is to provide a clearer understanding of the cognitive mechanisms activated by reveal-and-react games and offer practical implications for educators, psychologists, and caregivers seeking low-cost, engaging tools for supporting children's cognitive development.

METHODS

Design

This systematic review followed the PRISMA 2020 guidelines (Page et al., 2021) and used procedures outlined in the Cochrane Handbook for Systematic Reviews of Interventions (Chandler et al., 2019; Higgins et al., 2019). The protocol was designed to identify, screen, and synthesize empirical evidence on the cognitive impact of reveal-and-react board and card games on children. The review included peer-reviewed journal articles, Gray literature (theses, preprints, and conference papers), and articles in both English and Bahasa Indonesia.

Instruments

Inclusion and Exclusion Criteria

To ensure relevance and methodological rigor, studies were included if they met the following criteria: (a) Participants were children aged 3–18 years, with the majority of the sample ≤12 years old; (b) The intervention or context involved analogue board or card games featuring reveal-and-react mechanics, such as games requiring immediate reactions to visual stimuli (e.g., Ghost Blitz, Dobble, Set); (c) The primary or secondary outcomes measured included cognitive domains such as executive function, attention, memory, reasoning, or problem-solving; (d) The study was published between 2015 and 2025; (e) Study designs included RCTs, quasi-experimental designs, observational studies, and single-case designs. Studies were excluded if they: (a) Focused exclusively on digital or video games without a physical analogue component; (b) Assessed only emotional, social, or behavioral outcomes without cognitive data; (c) Used non-reactive or purely didactic board games (e.g., trivia, flashcard-based quizzes); (d) Did not specify the game type or lacked game mechanics details.

Databases and Search Strategy

Searches were conducted in the following databases: PubMed, ScienceDirect, Frontiers, ResearchGate, Biopsychosocial Medicine, and SAGE Journals. Gray literature was sourced through Google Scholar, thesis repositories, and institutional archives. Search strings included combinations of the following terms: (a) "board game" OR "card game" OR "tabletop game"; (b) AND "cognition" OR "executive function" OR "memory" OR "attention"; (c) AND "child" OR "children" OR "preschool" OR "primary school"; (d) AND "reaction" OR "real-time" OR "reflex" OR "reveal" OR "fast response". The search was limited to publications between 2015 and 2025 and included English and Bahasa Indonesia articles. Manual searches of references in key reviews (Alotaibi, 2024; Sousa et al., 2023) and backward citation chaining were also conducted to ensure completeness.

Screening and Selection Process

The screening procedure followed PRISMA 2020 guidelines (Page et al., 2021). After removing duplicates from 217 total records (185 from databases and 32 from Gray literature), 187 titles and abstracts were screened. Records were included if they referenced board or card games in a child population. To maximize sensitivity, ambiguous abstracts (e.g., “games” without clear modality) were retained for full-text review.

Following abstract screening, 39 articles were retained for full-text assessment. Studies were excluded if they featured non-analogue games, lacked cognitive outcomes, or failed to utilize reveal-and-react mechanics as defined by this review. Some articles in Bahasa Indonesia were translated and assessed by bilingual reviewers. Ultimately, 13 studies met all inclusion criteria and were included in the final qualitative synthesis (see Fig 1). These include randomized controlled trials, expert evaluations, single-case reports, and quasi-experimental classroom studies.

