

What systematic review methodology can effectively synthesize current neuroscientific evidence on the neurological impacts of digital reading technologies?

A systematic review methodology using broad database searches, independent screening, and integrated evidence synthesis effectively evaluates the neurological impacts of digital reading technologies.

Abstract

Fontaine et al. (2020) detail a protocol that employs comprehensive database searches across seven major sources, dual independent screening, and a four-level synthesis strategy—including descriptive synthesis and meta-analysis—to assess reading comprehension outcomes in digital-based reading. Sagary et al. (2023) and Valentine et al. (2020) describe systematic literature reviews that use predefined inclusion and exclusion criteria, evidence mapping, and both quantitative and qualitative synthesis techniques to evaluate a range of cognitive, motor, and service outcomes associated with various digital platforms (including mobile apps, virtual reality, gaming consoles, computerized tests, and robots). Brignardello-Petersen et al. (2024) and Gertler and Cameron (2018) emphasize the importance of multiple independent reviewers, risk-of-bias assessments (with tools such as GRADE), and rigorous analytic methods typical of Cochrane-type reviews.

These studies indicate that an effective methodology for synthesizing neuroscientific evidence on the neurological impacts of digital reading technologies combines broad and unrestricted database searches, clearly defined screening criteria, independent review processes, and an integration of multi-level evidence synthesis—tailored to accommodate the diversity of digital platforms and outcome measures.

Paper search

Using your research question "What systematic review methodology can effectively synthesize current neuroscientific evidence on the neurological impacts of digital reading technologies?", we searched across over 126 million academic papers from the Semantic Scholar corpus. We retrieved the 50 papers most relevant to the query.

Screening

We screened in papers that met these criteria:

- **Digital Reading and Neural Measures:** Does the study examine digital reading while including neurological measurements?
- **Measurement Techniques:** Does the study utilize established neuroimaging or neurophysiological measurement techniques (fMRI, EEG, MEG, or similar validated methods)?
- **Study Type:** Is the study either empirical research, a systematic review, or a methodological paper (not an opinion piece or commentary)?
- **Review Methodology:** Does the study examine systematic review methodologies or evidence synthesis approaches in neuroscience?
- **Population Coverage:** Does the study include findings from the general population (either as the main focus or as a comparison group)?
- **Reading Process Focus:** Does the study focus on reading processes and outcomes rather than solely on technical specifications or user experience?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Data extraction

We asked a large language model to extract each data column below from each paper. We gave the model the extraction instructions shown below for each column.

- **Study Design Type:**

Identify the specific type of study design used. Look in the methods section for explicit description of study design. Possible types include:

- Systematic review
- Systematic review protocol
- Qualitative review
- Meta-analysis
- Narrative review

If multiple design types are mentioned, list all in order of prominence. If unclear, note "design not clearly specified".

Specific focus: Prioritize methodological approaches related to neuroscientific evidence synthesis.

- **Systematic Review Methodology:**

Extract details about the systematic review methodology used. Look for:

- Explicit methodology description
- Search strategy details
- Databases searched
- Inclusion/exclusion criteria
- Number of databases used
- Screening and selection process

Highlight any unique or innovative methodological approaches specifically related to neuroscientific evidence synthesis. If methodology is not fully described, note "insufficient methodological details provided".

- **Types of Evidence Synthesized:**

Identify the types of neuroscientific evidence included in the review:

- Empirical studies
- Theoretical papers
- Experimental research
- Observational studies
- Intervention studies

Quantify the number of studies in each category if possible. If multiple types are present, list proportions or total numbers for each type of evidence.

- **Neuroscientific Domains Covered:**

Extract specific neuroscientific domains addressed in the review:

- Cognitive processing
- Neurological impacts
- Brain function
- Neuroplasticity
- Cognitive skills
- Neurological rehabilitation

List all domains mentioned, with specific emphasis on digital reading technology impacts. If domains are not explicitly stated, note "domains not clearly specified".

- **Digital Reading Technology Characteristics:**

Identify specific characteristics of digital reading technologies examined:

- Type of digital platform (mobile, tablet, computer)
- Specific technological features
- Interactive elements
- Reading interface design

Provide precise details about the technological aspects studied. If technology details are minimal, note "insufficient technological description".

