

Neurobiological Bases Of Motor And Cognitive Deficits In The Context Of Early Alzheimer Detection

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Performance on the MoCA correlates with distributed brain networks. Success depends on fronto-parietal and fronto-temporal integration facilitated by specific white matter tracts (e.g., Superior Longitudinal Fasciculus (SLF) for visuospatial, uncinate for semantic, and fornix-cingulum for episodic memory).

INTRODUCTION

Alzheimer's disease (AD) is characterized by severe cognitive decline, frequently accompanied by motor deficits. This work aims to understand the shared neuroanatomical substrates of these combined impairments for early diagnosis and tracking disease progression. The Montreal Cognitive Assessment (MoCA) domains are used as a structural framework to deconstruct and map the specific neural pathways and white-matter tracts that subserve both cognitive and motor functions. [1,2]

METHODS

A narrative review of indexed literature (2005–2026) was conducted to systematically deconstruct the seven domains of the MoCA. Cognitive tasks were mapped to their underlying neural substrates—specifically the intersection of cognitive-processing and motor-execution networks—to model the progressive structural disconnection characteristic of early-stage Alzheimer's disease.

MoCA decontruction on each 7 domains

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A comprehensive narrative review of indexed literature (2005-2026) was executed across major databases (Pubmed, Scopus, Web od Science, Google Scholar)

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Cognitive tasks were correlated with their underlying neural substrates, focusing specifically on the intersectionof cognitive processing hubs and motor execution networks

RESULTS

Visuospatial and Executive Domain

- Cognitive flexibility. [2, 3]
- Planning and organization. [4]
- Visuospatial construction. [5]

Naming Domain

- Visual object recognition. [14,15]
- Semantic retrieval. [16]
- Lexical access. [17]

Orientation Domain

- Temporal and spatial orientation. [2]
- Autobiographical integration. [47]

Abstraction Domain

- Conceptual reasoning. [1,39]
- Relational integration. [40,41]
- Categorization. [42]

Memory Domain

- Episodic memory encoding. [23,24]
- Consolidation. [25,26]

Attention Domain

- Sustained attention. [32]
- Selective attention. [33]
- Working memory or manipulation.[2]
- Basic mental calculation. [2]

Language Domain

- Repetition. [2]
- Phonological maintenance. [2,35]
- Phonemic fluency. [2, 36]

Cognitive functions assessed

Figure 1. Domains of the Montreal Cognitive Assessment. Schematic breakdown of the core cognitive and executive functions evaluated during clinical screening.

Table 1. Neuroanatomical Correlates of Cognitive Domains. Mapping of specific cortical structures and white matter tracts to their corresponding evaluated cognitive functions.

Domain	Neuroanatomical structures	White matter tracts
Visuospatial and Executive Domain	The dorsal visual pathway, Dorsolateral Prefrontal Cortex (DLPFC), Frontal Eye Fields (FEF). [6-10]	Superior Longitudinal Fasciculus (SLF), Arcuate Fasciculus (AF). [11,12,13]
Naming Domain	Ventral visual pathway,Temporal semantic and lexical regions. [14,15,16,18-22]	Inferior fronto-occipital fasciculus, uncinate fasciculus. [22]
Memory Domain	Hippocampal formation, the perforant pathway, The default mode network (DMN), parahippocampal gyrus. [23-30]	The fornix, the cingulum bundle. [30,31]
Attention Domain	Fronto-parietal pathway, ACC. [32,33,34]	Superior Longitudinal Fasciculus.[34]
Language Domain	The dorsal stream, Broca's and Wernicke's areas, Left frontal network. [2,36-38]	Superior Longitudinal Fasciculus , Arcuate Fasciculus, fronto-occipital fasciculus. [36-38]
Abstraction Domain	Frontal pole, fronto-parietal control network. [8,43]	SLF, corpus callosum, Uncinate Fasciculus. [44,45]
Orientation Domain	Default Mode Network, Medial Temporal Lobe. [46]	Cingulum bundle. [48]

CONCLUSIONS

- Deconstructing the Montreal Cognitive Assessment domains demonstrates that motor and cognitive deficits in Alzheimer's disease arise from the progressive disconnection of shared neuroanatomical pathways.
- Utilizing the Montreal Cognitive Assessment provides a precise structural map of this neural degradation.
- Degeneration within shared frontoparietal networks, the dorsal visual stream, and key white-matter tracts fully accounts for the overlap between executive and motor impairments.
- This structural perspective directly links progressive cognitive decline with impaired visually guided motor actions.

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Ciencia y Tecnología

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