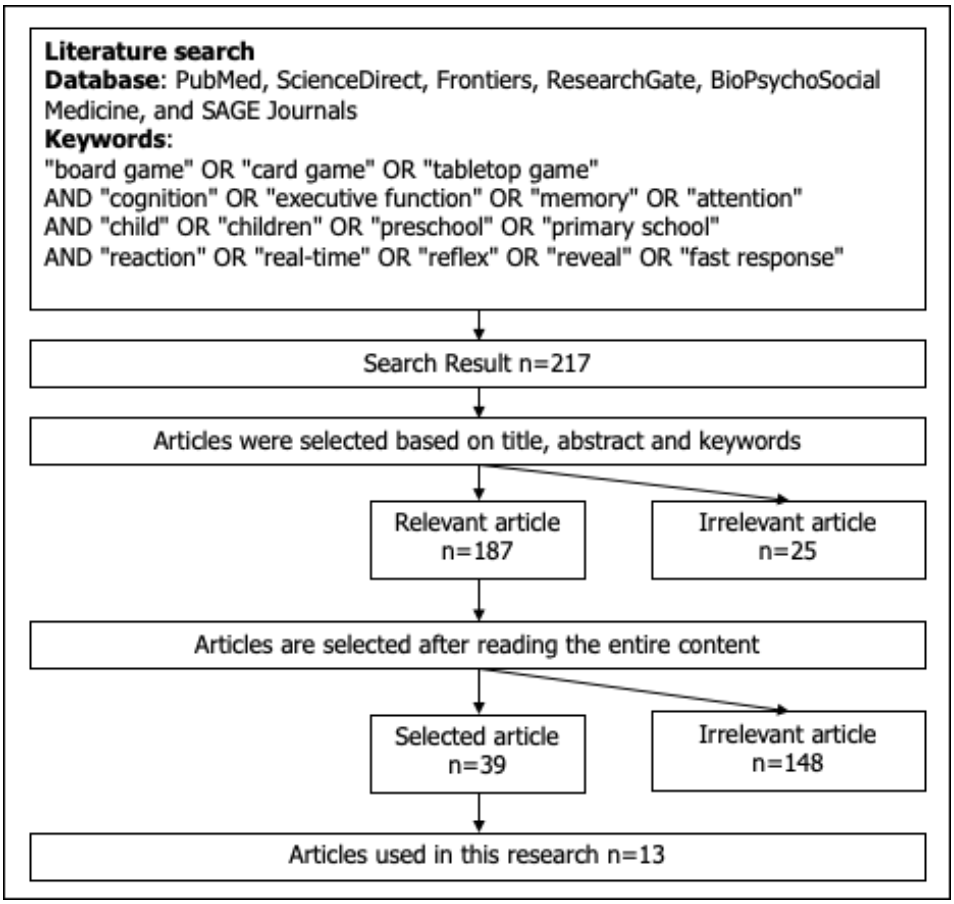

Fig 1. Reporting Items for Systematic Reviews (Adoption of PRISMA).

Data Analysis

Data Extraction and Synthesis

Data extraction was guided by the Cochrane Handbook (Higgins et al., 2019) and included the following fields: (a) Study author(s), year, country; (b) Age range and participant characteristics; (c) Game titles and genres; (d) Identified reveal-and-react mechanics (e.g., visual search, timed reaction, memory match); (e) Cognitive domains assessed (e.g., EF, working memory, inhibition, flexibility, attention); (f) Study design and key findings. A narrative synthesis approach was applied due to heterogeneity in measurement tools and study designs. Emphasis was placed on identifying consistent cognitive domains impacted by reveal-and-react gameplay.

Summary of Included Studies

Table 1 presents the characteristics of the 13 included studies. Games included real-time reaction titles like Ghost Blitz, Bee Alert, and Speed Cups, as well as hybrid math and memory games. Outcomes measured included executive function (EF), inhibition, cognitive flexibility, visuospatial memory, and logical reasoning. Across all studies, significant improvements were observed in at least one cognitive domain, with reveal-and-react mechanics often linked to gains in inhibition and working memory (Vita-Barrull, Guzmán, et al., 2022).

Table 1. Summary of included studies examining reveal-and-react board/card games and cognitive outcomes in children.

