Review Article

Event-Related Potentials in Verbal Episodic Memory in Mild Cognitive Impairment: A Scoping Review

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Running Title: Verbal Memory ERPs in MCI: A Scoping Review

Abstract

Introduction: Mild Cognitive Impairment (MCI) is considered a transitional stage between normal cognitive aging and Alzheimer's disease. Given the challenges in accurately distinguishing MCI from the healthy elderly (HE), researchers have increasingly turned to event-related potentials (ERPs) to identify early neural changes, particularly in verbal and episodic memory processing.

Methods: This review synthesizes ERP studies from 2000 to 2025 that utilized verbal episodic memory paradigms to differentiate between MCI and HE. The databases PsycINFO and PubMed were searched for peer-reviewed articles. The reporting of this review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews checklist.

Results: In these studies, core aspects of verbal processing—including semantic congruity and recognition—combined with episodic memory manipulation have consistently reported alterations in ERP components such as the N400, FN400, and Late Positive Component (LPC) in MCI.

Reduced or delayed N400 and LPC responses, as well as altered scalp distributions, have been shown to be sensitive to verbal memory deficits in MCI, often preceding behavioral impairments. Moreover, ERP paradigms integrating semantic and episodic memory have shown that the interaction between memory systems further enhances diagnostic precision.
Conclusion: The reviewed literature highlights that verbal ERP paradigms are not only effective in differentiating MCI from HE but also capture subtle neurophysiological changes that might be overlooked by behavioral measures alone. These results underscore the potential of ERPs as non-invasive, cost-effective biomarkers for early cognitive impairment.
Keywords: Mild Cognitive Impairment; Event-related potentials; Episodic Memory; Electroencephalography; Aging.

Introduction

As individuals age, susceptibility to cognitive disorders increases, making these conditions more prevalent in older populations [1-3]. This imposes substantial financial and emotional burdens on patients, families, and healthcare systems. Alzheimer's disease (AD) is the leading cause of cognitive decline in the European population, with a prevalence of 4.4% [4]. By 2050, the number of AD cases is projected to reach 106.8 million worldwide, including 16.5 million in Europe [3]. Evidence indicates that the early manifestations of cognitive decline emerge years before a formal AD diagnosis [5]. Petersen and colleagues introduced the term Mild Cognitive Impairment (MCI) to describe the transitional stage between normal aging and dementia [6]. MCI is considered a major risk factor for AD. Individuals with MCI demonstrate objective memory deficits on standardized cognitive tests but retain independence in daily functioning and therefore do not meet the diagnostic criteria for dementia [6, 7]. The prevalence of MCI among individuals over 60 years old is estimated at 12–18% [8], and approximately 50% progress to dementia within five years [9]. Consequently, early detection of cognitive decline in MCI has been extensively investigated over the past 25 years. However, distinguishing pathological cognitive decline from normal cognitive aging still requires more sensitive diagnostic tools.

Some studies have recruited structural and functional neuroimaging techniques to provide insights into the behavioral characteristics and neuropathology associated with MCI and the initial phases of AD [10-12]. The deficits were well accounted for by the Braak staging of neurofibrillary pathology in AD [13], in which the earliest lesions occur in the entorhinal cortex and structures near the medial temporal lobe, critical for episodic memory, and in the temporal neocortex, crucial for semantic memory. Although patients with MCI and AD show episodic memory deficits for both verbal and non-verbal materials, some studies have found that deficits in encoding and retrieval of verbal content shows up in the early stages [14-16]. Therefore, verbal episodic memory testing can be an invaluable tool for diagnosing memory dysfunction in the early stages of AD and MCI.

Verbal processing requires the flow of neural activity through the brain in a matter of milliseconds (ms) [17]. Hence, synaptic activity plays an important role in response accuracy and speed to verbal tasks [17]. Conversely, synaptic loss is the main predictor of cognitive decline in MCI [18]. Synaptic plasticity results in the strengthening of active synapses and therefore greater speed in data transmission between neurons. Several studies have shown that synaptic plasticity disorder results in early AD-related processing deficits and that almost 90% of the variation in dementia severity can be attributed to synaptic loss [19-21]. This phenomenon plays an important role in learning and memory tasks. Taken together, methodologies to assess synaptic plasticity and specific neural/cognitive processes with high temporal accuracy are invaluable for detecting MCI.

The event-related potential (ERP) technique provides information with unsurpassed temporal resolution and precision [14]. In this technique, the neural activity of different regions of the brain can be recorded during task performance. It provides the recording of summed excitatory and inhibitory postsynaptic potentials associated with a particular mental activity or event with a ms resolution. The elicited ERP information can be further interpreted in relation to the specific task. Researchers in the field of electro-neurophysiology have discovered ERP components that are highly responsive to specific mental processes. Changes in amplitude (in microvolts), latency (in ms), and scalp distribution of an ERP response can provide valuable insights into a person's mental state during a particular cognitive process.

