Studying semantics in people with mild cognitive impairment and Alzheimer's disease: Development of a short screening tool

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I am speaking to you all today from the University of Ottawa, which is situated on the traditional lands of the Algonquin people. We acknowledge their longstanding relationship with this territory, which remains unceded.

Mr M, a patient with semantic dementia — a neurodegenerative disease that is characterized by the gradual deterioration of semantic memory — was being driven through the countryside to visit a friend and was able to remind his wife where to turn along the not recently-travelled route. Then, pointing at the sheep in the field, he asked her “What are those things?” Prior to the onset of symptoms in his late 40s, this man had normal semantic memory. What has gone wrong in his brain to produce this dramatic and selective erosion of conceptual knowledge?

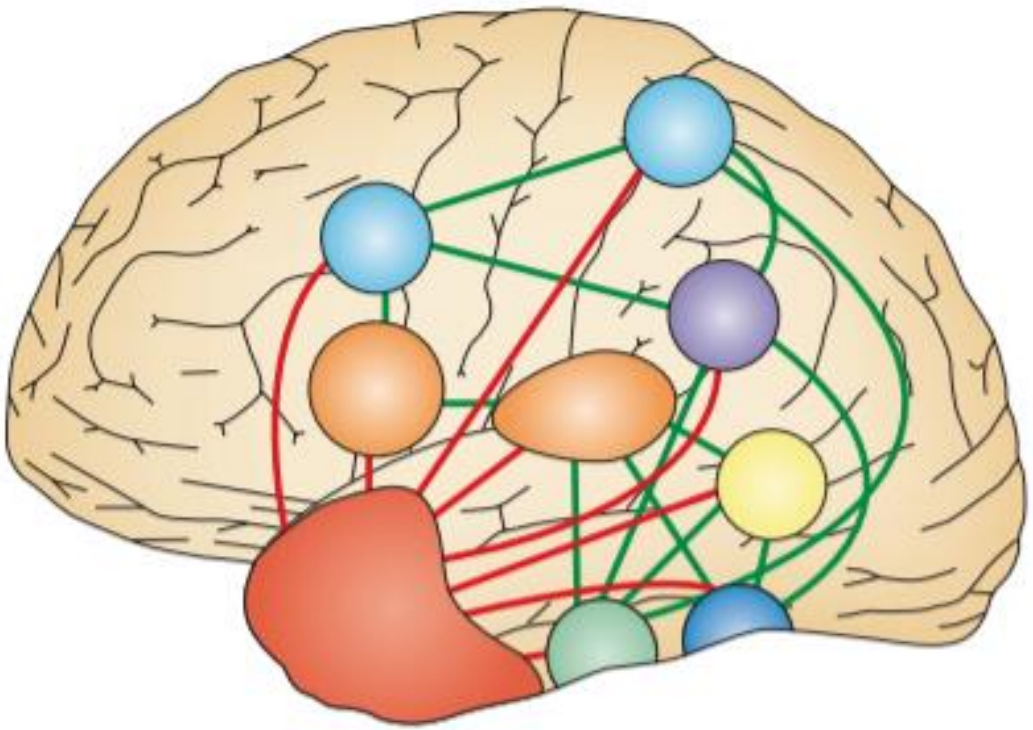
(from Patterson et al. 2007)