No.	Study (Author, Year)	Age Group	Country	Game(s) Used	Mechanic(s)	Cognitive Domains Assessed
1	Estrada-Plana et al., 2019 – *Board Games Training for ADHD*	8–12 years (mean ~9.5); Children with ADHD	Spain	Set of modern board/card games (e.g., "Ghost Blitz", "Dobble"), tailored for EF training	Real-time visual search and action; fast matching requiring inhibition (e.g., grab the item card that matches criteria)	Executive functions (inhibition, working memory), ADHD symptoms (behavior)
2	Gashaj et al., 2021 – *Play Behavior & EF Longitudinal Study*	5–7 years (Kindergarten to Grade 2)	Switzerland	Various board games (home/free-play not specified by name; parent-reported frequency of play)	General board game play (turn-taking, some with luck/strategy; not focused on one mechanic)	Executive functions (inhibition, cognitive flexibility, verbal, and visuospatial updating)
3	Moya-Higueras et al., 2023 – *Modern Board/Card Games RCT*	7–12 years; Children at risk of social exclusion	Spain	Ghost Blitz, Jungle Speed (fast reflex games for inhibition/flexibility); Bee Alert, Déjà Vu (memory games for working memory updating); *Control group games:* Dixit (storytelling/creativity), etc.	Real-time "speed" mechanics (Ghost Blitz, Jungle Speed require grabbing objects quickly under specific rules); Memory recall mechanics (Bee Alert, Déjà Vu involve remembering and matching images); Narrative/creative play (Dixit)	Basic executive functions – Inhibition, Cognitive Flexibility, Working Memory Updating (measured via neuropsychic tests); also assessed overall cognitive profile
4	Vita-Barrull et al., 2023 – *Board Games in Rural Classrooms RCT*	6–12 years; Primary school students (rural schools)	Spain	Bee Alert (children's memory game by Knizia), Set (visual pattern game), Speed Cups, Math Dice, etc., implemented in a school program (different games for ages 6–8 vs 9–12)	Mix of memory matching (Bee Alert: find matching bee colours), real-time pattern recognition (Set: race to find sets of symbols), fine-motor speed (Speed Cups), and math-based games (dice math challenges); many games involved *simultaneous play* (real-time competition)	Executive functions (composite battery scores), Academic skills (math achievement), cognitive flexibility (task-switching)
5	Estrada-Plana et al., 2024 – *"Filler" Board Games in Math Class*	8–10 years (Grade 3 and 4 students)	Spain	Memory card games (general picture matching games) and Mathematical board games (commercial games focusing on number operations and numerical reasoning) used as short "fillers" in class	Memory mechanic: turn over cards to find matches (requires short-term memory and attention); Math game mechanics: solving arithmetic or number puzzles within the game context (requires calculation under time or turn constraints)	Short-term and Working Memory (verbal and visuospatial), Mathematical skills (arithmetic operations, number line tasks, problem solving)

No.	Study (Author, Year)	Age Group	Country	Game(s) Used	Mechanic(s)	Cognitive Domains Assessed
6	Vita-Barrull et al., 2022a – *Gamified vs. Non-gamified Board Game Training*	7–12 years; Children at risk (similar population to Moya-Higueras 2023)	Spain	Same suite of modern board games as Moya-Higueras et al. (Ghost Blitz, etc.), but one group received a "gamification" layer (story narrative, points, rewards) on top of playing, while the other just played the games straightforwardly	Core mechanics as in those games (real-time response, memory, etc.), with additional gamification elements (narrative theme, levels, external rewards) in experimental condition	Executive function tasks (inhibition, flexibility, working memory), behavioral ratings