Hence, combining verbal cognitive tasks with the ERP technique may be helpful for early diagnosis and defining the stage of cognitive decline in MCI and early AD patients. This review will examine research that has employed verbal processing combined with episodic memory using ERP methodology to distinguish between MCI and healthy elderly (HE) groups. Initially, we shall examine the most frequently debated ERP components related to verbal episodic memory processes and tasks. The verbal and episodic memory tasks/paradigms that were utilized to elicit these ERP components in the MCI group will then be reviewed.

Methods

Methodological Framework

This scoping review was conducted in accordance with the methodological framework proposed by Arksey and O'Malley [22], enhanced by the recommendations of Levac et al. [23] and the Joanna Briggs Institute guidance for scoping reviews [24]. The reporting of this review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist [25]. No protocol for this review was preregistered.

Identifying the research question

The review was guided by the following research question: What is known from the existing literature about the use of ERPs to investigate verbal episodic memory in individuals with MCI compared to the HE controls?

Identifying Relevant Studies

A comprehensive search strategy was developed in consultation with an experienced librarian. The databases PsycINFO and PubMed were searched for peer-reviewed articles published between January 2000 and December 2025. The search strategy combined keywords and Boolean operators as follows: (MCI OR mild cognitive impairment) AND (ERP OR event-related potentials) AND (language OR semantics OR verbal). Reference lists of relevant review articles on ERPs in MCI populations were also screened to identify additional eligible studies.

Study Selection

All retrieved records were imported into EndNote and duplicates were removed. Screening was conducted in two phases: title and abstract screening to assess initial relevance and full-text review to confirm eligibility. Two reviewers (Hr F and Ar K) independently screened all records. Discrepancies were resolved through discussion or consultation with a third reviewer (Mr H).

Eligibility criteria

The research question was developed using the Population-Concept-Context framework recommended by Joanna Briggs Institute. The population of interest comprised individuals diagnosed with MCI compared to HE controls. The concept was the use of ERPs to assess verbal processing combined with episodic memory. The context encompassed peer-reviewed empirical studies published between January 2000 and December 2025, conducted in any setting using methodologies to compare verbal episodic memory between MCI and HE groups.
Studies were excluded if they did not include both MCI and HE participants, did not directly assess semantic processing, or used neurophysiological measures other than ERPs.

Charting the data

Data extraction was performed using a piloted data-charting form in Microsoft Excel. Two reviewers independently extracted the following data from each included study:

- Author(s) and year of publication
- Country and language of the semantic tasks
- Study design and methodology
- Population characteristics
- ERP task paradigm and language domain assessed
- ERP components measured
- Key findings

The data-charting form was refined iteratively during the extraction process.

Collating, Summarizing, and Reporting the Results

Extracted data were synthesized descriptively. Studies were grouped according to semantic domain assessed, ERP components measured, and main findings. Narrative summaries, tables, and visual mapping were used to illustrate the extent, range, and nature of the evidence.

PRISMA Flow Diagram

The study selection process is depicted in a PRISMA-ScR flow diagram (Figure 1), showing the number of records identified, screened, excluded based on mentioned criteria at 2.5 section, and included in the final synthesis.

Results

Overview of Study Selection

The initial database search identified a total of 1959 records: 326 from PsycINFO, 1,595 from PubMed, and 38 from cited references. After removing duplicates, 1,700 records remained for screening. Following title and abstract screening, 1,550 records were excluded for not meeting the inclusion criteria. The full texts of 150 articles were assessed for eligibility. Of these, 142 were excluded for reasons such as not including both MCI and HE groups, not focusing on verbal processing, or not using ERP measures. Ultimately, 8 studies were included in the final synthesis. The study selection process is illustrated in the PRISMA-ScR flow diagram (Figure 1).