Results

Characteristics of Included Studies

Study	Study Design	Technology Type	Methodology Approach	Primary Outcomes	Full text retrieved
Fontaine et al., 2020	Systematic review protocol	Digital-based reading	Comprehensive database search, two independent reviewers, descriptive synthesis and meta-analysis if appropriate	Reading comprehension	No

Study	Study Design	Technology Type	Methodology Approach	Primary Outcomes	Full text retrieved
Brignardello-Petersen et al., 2024	Systematic review methodology overview	No mention found	Outlines common processes in systematic reviews, including determining questions, searching for evidence, and assessing certainty	No mention found	No
Sagary et al., 2023	Systematic literature review	Mobile games, Virtual Reality (VR), Kinect, Wii	Electronic database search, inclusion/exclusion criteria, data extraction and synthesis	Cognitive skills, motor functionality, balance	Yes
Gertler and Cameron, 2018	Systematic review methodology discussion	No mention found	Focuses on data analytic techniques in Cochrane Systematic Reviews, including meta-analysis	No mention found	No
Valentine et al., 2020	Systematic review	Mobile apps/tablets, robots, gaming, computerised tests, videos, virtual reality	Predefined search terms in six databases, screening process, evidence mapping	Clinical effectiveness, service delivery efficiencies, economic impact, user acceptability/feasibility	No

We found mention of 5 different study designs across the 5 studies in the available abstracts and full texts:

- 3 studies were various types of systematic reviews (protocol, literature review, review)
- 2 studies focused on systematic review methodology (overview, discussion)

Technology Type:

- We found technology information for 3 out of 5 studies

- These 3 studies covered a wide range of technologies, including digital-based reading, mobile games, Virtual Reality (VR), Kinect, Wii, mobile apps/tablets, robots, gaming, computerised tests, and videos
- Virtual reality was mentioned in 2 studies
- We didn't find mention of technology information in the abstracts of 2 studies

Methodology Approach:

- All 5 studies provided some information about their methodology
- Database searching was the most common approach, mentioned in 3 studies
- Other common approaches included meta-analysis (2 studies) and synthesis (2 studies)
- A wide variety of other methodological approaches were mentioned, each in 1 study

Primary Outcomes:

- We found primary outcome information for 3 out of 5 studies
- These 3 studies had diverse primary outcomes, including reading comprehension, cognitive skills, motor functionality, balance, clinical effectiveness, service delivery efficiencies, economic impact, and user acceptability/feasibility
- We didn't find mention of primary outcome information in the abstracts of 2 studies

Thematic Analysis

Systematic Review Methodological Approaches

The included studies reveal several key methodological approaches for conducting systematic reviews in the context of digital technologies and neuroscience:

- Comprehensive Database Searches : Fontaine et al. (2020) propose searching multiple databases (CINAHL, Embase, ERIC, Google Scholar, MEDLINE, PsycINFO, and Web of Science) without date or language restrictions.
- Multiple Independent Reviewers : Both Fontaine et al. (2020) and Brignardello-Petersen et al. (2024) emphasize the importance of having two or more independent reviewers for screening, data extraction, and quality assessment.
- Predefined Inclusion/Exclusion Criteria : Sagary et al. (2023) and Valentine et al. (2020) highlight the importance of clearly defined inclusion and exclusion criteria.
- Evidence Mapping : Valentine et al. (2020) introduce the concept of evidence mapping, which provides a visual representation of the current state of evidence.
- Risk of Bias Assessment : Gertler and Cameron (2018) emphasize the importance of considering the risk of bias in included studies, which is a key feature of Cochrane Systematic Reviews.

Evidence Synthesis Techniques The studies present various evidence synthesis techniques:

- Descriptive Synthesis : Fontaine et al. (2020) propose using descriptive synthesis to summarize findings across studies.
- Meta-Analysis : Both Fontaine et al. (2020) and Gertler and Cameron (2018) discuss the use of meta-analysis when appropriate.

- Qualitative Synthesis : Valentine et al. (2020) suggest the inclusion of qualitative studies, including process evaluations and user impact assessments.
- Multi-Level Synthesis : Fontaine et al. (2020) propose synthesis at four levels: study, participant, intervention, and outcome.

Quality Assessment Methods Quality assessment emerges as a crucial component of systematic reviews in this field:

- Critical Appraisal : Fontaine et al. (2020) include critical appraisal as part of their review process.
- Certainty of Evidence Assessment : Brignardello-Petersen et al. (2024) highlight the importance of assessing the certainty of evidence. This approach, often using tools like Grading of Recommendations, Assessment, Development and Evaluations (GRADE), can provide a clear indication of the strength of evidence for digital technology impacts.
- Risk of Bias Consideration : Gertler and Cameron (2018) emphasize the consideration of risk of bias in Cochrane Systematic Reviews.