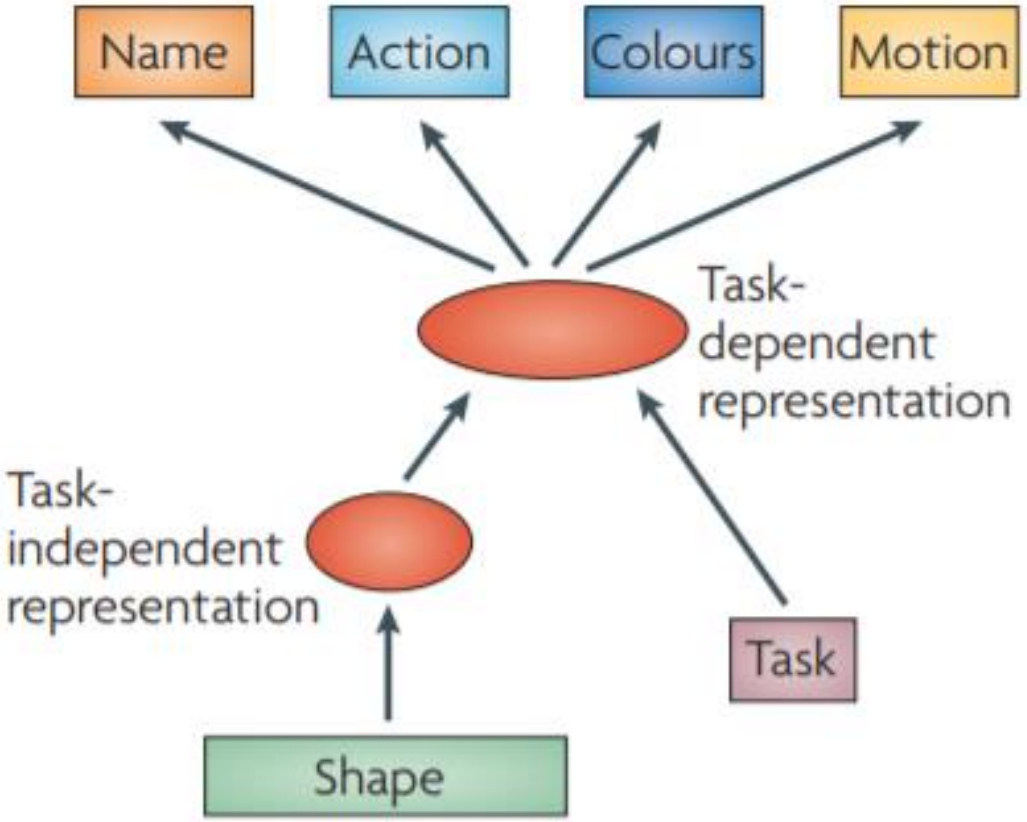
What is semantic memory?

- A type of *long-term memory*
- Encodes culturally-shared knowledge about objects, facts, places, people and concepts
- This includes knowledge of words and their meanings
- Semantic memory is critically important for most cognitive functions

Semantic memory in the brain

from Patterson et al. (2007)