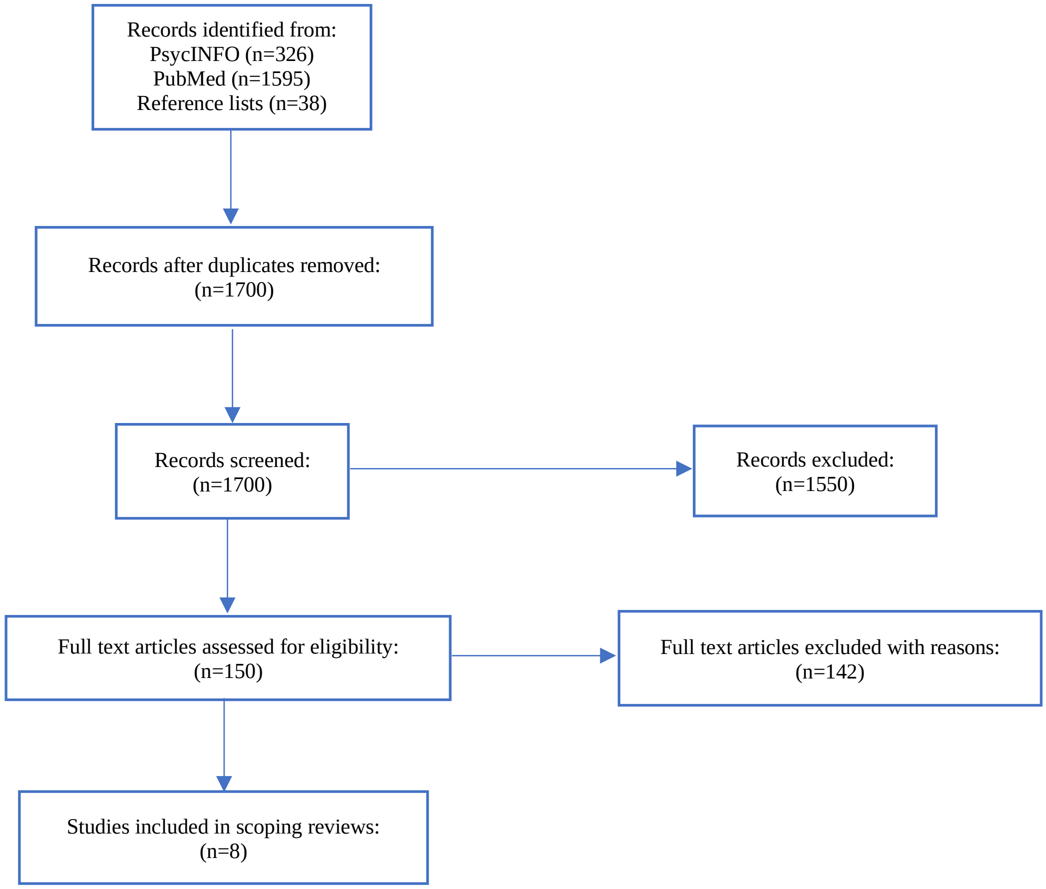

Fig 1. PRISMA-ScR flow diagram illustrating the identification, screening, eligibility assessment, and inclusion of studies examining ERPs in verbal episodic memory among individuals with MCI and HE controls.

Characteristics of included studies

The eight included studies were published between 2002 and 2017 and conducted in English, German, and Chinese. All were peer-reviewed empirical investigations comparing ERP responses during verbal episodic memory processing between individuals with MCI and HE controls. Most studies employed cross-sectional designs using visual or auditory semantic tasks. Based on the research question, the studies incorporated two primary verbal episodic memory manipulations. Three studies examined verbal/semantic processing using a congruity effect combined with a repetition paradigm as the episodic memory manipulation. The remaining five studies assessed verbal/semantic processing through recognition tasks paired with an old/new paradigm. Table 1 summarizes the characteristics of the included studies. The following sections describe the ERP components relevant to these processes, followed by an explanation of the verbal episodic memory paradigms used in the included studies.

Table 1. Event-Related Potentials in Verbal Memory Studies.

Study, year	ERP Test (Stimuli, Response, Task)	ERP Components	Behavioral Measurements
Olichney et al. [26], 2002	Auditory phrases & visual words Verbal (yes/no) Congruity, Repetition (incongruous/congruous)	N400* (L, D), LPC (parietal)	Accuracy*
Olichney et al. [27], 2008	Auditory phrases & visual words Verbal (yes/no) Congruity, Repetition (incongruous/congruous)	N400* (A, D), LPC (parietal)* (A, D)	Accuracy*
Ally et al. [28], 2009	Visual words, Pictures Verbal (old/new) Recognition	FN400 (early frontal)* (A), LPC (parietal)* (A), LFE (~1000–1800 ms)	Accuracy*, Response bias
Galli et al. [29], 2010	Pictures Push button & naming Visual priming, Recognition, Old/new	FN400 (early frontal)* (A), LPC (parietal)	Mean identification*, Priming effect*
Hoppstädter et al. [30], 2010	Visual words Push button Recognition, Old/new	FN400 (early frontal)* (A), LPC (parietal)	Performance*, Response bias, RT*
Wolk et al. [31], 2013	Words Push button Recognition, Old/new	N400*, LPC (parietal)*	Accuracy*
Yang et al. [32], 2013	Auditory phrases & visual words Verbal (yes/no) Congruity, Repetition	N400* (A, D), LPC (parietal)* (A)	Accuracy
Kuo [33], 2017	Visual words Push button Recognition	LPC (parietal)*	Accuracy, RT

Notes: * indicates significant effects. Abbreviations: MCI = Mild Cognitive Impairment; HE = Healthy Elderly; ERP = Event-Related Potential; LPC = Late Positive Component; FN400 = Frontal N400; LFE = Late Frontal Effect; A = Amplitude; D = Distribution; L = Latency; RT = Reaction time; ms = milliseconds.

Components related to verbal recognition memory

In this section, we describe the well-known ERP components related to verbal episodic memory. We also describe how different studies have manipulated linguistic stimuli to identify changes and intergroup differences in these components.