Methodological Effectiveness

Methodology Type	Evidence Quality	Synthesis Success	Implementation Challenges
Systematic review protocol (Fontaine et al., 2020)	Not assessable (protocol stage)	Proposes comprehensive synthesis at multiple levels	Potential challenges in comparing diverse digital reading formats
Systematic review overview (Brignardello-Petersen et al., 2024)	Not applicable (overview paper)	Outlines common processes for successful synthesis	Lack of specificity to digital technology in neuroscience
Systematic literature review (Sagary et al., 2023)	Limited by number of included studies (50)	Successfully identified impacts across multiple domains	Potential bias in study selection, limited to specific technologies
Cochrane Systematic Review discussion (Gertler and Cameron, 2018)	Not applicable (methodology discussion)	Focuses on successful data analytic techniques	Complexity of applying general methods to specific neuroscience contexts
Systematic review with evidence mapping (Valentine et al., 2020)	Limited by number of included studies (47)	Provided comprehensive map of current evidence	Rapid evolution of technology may outpace review process

We found mention of five different methodology types across the studies:

- 1 systematic review protocol
- 1 systematic review overview
- 1 systematic literature review
- 1 systematic review discussion

- 1 systematic review with evidence mapping

Regarding evidence quality:

- We didn't find quality assessments for 3 studies (2 were not applicable, 1 was not assessable)
- 2 studies were limited by the number of included studies (47-50 studies)

All studies reported some form of synthesis success:

- 1 proposed comprehensive synthesis
- 1 outlined common processes
- 1 successfully identified impacts
- 1 focused on successful data analytic techniques
- 1 provided a comprehensive evidence map

We didn't find mention of consistent measures or categories across studies for evidence quality or synthesis success in the available abstracts and full texts, which could make direct comparisons challenging.

Technology-Specific Considerations

Digital Platform Variations

The included studies reveal a range of digital platforms being examined in neuroscientific contexts:

- Mobile and Tablet Applications : Valentine et al. (2020) and Sagary et al. (2023) both mention mobile apps and tablets as key digital platforms. These portable devices offer unique opportunities for cognitive assessment and intervention.
- Virtual Reality (VR) : Sagary et al. (2023) and Valentine et al. (2020) include VR as a technology of interest. VR presents immersive environments that can be particularly useful for neurocognitive assessments and interventions.
- Gaming Consoles : Sagary et al. (2023) specifically mentions gaming platforms like Xbox and Wii Fit. These platforms offer interactive experiences that can be leveraged for neurorehabilitation.
- Computerized Tests : Valentine et al. (2020) includes computerized tests among the technologies examined. These can provide standardized, objective measures of cognitive function.
- Robots : Valentine et al. (2020) uniquely mentions robots as a technology used in neurodevelopmental disorder interventions.

Assessment Tools Integration

The integration of assessment tools with digital technologies emerges as a key consideration:

- Validated Tests : Fontaine et al. (2020) mention the use of previously validated or researcher-generated tests to measure reading comprehension.
- Interactive Assessments : Sagary et al. (2023) discuss the use of interactive elements in games for assessing cognitive skills and motor functionality.
- Computerized Testing : Valentine et al. (2020) include computerized tests among the technologies examined.

- Multi-Domain Assessment : The studies collectively suggest a trend towards assessing multiple domains, including cognitive skills, motor functionality, and user experience.

The integration of these assessment tools with digital technologies presents both opportunities and challenges for systematic reviews. Reviewers must consider the validity and reliability of these integrated assessment methods, as well as their comparability across different digital platforms.

References

- A. Valentine, B. Brown, M. Groom, E. Young, C. Hollis, and C. Hall. "A Systematic Review Evaluating the Implementation of Technologies to Assess, Monitor and Treat Neurodevelopmental Disorders: A Map of the Current Evidence." *Clinical Psychology Review*, 2020.
- G. Fontaine, Ivry Zagury-Orly, S. de Denus, M. Lordkipanidzé, M. Beauchesne, Marc-André Maheu-Cadotte, Michel White, N. Thibodeau-Jarry, and Patrick Lavoie. "Effects of Reading Media on Reading Comprehension in Health Professional Education: A Systematic Review Protocol." *JBIR Evidence Synthesis*, 2020.
- P. Gertler, and I. Cameron. "Making Sense of Data Analytic Techniques Used in a Cochrane Systematic Review." *Brain Impairment*, 2018.
- Romina Brignardello-Petersen, Nancy Santesso, and Gordon H. Guyatt. "Systematic Reviews of the Literature: An Introduction to Current Methods." *American Journal of Epidemiology*, 2024.
- Ruvenaa Sagary, Nurul Malim, N. L. Abdullah, Wan Nor Azlen Wan Mohamad, and Alwani Liyana Ahmad. "Impact of Mobile Games-Aided Neurorehabilitation: A Systematic Literature Review." *Malaysian Journal of Medical Sciences*, 2023.