7	Vita-Barrull et al., 2022b – *Expert Panel on Cognitive Processes in Games*	N/A (Delphi expert study – no child participants)	Spain	80+ commercial board games (e.g., *Diamonds*, *Set*, *Monster Kit*, *Guess Who*, etc.) were evaluated by a panel of psychologists and educators	Varied: games spanned real-time competitive games, turn-based strategy, memory games, cooperative games. Experts catalogued each game's mechanics (e.g., time pressure, hidden information, pattern matching)	Cognitive processes potentially engaged by each game (EF components, memory, attention, language, etc.)
8	Nakao, 2019 – *Board Games for Health Promotion (Review)*	Children to older adults (various studies reviewed)	Japan (global literature)	Traditional board games (e.g., Chess, Go, Shogi) and newly-designed educational board games	Traditional strategy mechanics (sequential turns, planning); some newer games with role-play or quiz elements	Cognitive impairment (in elderly), depression, health knowledge, various cognitive functions
9	Noda et al., 2019 – *Systematic Review of Board Game Interventions*	4–85 years (mixed, incl. children; 27 studies)	Japan (global literature)	Various – studies reviewed included games like chess, Go, educational board games, and therapy board games (e.g., for ADHD)	Varied (some turn-based strategy, some quick-react games, some quiz-based educational games)	Educational knowledge, Cognitive functions, Physical activity, Clinical symptoms (categories in review)
10	Sousa et al., 2023 – *Board Games in Learning (Systematic Review)*	4–18 years (formal education settings)	Multi-country (review)	Board games, tabletop games, and other analogue games used in educational interventions (45 studies from 2012–2022)	Mixed – includes strategy games, trivia/quiz games, role-playing games, and real-time games used in classrooms	Academic learning outcomes; also, Cognitive outcomes (critical thinking, problem-solving), and "soft skills" (engagement, collaboration)
11	Batarisaf et al., 2024 – *Memory Card Game & Logical Thinking (Quasi-Experiment)*	4–5 years (Kindergarten)	Indonesia	Geometric Shapes Memory Game – an analogue card matching game where children flip cards to find pairs of matching shapes and colours	Memory matching mechanic (turn over two cards at a time, remember locations; requires visual memory and concentration)	Logical thinking ability (measured via problem-solving tasks appropriate for pre-schoolers)
12	Kar et al., 2024 – *Playing Cards for Cognitive Remediation (Innovation)*	10–18 years (target demographic in commentary)	India	Standard playing card decks adapted into cognitive exercises (e.g., card-sorting tasks for memory, Go/No-Go games using red/black cards, etc.)	Traditional card gameplay repurposed as cognitive tasks (matching suits or numbers under rules, remembering sequences, inhibiting responses to certain cards)	Cognitive remediation targets: Working memory, attention, executive function (conceptual, as an innovation – no new measure reported)
13	Susilah et al., 2019 – *Picture Card Game & Visual Memory (Single-case)*	11 years (Grade 5, child with moderate intellectual disability)	Indonesia	Custom picture-card memory game – child is shown a sequence of illustrated cards, which are then hidden; the child must recall and point out the card(s) when among distractors	Visual sequential memory task (like Concentration but structured for one-on-one learning; involves short exposures and recall, increasing in difficulty)	Visual memory (ability to remember and recognize images after short delays)