Frontal N400 (FN400)

FN400 is a negative-going component related to “familiarity” within the processes of stimulus recognition [34]. Some studies have investigated familiarity through old/new judgments to show the impact of episodic memory on semantic processing [34, 35]. In HEs, FN400 as an index of familiarity tends to be smaller for old (studied) stimuli [31, 34, 35]. This effect is also called the "early frontal" effect, and the diminution of this effect is a sign of absent or reduced familiarity.

N400

Most of the ERP studies on semantic processing have investigated this component which is elicited by every content word. It peaks between 300 and 600 ms following the presentation of the stimulus and is sensitive to meaningfulness evaluation [36]. Comparing the effects of priming or congruity conditions as semantic content modifications on N400 alterations, and contrasting these changes between groups has been the subject of some research [37-39].

Late Positive Component (LPC)

The LPC is a positive-going wave peaking between 600 and 800 ms after stimulus-onset. This component is commonly studied as an index of recollection, an important aspect of recognition memory [34]. Furthermore, LPC is known to be sensitive to mental processes such as memory encoding and retrieval [40]. In studies of verbal episodic memory, LPC amplitude is larger for old or familiar stimuli encoded in episodic memory than for new stimuli [41-44].

Congruity effect combined with Repetition paradigm

As a semantic manipulation, the congruity paradigm presents participants with two verbal stimuli—either spoken or written—and requires them to judge whether they are semantically consistent (e.g., breakfast–bread: congruous; breakfast–soap: incongruous). Responses are typically given verbally (yes/no) or via button press. ERP studies have demonstrated smaller N400 amplitudes for semantically congruous stimuli compared with incongruous stimuli, known as the "N400 congruity effect," an electrophysiological index of semantic memory [38]. Delayed N400 latency or reduced amplitude may indicate impaired semantic processing.

Olichney et al. [26] compared ERP responses to the congruity effect between individuals with MCI and HE participants. Auditory category statements were followed by visually presented target words, and participants judged whether the word matched the preceding category. The N400 peak (350–550 ms time window) showed delayed latency in the MCI group, and the effect persisted longer than in HE participants. To assess the contribution of episodic memory, the paradigm included repetition of auditory primes and their associated visual targets. N400 amplitudes were larger for novel stimuli in both groups, and smaller for repeated incongruous stimuli compared with novel items; however, this repetition effect was delayed in MCI. Larger LPC responses to novel stimuli were also observed for congruent items. Compared with HE participants, the repetition effect for congruous stimuli was reduced in the MCI group [26]. The largest LPC amplitudes were recorded at vertex and bi-temporal sites, with significant group differences in scalp distribution [26]. The combined measures of semantic processing (N400 congruity effect) and episodic memory (LPC repetition effect) effectively differentiated MCI from HE participants.

Using the same paradigm, Olichney et al. [27] followed MCI participants for up to three years after the initial ERP recording. Approximately 87% of individuals with smaller congruous word repetition effects (LPC) and/or reduced incongruous word repetition effects (N400) converted to AD within three years [27]

Congruity and repetition paradigms were also used in the study of Yang et al. [32] in HE and MCI groups. The N400 congruity effect was reduced or absent in MCI patients and, along with a different scalp distribution, could differentiate between groups. N400 response to incongruous repetition was also diminished in the MCI group. The LPC response to congruous repetition was also diminished in the MCI group compared to HE. Hence, across all participants, the N400 response correctly classified 84% of MCI patients, and the LPC response correctly classified 60% [32].

Recognition combined with old/new effect

Familiarity and recollection are two distinct processes underlying recognition memory [45] and contribute to the speed and accuracy of memory performance. Recollection involves retrieval of contextual information associated with a prior encounter, and is supported by the parietal lobe, prefrontal cortex, and hippocampus [46-48]. In ERP research, the LPC, also termed the parietal effect, is considered an index of recollection [49] and has been widely examined in electro-neurophysiological studies, with the medial temporal lobe playing a central role [50].

In contrast, FN400, typically recorded from frontal electrodes, is associated with familiarity processing [34]. ERP methodology enables comparison of recognition processes across different populations. Both FN400 and LPC are sensitive to stimulus characteristics (e.g., words vs. pictures) and memory manipulations (e.g., old/new or repetition effects). Most studies investigating familiarity and recollection employ the old/new recognition paradigm, in which previously encountered (old) items typically elicit smaller FN400 amplitudes and larger LPC amplitudes than new items [35, 49]. Attenuation or absence of this pattern may indicate episodic memory impairment.