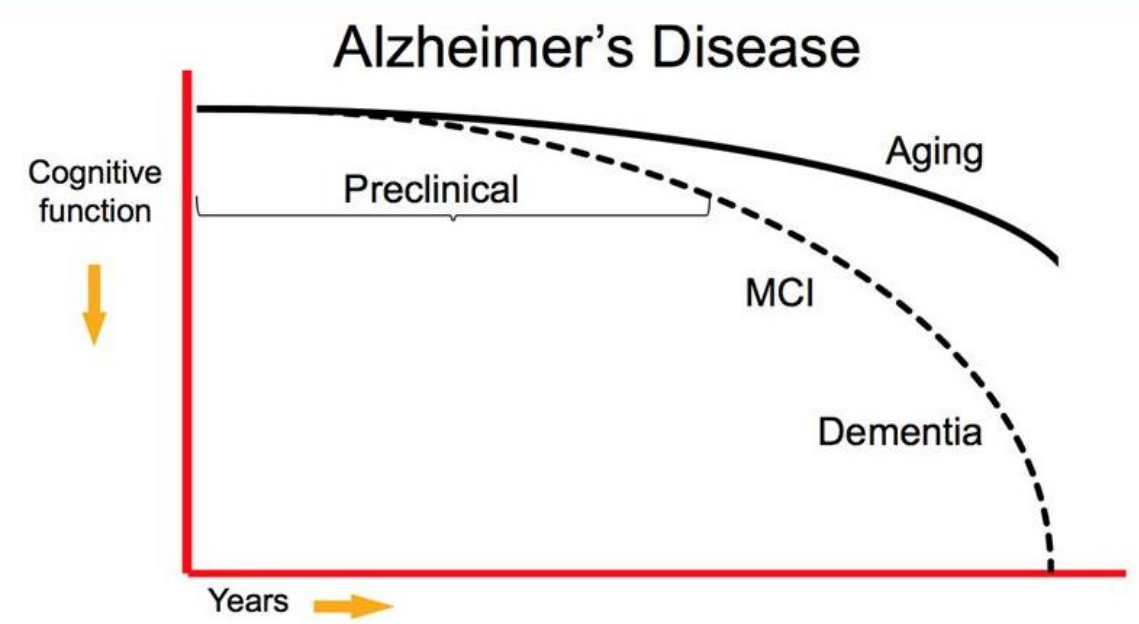


Semantic memory in neurological disorders

- Impairments are frequently observed in neurological disorders (e.g., stroke, neurodegenerative disease)
- Challenges in assessment arise because:
  - It is necessary to assess across multiple modalities
  - Other deficits such as visual agnosia and speech difficulties may complicate assessment
  - Performance may be affected by the language background of the client/participant

Mild cognitive impairment

- MCI refers to subjective and objective cognitive impairment in the absence of dementia
- It constitutes a risk factor for development of dementia
- In many cases, it is a transitional state between cognitive health and dementia

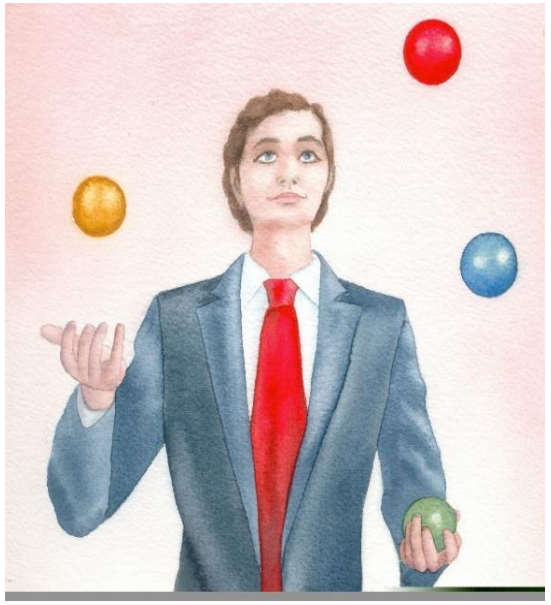


Goals of the present research

1. We aimed to develop and validate a battery that assesses semantic function across multiple ***modalities*** using different ***tasks***
2. The battery contained tasks assessing semantic function using spoken and written input/output, picture input, and pointing

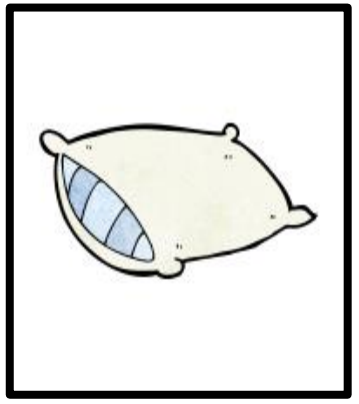
Tasks 1a and 1b: spoken and written picture naming

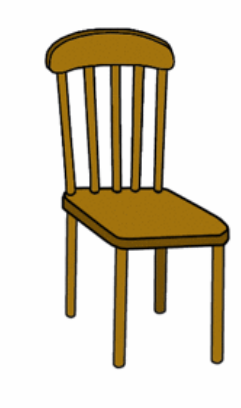
- Stimuli included 6 items for each category (biological, artifact, and action items) for a total of 18 spoken and 18 written stimuli

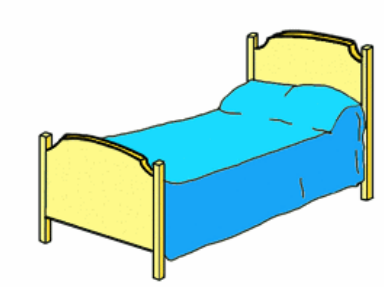


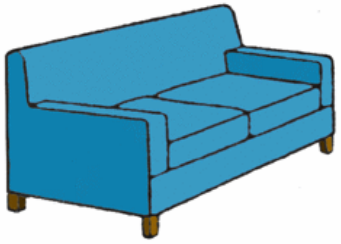
Tasks 2a and 2b: picture-picture and word-word matching

- Stimuli included 6 items for each modality (biological and artifact) for a total of 12 items for each modality









Task 3: Shared feature selection

How is a tiger like a zebra?

a) Both have stripes
b) Both have spots
c) Both are animals
d) Both are vegetables

(12 stimuli total)

Task 4: Semantic questions

Biological (12 stimuli total)

e.g., Does a kangaroo come from China?