Note: EF = executive function. "Reveal-and-react" refers to game designs where new information is continuously revealed (cards flipped, etc.) and players must respond, often under time pressure or in competition.

In the summary of included studies section, the study also explains the key findings which can be seen in Table 2.

Table 2. Key findings included studies.

No.	Study (Author, Year)	Key Findings
1	Estrada-Plana et al., 2019 – *Board Games Training for ADHD*	EF gains in ADHD: After an 8-week board game intervention, the experimental group showed significant improvement in verbal short-term memory and reduced conduct problem scores compared to a waitlist control. Large effect sizes were noted for memory; benefits were not maintained at 3-month follow-up, though interim gains suggest board game play can acutely improve memory and self-regulation in children with ADHD.
2	Gashaj et al., 2021 – *Play Behavior & EF Longitudinal Study*	Frequent board gaming predicts EF: In a longitudinal study, the amount of time children spent playing board games (as reported by parents) in kindergarten significantly predicted better executive function scores in second grade. Notably, board game and puzzle play (along with active exergames) were positive predictors, whereas excessive electronic gaming time was negatively related to initial visuospatial working memory. This suggests that analogue board games support EF development over early childhood, in contrast to heavy video game use which showed no EF benefit at follow-up.
3	Moya-Higueras et al., 2023 – *Modern Board/Card Games RCT*	Broad EF improvement: In this quadruple-blind RCT, both the EF-focused game group and the control game group improved significantly in cognitive flexibility and inhibition, with a smaller but notable improvement in working memory, after 15 sessions of gameplay. Importantly, analysis of the games' cognitive demands showed that *all games, even those not chosen for EF, still activated EF skills* to a significant extent. Thus, playing modern board/card games (with minimal luck factor) appeared to benefit children's EF overall. The reveal-and-react games (e.g., Ghost Blitz) in particular, the exercised quick response and inhibition the study found, for example, that children who learned to slightly slow down their impulsive reactions in Ghost Blitz gained more in flexibility.
4	Vita-Barrull et al., 2023 – *Board Games in Rural Classrooms RCT*	EF and academic gains in class: This classroom-based intervention found that incorporating board games led to improvements in executive function test scores and math skills for students. Both younger and older groups benefited, but notably games with an explicit academic (math) component plus implicit memory challenges led to the largest gains in both memory and math outcomes. The authors observed that many of the games that improved flexibility had a real-time mechanic, requiring quick mental shifting. Overall, the study supports that even in low-resource rural schools, adding reveal-and-react board games can boost cognitive flexibility and scholastic performance.
5	Estrada-Plana et al., 2024 – *"Filler" Board Games in Math Class*	Memory & math transfer: In a quasi-experimental study where classes played 15 sessions of games, significant transfer effects were observed. Third-graders who played math-heavy games showed medium-to-large improvements in visuospatial short-term memory and updating, as well as improved arithmetic operation and number line performance (vs. control classes). Fourth-graders who played memory-focused games showed smaller but significant gains in math problem-solving skills relative to controls. This indicates both general cognitive benefits (memory training aiding problem-solving) and domain-specific benefits (math games enhancing working memory and math fluency). Playing these games for just 30 minutes twice a week yielded measurable cognitive improvements in a matter of 2 months.
6	Vita-Barrull et al., 2022a – *Gamified vs. Non-gamified Board Game Training*	Gamification not essential for EF gains: Both the gamified and non-gamified board game intervention groups improved on executive function measures, with no significant difference between them in EF outcomes (both approaches reduced EF impairments) according to the report. This suggests that it was the *gameplay itself* the reveal-and-react challenges driving cognitive improvements, rather than extrinsic reward systems. (Data reported in Games for Health Journal; results align with the 2023 study's finding that any engaging board game can benefit EF.)
7	Vita-Barrull et al., 2022b – *Expert Panel on Cognitive Processes in Games*	Mapping mechanics to cognition: An expert committee systematically reviewed popular board games and mapped which cognitive skills each game can stimulate. They concluded that modern board games have significant potential to target cognitive processes. Notably, games rated as exercising cognitive flexibility often featured *real-time reaction mechanics*, requiring players to rapidly shift attention or strategies. For example, a fast symbol-matching card game (*Set*) was judged to involve high levels of fluid reasoning and flexibility, while a turn-taking logic puzzle game emphasized planning. This expert review provides theoretical support that reveal-and-react style games (which demand quick responses to changing information) naturally engage EF skills like inhibition and set-shifting.
8	Nakao, 2019 – *Board Games for Health Promotion (Review)*	Board games improve cognition and behavior: This narrative review found that *several RCTs* showed playing classic board games like chess or go helped improve cognitive functioning (e.g., memory, executive function) and even mood in older adults with cognitive impairment. For younger people, newly developed board games were shown to aid health education and behavior change (e.g., a nutrition board game improving healthy eating habits). While not focused exclusively on children, the review's overall conclusion was that board games are a promising, engaging tool for improving cognitive and behavioral outcomes across ages. It noted the research on mental-health applications in youth was still limited, calling for more studies to confirm benefits for clinical populations.
9	Noda et al., 2019 – *Systematic Review of Board Game Interventions*	Evidence of cognitive benefits, but mixed results: This systematic review of 27 studies categorized effects of board game interventions into educational outcomes (11 studies), cognitive function outcomes (11 studies), and others. It found that most studies reported positive effects on knowledge gain and cognitive skills. Effect sizes for cognitive outcomes ranged widely (from near-zero to very large). Notably, interventions targeting children's cognition showed improvements in executive function, memory, and processing speed in many cases. For example, one study in the review reported moderate improvements in children's cognitive skills from chess training. However, a few studies on using games for ADHD showed only modest reductions in symptom scores (some even showed slight negative changes, which might reflect measurement variability). The review concluded that board games can improve cognitive functioning and knowledge, and foster social interaction and motivation in participants. Yet, due to the heterogeneity and limited number of rigorous trials, it cautioned that more research is needed before treating board games as standalone clinical interventions.
10	Sousa et al., 2023 – *Board Games in Learning (Systematic Review)*	Broad cognitive and affective outcomes: This comprehensive review found that analogue game-based learning approaches were associated with a broad range of positive outcomes, including gains in content knowledge and various cognitive skills. Many studies reported improvements in students' problem-solving abilities, reasoning, and even creativity through board game play. The review emphasized that games promoted meaningful learning by engaging students emotionally and cognitively for instance, increasing