Ally et al. [28] investigated FN400 and LPC components to evaluate familiarity and recollection in individuals with MCI and HE participants. They also compared performance across stimulus types (images vs. words). The results showed that MCI participants exhibited a familiarity effect comparable to HE participants for pictorial stimuli, whereas this effect was reduced for written words. Regarding recollection, the LPC for written stimuli was reduced in both groups relative to images. For pictorial stimuli, however, the parietal effect was diminished only in the MCI group: HE participants demonstrated a parietal effect for images but not for written words. Additionally, Ally et al. [28] examined the late frontal effect (~1000-1800 ms), which reflects post-retrieval monitoring processes rather than core recognition memory. In their study, LFE responses were relatively preserved for pictorial stimuli in MCI participants, indicating that executive monitoring of retrieved information may remain intact even when familiarity or recollection is impaired.

The old/new recognition paradigm with word stimuli was also used by Wolk et al. [31] to compare MCI and HE participants. During the study phase, half of the words were presented once and the other half three times. Behavioral results (hits and correct rejections) indicated better performance for thrice-studied words than once-studied words in both groups. The HE group outperformed the MCI group; notably, MCI performance on thrice-studied items was comparable to HE performance on once-studied items. ERP analyses first compared FN400 and LPC responses after matching groups for behavioral performance and revealed no significant group differences. A second analysis based on retrieval attempt (studied vs. unstudied words) demonstrated reduced FN400 and LPC old/new effects in the MCI group [31].

Hoppstädter et al. [30] also examined the old/new effect on recognition memory in the MCI and HE groups. They used two sets of 100 written concrete words, of which half were studied in the study phase. Participants were asked to judge whether the words were novel by pressing a yes/no button. The ERP data showed no LPC effect in either group, and only an FN400 old/new effect was identified in HE participants. This result was correlated with the volume of the medial temporal lobe as determined by brain morphology analysis.

Galli et al. [29] also examined old/new effects in the context of a visual priming paradigm to address recognition in the MCI and HE groups. They utilized 96 images organized into eight blocks, each block containing 12 images, six of which were presented to the participants earlier in the study. In the test phase, they presented the pictures in an ascending series from blurred to clear while recording ERPs. The FN400 effect was observed exclusively in the HE group, and not in the MCI group. No group differences were observed in the LPC responses to old and new stimuli.

Kuo [33] also examined the MCI group's LPC response using an old/new paradigm. The study aimed to assess the semantic encoding ability of MCI patients. In the study phase, participants were asked to indicate whether a shown Chinese character could produce a sound. The study phase was followed by a recognition task in which participants were asked to answer if the characters were old or new, while ERPs were recorded. LPC responses showed no difference between old and new items which was interpreted as poor semantic encoding ability in these patients [33].

Discussion

This review examined ERP studies that utilized verbal processing combined with episodic memory to distinguish between MCI and HE. The relatively small number of included studies (n = 8) reflects the limited application of ERP methodologies specifically designed to investigate verbal episodic memory in clinically well-defined MCI populations. Although ERP research in cognitive impairment has expanded, studies combining standardized verbal episodic memory paradigms with clear diagnostic criteria for MCI remain scarce.

Among all the reviewed ERP studies, those of Olichney et al. [26, 27] and Yang et al. [32] have assessed verbal processing directly. Investigations of the congruity effect in Olichney et al. [26] and Yang et al. [32] showed that a smaller N400 in MCI discriminated this group from the HE group. These studies revealed that neural activity changes related to semantic processing occur in the early stages of age-related cognitive impairment and these changes can be useful to differentiate between MCI and normal aging.

In addition to the direct verbal processing paradigms, studies that examined semantic memory with the controlled engagement of episodic memory also discriminated well between the MCI group and the HE group. In those studies, altered ERP responses to semantic processing via episodic memory manipulation provided key indicators of the memory deficits in MCI. In Olichney et al. [26] and Yang et al. [32], word repetition effects were measured in conjunction with the congruity effect to new words. Participants were required to determine whether the stimuli were congruent, and half of the stimuli were repeated in a pseudo-random manner. This paradigm revealed delayed and diminished LPC responses in Olichney et al. [26] and diminished N400 and LPC responses in Yang et al. [32] in MCI compared to HE. These findings reflected the inability of the MCI group to benefit from enhanced semantic judgment via repetition, and the relevant ERP impairments can be used to differentiate between the MCI group and the HE group [26, 32]. These ERP abnormalities indicate that MCI patients may take less advantage of repetition due to a synaptic plasticity disorder. Synaptic changes (e.g., changes in the amount of released neurotransmitter, altered receptors, microstructural changes) normally occur with encountering repeated stimuli. These changes underlie synaptic plasticity, the neurobiological foundation of learning and memory [52]. This interpretation is consistent with previous findings that pre-synaptic density (measured by synaptophysin staining of frontal cortex) can explain approximately 90% of dementia severity [19-21].

Similar ERP responses related to the synaptic plasticity disorder were observed in Ally et al. [28], Hoppstädter et al. [30], Galli et al. [29], Wolk et al. [31], and Kuo [33] studies, in which semantic processing involved recognition and episodic memory was manipulated by the old/new paradigm. Additionally, similar ERP responses were found in these studies, in which the response was episodic memory judgment (old/new), in contrast to Olichney et al. [26, 27] and Yang et al. [32] in which the responses were semantic judgment of congruence or incongruity. These consistent results, observed regardless of the type of the tasks, could indicate that ERP responses are highly related to specific cognitive processing. This finding could be interpreted as the reliability of ERP methodology in MCI assessments.