Artifact (12 total)

e.g., Is a soccer ball usually thrown?

Study 1:
Assessing face validity

Participants:

Local clinicians (2 neuropsychologists and 1 MD) and researchers (n=2) were recruited from a research institute, a hospital-based memory program, and a university. All participants have expertise in MCI and language function.

Methods:

Participants took part in structured interviews and completed a question package (including check boxes, Likert scale responses, and some open-ended questions) to examine the effectiveness, relevance and appropriateness of the overall battery and each task. Interviewees were also asked about the clarity of the instruction and response sheets.

Face validity: results

Interviewees indicated that:

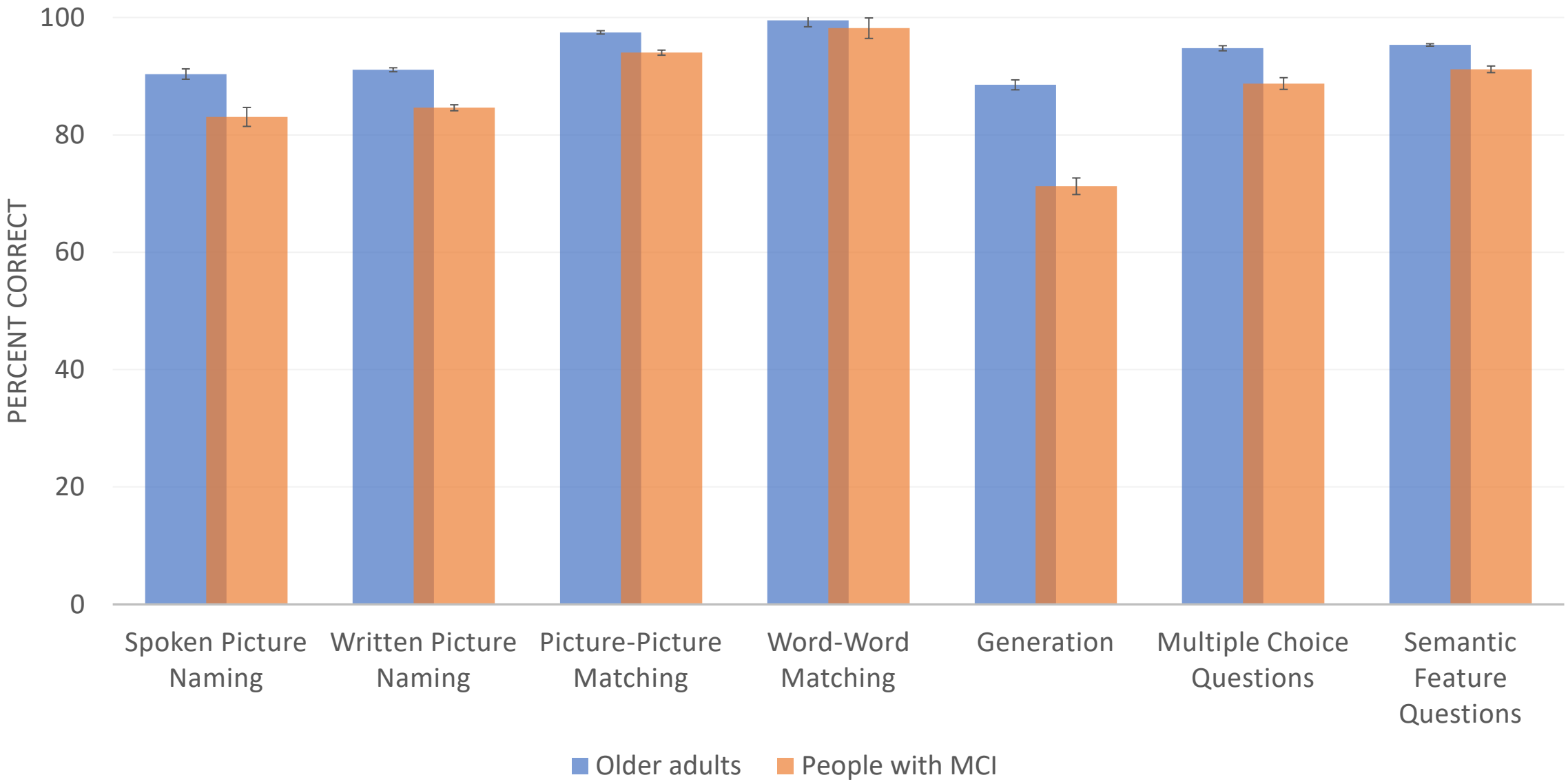
- the battery is an appropriate assessment of semantic function (M = 4.4, range = 4–5), and is easy to administer (M = 4.8, range = 4–5).
- the battery is logical (4/5), easy to use (5/5), useful (4/5), and relevant (4/5) for detecting semantic impairments.
- the battery assesses several aspects of semantic memory, including semantic function, semantic knowledge, and language semantics.
- the battery is appropriate for populations other than MCI, including AD (4/5), aphasia (5/5), progressive primary aphasia (5/5) an traumatic brain injury (4/5).