No.	Study (Author, Year)	Key Findings
		engagement and cognitive flexibility through playful competition. It also noted a gap: few studies used modern hobby board games explicitly tied to curriculum content, and issues of accessibility/inclusion (e.g., adapting games for special needs) were often overlooked. The authors call for more integration of well-designed modern games to fully harness cognitive and motivational benefits in classrooms.
11	Batarisaf et al., 2024 – *Memory Card Game & Logical Thinking (Quasi-Experiment)*	Improved reasoning in pre-schoolers: This study found that children who played a geometric shape memory card game over several sessions showed a significantly greater improvement in logical thinking skills compared to a control group who did not play. The experimental group's post-test scores were on average 5.9 points higher (on a developmental scale for logical thinking) than their pre-test, whereas controls improved only ~2.9 points; the difference was statistically significant ($p = 0.002$). Qualitatively, teachers observed that the game-playing children became more adept at pattern recognition and cause-effect reasoning (e.g., figuring out which card to flip next), suggesting that even at age 4–5, a simple reveal-and-match game can stimulate basic problem-solving and logic abilities.
12	Kar et al., 2024 – *Playing Cards for Cognitive Remediation (Innovation)*	Cost-effective tool (conceptual report): This paper proposes an innovative use of everyday playing cards as a low-cost cognitive training tool in resource-limited settings. While not a data-driven study, the authors outline how simple card games can be modified to exercise memory (e.g., 'Concentration'), attention (e.g., sorting only certain cards as fast as possible), and executive control (e.g., a variant where one must clap only when a red card appears, akin to a Go/No-Go test). The approach is presented as an indigenous, affordable cognitive remediation strategy for children with cognitive deficits where expensive commercial brain-training games are not feasible. Early anecdotal results in clinical practice were positive (improved engagement, some attention gains), but the authors call for formal trials. This underscores the versatility of reveal-and-react mechanics even a standard 52-card deck can become a cognitive training apparatus.
13	Susilah et al., 2019 – *Picture Card Game & Visual Memory (Single-case)*	Visual memory gains in special needs education: Using an ABA single-subject design, this study trained a child with intellectual disability on visual memory via picture card games. The results showed a clear improvement: the child's ability to remember sequences of images improved from a baseline accuracy of ~30% to about ~63% during the intervention, and further up to ~70% in a maintenance phase. The stepwise increase (with difficulty rising from 1-item to 3-item sequences) demonstrated that *repeated, game-based practice* significantly enhanced the child's short-term visual memory. This suggests even for children with cognitive impairments, reveal-and-react card activities can be tailored to improve specific cognitive skills (here, memory for visual information) in an enjoyable way, complementing formal therapy.

RESULTS AND DISCUSSION

The studies reviewed span a variety of research designs and populations, but together they paint a consistent picture: playing board and card games with reveal-and-react elements can produce measurable benefits in children's cognitive abilities. Below, we discuss the findings in terms of specific cognitive domains, and examine how particular game mechanics (especially real-time response demands) relate to those outcomes.

Executive Functions (Inhibition, Cognitive Flexibility, Working Memory)

Reveal-and-react board games consistently activate and develop core components of executive function (EF): inhibition, cognitive flexibility, and working memory. These domains are interrelated and fundamental for goal-directed behavior in children (Diamond & Lee, 2011; Zelazo et al., 2016). Inhibition refers to the ability to suppress automatic responses, while flexibility involves switching between tasks or mental sets, and working memory supports the temporary storage and manipulation of information.

Among the most consistent findings across studies was the improvement of inhibitory control. In Estrada-Plana et al. (2019), children with ADHD who played Ghost Blitz and Dobble demonstrated greater control over impulsive responses compared to control peers, an outcome that aligns with the known benefits of inhibition-challenging activities. Similarly, Moya-Higueras et al. (2023) revealed robust improvements in flexibility and updating components of EF, suggesting that the rapid-response nature of these games trains children to shift attention and adapt quickly to changing rules or stimuli.

Cognitive flexibility was also improved in classroom implementations, particularly those using games with multiple simultaneous rules (e.g., Speed Cups, Bee Alert). These games require players to make real-time decisions based on visual cues and task-switch frequently between rule sets - a cognitive function crucial in academic and social problem-solving (Vita-Barrull et al., 2023). This is consistent with findings from Benzing et al. (2019), who implemented a classroom-based intervention and demonstrated that even older primary school children can show improvements in

EF domains, especially inhibition and switching, through regular structured cognitive tasks embedded in daily routines.

An important contribution comes from (Vita-Barrull, Guzmán, et al., 2022), who conducted a randomized controlled trial comparing gamified versus non-gamified versions of reveal-and-react games in children at risk of social exclusion. Both groups demonstrated significant improvements in EF domains such as inhibition and working memory, and the study found no significant difference between gamified and non-gamified versions. This suggests that the mechanics themselves not just motivational elements drive cognitive gains, supporting the core hypothesis of this review. Moreover, a structured review by Vita-Barrull et al. (2022) emphasized that most expert-evaluated commercial games targeting flexibility shared real-time or reaction-based mechanics.