The other point to discuss is the type of stimuli. In Hoppstädter et al. [30] and Ally et al. [28], when stimuli were written words, neither the MCI nor the HE group showed the recollection effect, but HE showed the familiarity effect. Thus, the FN400 response in the written word condition distinguished between the two groups. Similarly, Wolk et al. [31], using visual words, showed diminished FN400 and LPC responses in the MCI group compared to HE participants. Both components successfully discriminated between the groups. A lack of LPC response in an old/new paradigm was also observed in the study of MCI patients conducted by Kuo [33].

In contrast, some studies have used picture stimuli instead of written words to compare MCI and HE in recognition memory. Ally et al. [28] included both picture and word stimuli and found that behavioral performance in both MCI and HE groups was better with pictures. This is consistent with the well-established picture superiority effect in neuropsychological research [51]. ERP results showed that the MCI group could benefit from pictorial input to facilitate familiarity but not recollection, whereas the HE group showed old/new effects for both familiarity and recollection. Consequently, with picture stimuli, the LPC response to the old/new effect successfully discriminated between the two groups [28].

In Galli et al., where stimuli were also pictures, the FN400 distinguished between the groups, as the familiarity effect appeared only in the HE group [29]. The absence of a familiarity effect in MCI patients in Galli et al. [29], compared to Ally et al. [28], may be explained by two factors. First, the mean general cognition score (assessed by Mini-Mental State Examination) of the MCI group in Galli et al. (M=25.5, SD=3.4) [29] was lower than that in Ally et al. (M=28.1, SD=1.3) [28]. Second, Ally et al. [28] used a straightforward old/new paradigm, whereas Galli et al. [29] employed a visual priming task with progressively blurred stimuli.

Overall, ERP findings suggest that examining verbal processing with varying complexity, in combination with episodic memory manipulations, helps differentiate MCI from HE. These processes are sensitive to stimulus type (words or pictures) and task nature. Examining verbal processing differences in response to particular manipulations can reliably distinguish MCI from HE. Importantly, these early neurophysiological markers can inform rehabilitation strategies, as recent evidence indicates that targeted cognitive training and neuromodulation interventions may improve memory outcomes in individuals with MCI [53]. ERP measures such as N400 and LPC provide sensitive indices of early cognitive decline in MCI. When combined with task- and stimulus-specific paradigms, they not only differentiate MCI from HE but also offer valuable guidance for designing targeted cognitive rehabilitation interventions.

Limitations

This scoping review has several limitations. First, the number of included studies was relatively small, which reflects the limited availability of ERP investigations specifically focusing on verbal episodic memory in clinically defined MCI populations. Second, methodological heterogeneity across studies, including differences in ERP paradigms, stimulus types, diagnostic criteria, and reported components, may limit direct comparability. Third, as a scoping review, this study did not perform a quantitative meta-analysis or formal risk-of-bias assessment. Future research employing standardized verbal episodic memory paradigms and uniform diagnostic criteria is needed to strengthen the evidence base.

Conclusion

ERP studies investigating verbal episodic memory reveal neural markers that distinguish MCI from HE participants. Particularly, changes in N400 and LPC components reflect early deficits in semantic integration and memory retrieval. Some ERP abnormalities precede behavioral impairments, highlighting their potential for early diagnosis. Furthermore, combining semantic and episodic memory tasks—especially those involving word repetition or recognition paradigms—enhances diagnostic sensitivity. Differences in task complexity, stimulus type, and ERP latency/amplitude offer a nuanced picture of how MCI affects cognition. Overall, ERP measures of verbal episodic memory serve as valuable tools in understanding and detecting early cognitive decline in aging populations.

Ethical Considerations

Compliance with ethical guidelines

Ethical approval was not required for this review article.

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Conflict of Interest

The authors declare no conflict of interest.

Authors' Contributions

Conceptualization was carried out by all authors. The literature search was conducted by the first author. Data extraction was performed by the first and second authors. Manuscript drafting was undertaken by all authors. Critical revision of the manuscript was performed by the second and third authors. All authors read and approved the final manuscript.

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References

1. Aronson MK, Ooi WL, Geva DL, Masur D, Blau A, Frishman W. Dementia: age-dependent incidence, prevalence, and mortality in the old old. Arch. Intern. Med. 1991;151(5):989-92.
2. Brookmeyer R, Gray S, Kawas C. Projections of Alzheimer's disease in the United States and the public health impact of delaying disease onset. Am J Public Health. 1998;88(9):1337-42.
3. Brookmeyer R, Johnson E, Ziegler-Graham K, Arrighi HM. Forecasting the global burden of Alzheimer's disease. Alzheimers Dement. 2007;3(3):186-91.
4. Lobo A, Launer LJ, Fratiglioni L, Andersen K, Di Carlo A, Breteler M, et al. Prevalence of dementia and major subtypes in Europe: a collaborative study of population-based cohorts. Neurology. 2000;54(5):S4.