Study 2:
Performance on the battery in aging & MCI

- We examined performance on these semantic tasks in cognitively healthy older adults and people with a diagnosis of mild cognitive impairment
- 20 of the participants completed the battery again six months later
- Participants also completed additional standardized tasks of semantic function:
  - Boston Naming Test
  - Pyramids & Palm Trees test

Participants

	Older Adults	***MCI***
Number	102	60
Men/women	31 men/71 women	33 men/27 women
Age	73.61±4.60	75.27±6.11
Education	16.15±2.81	15.68±3.71


100
80
60
40
20
0
PERCENT CORRECT
Spoken Picture Naming
Written Picture Naming
Picture-Picture Matching
Word-Word Matching
Generation
Multiple Choice Questions
Semantic Feature Questions
Older adults
People with MCI

Psychometric properties

Convergent validity

- We compared the performance of people with MCI on the semantic battery to existing measures of semantic function (BNT and PPT).
- Performance on the overall battery positively correlated with performance on existing measures. Most subtasks were significantly and positively correlated with performance on the BNT and PPT-Picture.

Reliability: inter-rater reliability, test-retest reliability, and internal consistency

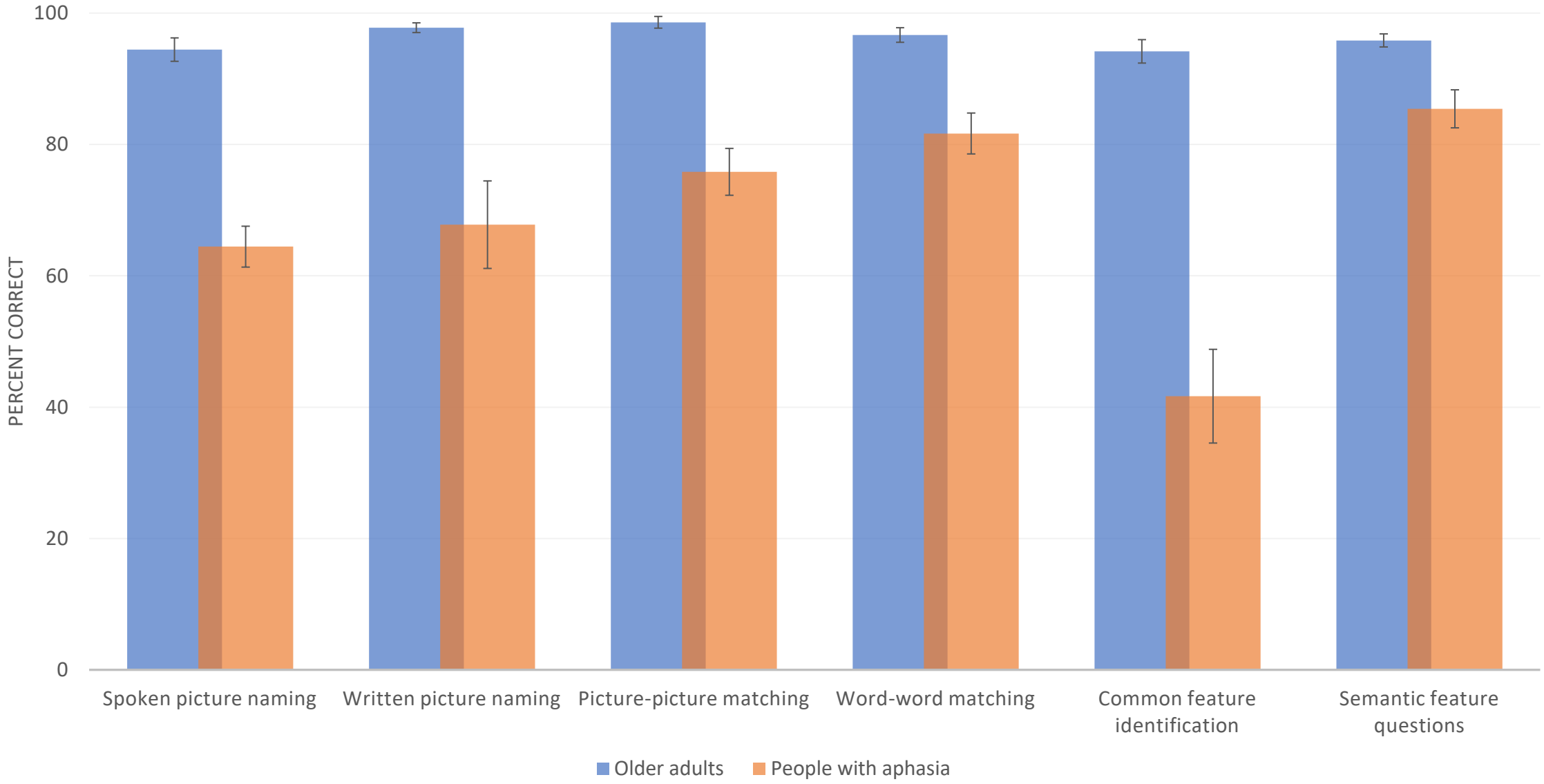
- Inter-rater reliability was high for the overall semantic battery (Pearson's r = 0.999). The correlations for each task were also high, ranging from 0.991–1.00.
- There was no significant change in mean scores between first and second testing sessions (p = .28), with a mean period of 17.98 weeks between sessions.
- Cronbach's alpha was calculated to evaluate the internal consistency of the battery, and results demonstrate that the overall battery has a high level of internal consistency (a = 0.83).

Study 3:
Performance in French

- A pilot study has begun to examine performance in a French version of the battery.