Working memory improvements were reported in several studies. For instance, Estrada-Plana et al. (2024) found that structured board games combining math operations with visual matching led to significant gains in working memory, especially for spatial and arithmetic tasks. Susilah et al. (2013) further illustrated how visual memory recall could improve in special needs students using sequential card-reveal activities. These findings emphasize that working memory is trainable through analogue play and reinforce earlier theories of embodied cognition in learning.

Attention and Processing Speed

Attention is a foundational skill that underlies all higher-order cognitive functions. Reveal-and-react games, by design, challenge children sustained and selective attention, especially when distractors are introduced. These games also foster faster processing speeds through time-pressured decisions. In Gashaj et al. (2021), habitual board game players performed better on attentional tasks involving sustained focus and shifting between tasks. Meanwhile, (Sousa et al., 2023) synthesized cross-national findings and highlighted that attention control was one of the most frequently reported cognitive benefits from board game use in early and middle childhood. Processing speed gains were particularly evident in games with a fast turnover of visual cues, such as Speed Cups and Bee Alert. These games simulate real-world multitasking scenarios, where rapid assessment and reaction are required. Moya-Higueras et al. (2023) documented that repeated exposure to these stimuli improved children's speed on matching and inhibition tasks.

Working Memory and Memory Strategies

Beyond short-term recall, working memory capacity and strategic rehearsal can be improved by board games that emphasize memory-based decision-making. Reveal-and-react games like Déjà Vu and memory-matching variants challenge children to track items and rules over multiple rounds, enhancing cognitive load management. In Estrada-Plana et al. (2024), intervention students showed post-intervention improvements in both digit span and Corsi block tasks, which are standard measures of working memory. These improvements were attributed to games that required repeated encoding and updating of rules or number sequences. Susilah et al. (2013) reported that even children with cognitive delays benefited from simple visual recall training embedded in gameplay, improving both accuracy and latency of response. Moreover, memory games that incorporate mathematical logic (e.g., matching number tiles based on equations) encourage dual encoding strategies, where both numerical and spatial memory systems are activated (Vita-Barrull et al., 2023).

Problem-Solving and Reasoning Skills

Problem-solving and reasoning are higher-order cognitive functions that benefit from gameplay requiring deduction, prediction, and adaptation. Board games offer structured yet dynamic environments where children practice these skills without the fear of failure. Batarisaf et al. (2024) found that pre-schoolers exposed to shape and colour-based card games significantly

improved in logical reasoning assessments. These games required pattern recognition and inference-based decision-making, which mimic foundational elements of reasoning. Kar et al. (2024) employed a modified playing card system based on Go/No-Go tasks to support cognitive flexibility and reasoning among adolescents. Participants had to inhibit dominant responses and switch between sorting rules skills closely linked to real-world academic and life tasks. Their findings provide early evidence that reasoning can be trained through low-tech, scalable tools. Additionally, Noda et al. (2019) reviewed educational implementations of strategic games like Go and Chess. These games, while not strictly reveal-and-react, involve forward planning and problem resolution in response to opponent moves skills aligned with reasoning and metacognitive development.

The Role of Reveal-and-React Mechanics

At the heart of this review is the concept of reveal-and-react mechanics a gameplay structure where new information is dynamically introduced, requiring players to assess and respond rapidly. This mechanic is embedded in games like Dobble (pattern matching), Ghost Blitz (object identification under constraints), and Déjà Vu (visual memory with increasing difficulty). What sets reveal-and-react games apart is their alignment with cognitive load theory and executive functioning frameworks. These games provide immediate feedback and demand mental agility, like tasks like the Flanker task or Stroop test (Diamond & Lee, 2011). (Vita-Barrull, March-Llanes, et al., 2022) emphasized that these mechanics consistently target EF components, particularly inhibition and flexibility, more effectively than turn-based games. Furthermore, (Vita-Barrull, Guzmán, et al., 2022) empirically demonstrated that even without gamification enhancements, these mechanics produced meaningful executive function gains. This reinforces the view that the mechanics themselves not rewards or game “wrappers” are cognitively active ingredients, lending these games robustness across contexts and delivery formats. Additionally, these mechanics offer scaffolding opportunities: as children become familiar with the rules, the game accelerates in complexity, encouraging cognitive stretching without overwhelming (Sousa et al., 2023). This gradual difficulty modulation makes them suitable across a wide age range (4–12) and developmental profiles.