5. Jack CR, Knopman DS, Jagust WJ, et al. Tracking pathophysiological processes in Alzheimer's disease: an updated hypothetical model of dynamic biomarkers. Lancet Neurol. 2013;12(2):207-16.
6. Petersen RC, Smith GE, Waring SC, Ivnik RJ, Tangalos EG, Kokmen E. Mild cognitive impairment: clinical characterization and outcome. Arch. Neurol. 1999;56(3):303-8.
7. Petersen RC, Stevens JC, Ganguli M, Tangalos EG, Cummings J, DeKosky ST. Practice parameter: early detection of dementia: mild cognitive impairment (an evidence-based review): report of the Quality Standards Subcommittee of the American Academy of Neurology. Neurology. 2001;56(9):1133-42.
8. Ganguli M, Chang C-CH, Snitz BE, Saxton JA, Vanderbilt J, Lee C-W. Prevalence of mild cognitive impairment by multiple classifications: The Monongahela-Youghiogheny Healthy Aging Team (MYHAT) project. Am J Geriatr Psychiatry. 2010;18(8):674-83.
9. Gauthier S, Reisberg B, Zaudig M, et al. Mild cognitive impairment. Lancet. 2006;367(9518):1262-70.
10. Machulda M, Ward H, Borowski B, et al. Comparison of memory fMRI response among normal, MCI, and Alzheimer's patients. Neurology. 2003;61(4):500-6.
11. Hojjati SH, Ebrahimzadeh A, Babajani-Feremi A. Identification of the early stage of Alzheimer's disease using structural MRI and resting-state fMRI. Front Neurol. 2019;10:904.
12. Li X, Wang F, Liu X, et al. Changes in brain function networks in patients with amnestic mild cognitive impairment: a resting-state fMRI study. Front Neurol. 2020;11:554032.
13. Braak H. Neuropathological staging of Alzheimer-related changes correlates with psychometrically assessed intellectual status. In: Terry RD, Katzman R, Bick KL, editors. *Alzheimer's Disease: Advances in Clinical and Basic Research. Third International Conference on Alzheimer's Disease and Related Disorders*. New York: John Wiley & Sons; 1993, 131-137.
14. Taler V, Phillips NA. Language performance in Alzheimer's disease and mild cognitive impairment: a comparative review. J. Clin. Exp. Neuropsychol. 2008;30(5):501-56.
15. Joubert S, Brambati SM, Ansado J, et al. The cognitive and neural expression of semantic memory impairment in mild cognitive impairment and early Alzheimer's disease. Neuropsychologia. 2010;48(4):978-88.
16. Taler V, Voronchikhina A, Gorfine G, Lukasik M. Knowledge of semantic features in mild cognitive impairment. J. Neurolinguistics. 2016;38:56-70.
17. Kutas M, Schmitt BM. Language in microvolts. Mind, brain, and language: Multidisciplinary perspectives. 2003:171-209.
18. Mufson EJ, Binder L, Counts SE, et al. Mild cognitive impairment: pathology and mechanisms. Acta Neuropathol. 2012;123:13-30.
19. Terry RD, Masliah E, Salmon DP, et al. Physical basis of cognitive alterations in Alzheimer's disease: synapse loss is the major correlate of cognitive impairment. Ann. Neurol: Official Journal of the American Neurological Association and the Child Neurology Society. 1991;30(4):572-80.
20. Mesulam M-M. Neuroplasticity failure in Alzheimer's disease: bridging the gap between plaques and tangles. Neuron. 1999;24(3):521-9.
21. Selkoe DJ. Alzheimer's disease is a synaptic failure. Science. 2002;298(5594):789-91.
22. Arksey H, O'malley L. Scoping studies: towards a methodological framework. Int. J. Soc. Res. 2005;8(1):19-32.
23. Levac D, Colquhoun H, O'brien KK. Scoping studies: advancing the methodology. **Implement Sci**. 2010;5(1):69.