- Participants include cognitively healthy older adults and people with primary progressive aphasia

Participants

	Older Adults	***People with aphasia***
Number	14	14
Men/women	5 men/9 women	6 men/8 women
Age	65.64±13.38	66.07±14.03
Education	12.05±3.67	12.71±2.76


100
80
60
40
20
0
PERCENT CORRECT
Spoken picture naming
Written picture naming
Picture-picture matching
Word-word matching
Common feature identification
Semantic feature questions
Older adults
People with aphasia

Psychometric properties

Sensitivity & specificity

- Six participants with aphasia showed semantic deficits; we compared their performance with that of six matched control participants
- Sensitivity was 100% and specificity was 67%

Test-retest reliability:

- Eight control participants were tested 3 months later
- Performance did not differ across testing sessions

Cronbach's alpha

- High for tasks 1 (spoken naming) and 3 (picture-picture matching)
- Low for the remaining tasks

Summary/ conclusions: French

- Tasks 1 (spoken naming) and 3 (picture-picture matching) seem to be the strongest and most coherent tasks in the battery, and these two tasks discriminate the groups best.
- The tasks exhibited excellent psychometric properties in the validation and reliability tests.
- Normative data have been collected for 96 French speakers aged 19-90, and data collection is ongoing

Conclusions

In English:

- Deficits were observed in all semantic tasks for MCI
- The largest effect sizes were seen in spoken picture naming
- The semantic battery exhibited good psychometric properties

In French:

- Deficits were observed in all semantic tasks for people with aphasia
- Spoken picture naming and picture-picture matching best discriminated the groups

Ongoing work:

- Collection of norms for a larger group across adult age ranges
- Development of a mini-battery for clinical assessment

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Alzheimer Society CANADA