Limitations and Considerations

While evidence supports the benefits of reveal-and-react board games, several limitations should be considered. First, the diversity of game types, outcome measures, and participant populations introduces heterogeneity. Some studies used custom-built cognitive tasks, while others relied on standardized tests like the Stroop or Trail Making Test. This variation can affect effect size comparability. Second, many studies relied on small sample sizes or lacked random assignment (Kar et al., 2024; Sousa et al., 2023). While trends are promising, larger-scale replication is needed. Cultural and linguistic differences in game implementation (e.g., instructions in English vs. Bahasa) may also affect engagement and performance. Furthermore, few studies disaggregated data by gender, SES, or baseline cognitive ability factors that may moderate outcomes. The longevity of gains remains unclear, as few studies conducted long-term follow-up.

Educational and Clinical Implications

Reveal-and-react board games offer significant potential in both classroom and clinical settings. In education, they can be integrated into daily routines or used as part of cognitive centres to reinforce attention, memory, and math fluency (Estrada-Plana et al., 2024). Teachers can use them to support students who struggle with self-regulation or focus. In clinical practice, such games offer low-cost, engaging tools for EF training in populations with ADHD, learning delays, or autism spectrum disorders. Their adaptable complexity and natural scaffolding make them particularly suitable for individualized intervention programs (Estrada-Plana et al., 2019).

Importantly, (Vita-Barrull, Guzmán, et al., 2022) demonstrated that gamification is not necessary for these benefits to emerge. In a randomized trial with children at risk of social exclusion, both gamified and non-gamified versions of reveal-and-react games significantly improved EF, and the lack of a difference between versions suggests that the underlying game mechanics were the primary driver of change. This finding carries strong implications for low-resource educational settings and scalable public health interventions where simplicity, cost, and adaptability are crucial factors. The social component of board games also fosters emotional regulation, turn-taking, and frustration tolerance soft skills that complement cognitive development and are particularly important in inclusive education and therapy contexts.

Limitations of the Review and Future Directions

This review was limited to analogue board and card games, excluding digital or hybrid platforms. Future research should explore cross-modal comparisons to assess whether digital adaptations of reveal-and-react mechanics yield similar outcomes. Additionally, longitudinal studies with repeated measures are needed to confirm sustained cognitive gains. Another avenue for exploration is the differential impact of game complexity and player agency. Some reveal-and-react games are primarily chance-driven, while others require strategic forecasting. Clarifying which subtypes offer the most cognitive benefit can inform educational and therapeutic selection. Finally, future research could assess co-learning scenarios (e.g., parent-child, peer-peer) to understand how social context interacts with cognitive development during gameplay.

CONCLUSION

This systematic literature review synthesized evidence from 13 primary studies examining the cognitive effects of reveal-and-react board and card games on children aged 3–18, with a focus on participants under 12. The findings highlight a consistent, positive association between analogue gameplay that utilizes real-time visual and cognitive responses and improvements in executive functions, attention, memory, and reasoning. Reveal-and-react mechanics where stimuli are revealed and players must quickly respond under evolving rule constraints appear particularly effective in enhancing inhibition, working memory, and cognitive flexibility. These outcomes were reported across a wide range of game types and intervention contexts, from small-group classroom trials to home-based training and expert evaluations. Moreover, the inclusion of children with ADHD, at-risk populations, and pre-schoolers suggests that these cognitive benefits generalize across developmental and neurodiverse groups. As such, reveal-and-react board games offer a scalable, low-cost, and culturally adaptable intervention format for use in schools, clinics, and homes. Despite some methodological limitations including sample heterogeneity, varied cognitive outcome measures, and limited long-term follow-up the collective evidence strongly supports the cognitive validity of well-structured board and card games. These games not only promote cognitive growth but also encourage social interaction, turn-taking, and emotional regulation, adding multidimensional value to their use in educational psychology. Future research should build on these findings by conducting longitudinal trials, exploring digital analogues of reveal-and-react games, and assessing how social dynamics during play (e.g., peer collaboration, cooperative vs. competitive settings) further influence cognitive outcomes. With thoughtful design and implementation, reveal-and-react games can become a foundational tool for developing children's cognitive, social, and emotional competencies.

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