24. Peters MD, Godfrey C, McInerney P, Munn Z, Tricco AC, Khalil H. Chapter 11: scoping reviews. JBI manual for evidence synthesis. 2020;169(7):467-73.
25. Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Ann. Intern. Med. 2018;169(7):467-73.
26. Olichney JM, Morris S, Ochoa C, et al. Abnormal verbal event related potentials in mild cognitive impairment and incipient Alzheimer's disease. J Neurol Neurosurg Psychiatry. 2002;73(4):377-84.
27. Olichney J, Taylor J, Gatherwright J, et al. Patients with MCI and N400 or P600 abnormalities are at very high risk for conversion to dementia. Neurology. 2008;70(19_part_2):1763-70.
28. Ally BA, McKeever JD, Waring JD, Budson AE. Preserved frontal memorial processing for pictures in patients with mild cognitive impairment. Neuropsychologia. 2009;47(10):2044-55.
29. Galli G, Ragazzoni A, Viggiano MP. Atypical event-related potentials in patients with mild cognitive impairment: an identification-priming study. Alzheimers Dement. 2010;6(4):351-8.
30. Hoppstädter M, King AV, Frölich L, Wessa M, Flor H, Meyer P. A combined electrophysiological and morphological examination of episodic memory decline in amnestic mild cognitive impairment. Front. aging neurosci. 2013;5:51.
31. Wolk DA, Manning K, Kliot D, Arnold SE. Recognition memory in amnestic-mild cognitive impairment: insights from event-related potentials. Front. aging neurosci. 2013;5:89.
32. Yang J-C, Chi L, Teichholtz S, et al. ERP abnormalities elicited by word repetition in fragile X-associated tremor/ataxia syndrome (FXTAS) and amnestic MCI. Neuropsychologia. 2014;63:34-42.
33. Kuo M. Semantic encoding in mild cognitive impairment: A preliminary ERP study. Int. clin. neurosci. j. 2017;4(2):51-6.
34. Curran T. Brain potentials of recollection and familiarity. Mem. Cogn. 2000;28:923-38.
35. Ally BA, Budson AE. The worth of pictures: Using high density event-related potentials to understand the memorial power of pictures and the dynamics of recognition memory. NeuroImage. 2007;35(1):378-95.
36. Kutas M, Hillyard SA. Event-related brain potentials to grammatical errors and semantic anomalies. Mem. Cogn. 1983;11(5):539-50.
37. Holcomb PJ. Automatic and attentional processing: An event-related brain potential analysis of semantic priming. Brain Lang. 1988;35(1):66-85.
38. Marta K, Van Petten C. Psycholinguistics electrified: event-related brain potential investigations. In: Gernsbacher MA, editor. Handbook of psycholinguistics. New York: Academic Press; 1994. p. 83-143.
39. Karayanidis F, Andrews S, Ward PB, McConaghy N. Effects of inter-item lag on word repetition: An event-related potential study. Psychophysiology. 1991;28(3):307-18.
40. Petten CV, Kutas M, Kluender R, Mitchiner M, McIsaac H. Fractionating the word repetition effect with event-related potentials. J. Cogn. Neurosci. 1991;3(2):131-50.
41. Friedman D, Johnson Jr R. Event-related potential (ERP) studies of memory encoding and retrieval: A selective review. Microsc. Res. Tech. 2000;51(1):6-28.
42. Olichney JM, Van Petten C, Paller KA, Salmon DP, Iragui VJ, Kutas M. Word repetition in amnesia: Electrophysiological measures of impaired and spared memory. Brain. 2000;123(9):1948-63.
43. Groh-Bordin C, Zimmer HD, Mecklinger A. Feature binding in perceptual priming and in episodic object recognition: Evidence from event-related brain potentials. Cogn. Brain Res. 2005;24(3):556-67.

44. Besson M, Kutas M, Petten CV. An event-related potential (ERP) analysis of semantic congruity and repetition effects in sentences. J. Cogn. Neurosci. 1992;4(2):132-49.
45. Yonelinas AP. Receiver-operating characteristics in recognition memory: evidence for a dual-process model. J. Exp. Psychol.: Learn. Mem. Cogn. 1994;20(6):1341.
46. Simons JS, Owen AM, Fletcher PC, Burgess PW. Anterior prefrontal cortex and the recollection of contextual information. Neuropsychologia. 2005;43(12):1774-83.
47. Yonelinas AP, Otten LJ, Shaw KN, Rugg MD. Separating the brain regions involved in recollection and familiarity in recognition memory. J. Neurosci. 2005;25(11):3002-8.
48. Ally BA, Simons JS, McKeever JD, Peers PV, Budson AE. Parietal contributions to recollection: electrophysiological evidence from aging and patients with parietal lesions. Neuropsychologia. 2008;46(7):1800-12.
49. Rugg MD, Curran T. Event-related potentials and recognition memory. Trends Cogn Sci. 2007;11(6):251-7.
50. Eichenbaum H, Yonelinas AP, Ranganath C. The medial temporal lobe and recognition memory. Annu Rev Neurosci. 2007;30(1):123-52.
51. Mintzer MZ, Snodgrass JG. The picture superiority effect: Support for the distinctiveness model. Am. J. Psychol. 1999;112(1):113.
52. Martin SJ, Grimwood PD, Morris RG. Synaptic plasticity and memory: an evaluation of the hypothesis. Annu. Rev. Neurosci. 2000;23(1):649-711.
53. Chu KY, Cheng KH. Effects of transcranial direct-current stimulation and cognitive training on individuals with mild cognitive impairment and dementia: a systematic review and meta-analysis. J Mod Rehabil. 2024.