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# Communication Difficulty and Relevant Interventions in Mild Cognitive Impairment

## *Implications for Neuroplasticity*

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Mild cognitive impairment (MCI) represents a critical point for controlling cognitive decline. Patterns of communication difficulty have been observed in patients with MCI and warrant examination and management. This systematic review examined (1) characteristics of communication difficulty in MCI by focusing on 2 domains, expressive and receptive communication, and (2) cognitive interventions that addressed communication difficulties in individuals with MCI. Of the 28 observational studies reviewed, expressive and receptive communications were generally impaired in individuals with MCI compared with their healthy counterparts. However, only 1 of the 7 interventions effectively improved communication-related outcomes. We summarize the article with a discussion about how neuroplasticity influences communication abilities in individuals with MCI to inform the future development of interventions for communication difficulty.

**Key words:** cognitive intervention, communication difficulty, compensatory scaffolding, mild cognitive impairment, neuroplasticity

Mild cognitive impairment (MCI), a heterogeneous disorder of older adults characterized by mild cognitive decline, is often a prodromal phase of Alzheimer disease (AD) and other dementias.[1] Clinically, individuals with MCI may complain of subjective cognitive concerns and will demonstrate objective evidence of cognitive impairment (1-1.5 SD below the mean for age- and education-matched peers) that cannot be accounted for by normal aging processes. They do not yet exhibit impairment in their ability to perform basic activities of daily living, while instrumental activities of daily living may or may not be impaired.[1,2] There are 4 clinical subtypes of MCI. In amnestic MCI (aMCI), the individual experiences memory impairment; in non-aMCI, memory is unimpaired but deficits are seen in other cognitive domains such as executive functions, visual-spatial skills, and/or language.[3] Each of these subtypes is then further divided into single- or multiple-domain categories, depending on whether 1 or more cognitive skills are affected.[1]

Mild cognitive impairment represents a critical point for controlling cognitive decline and an important target for secondary prevention techniques aimed at slowing further progression to dementia.[4,5] Of note, most available interventions in MCI have targeted memory.[4,6] However, patterns of communication difficulty have also been observed in patients with MCI and warrant examination and, potentially, management. Communication difficulty refers to deficits in receiving, sending, processing, or comprehending verbal, nonverbal, or graphic messages and is an important domain for everyday functioning.[7] In one study of patients with heart failure, communication impairments were found to significantly predict adherence to treatment guidelines.[8] In addition, in a study of more than 12 000 Medicare beneficiaries, those with communication impairments were found to be significantly more dissatisfied with the health care they received than those without such impairments.[9] From these studies, one can infer that communication difficulty may serve a similar role in predicting health care quality and satisfaction in MCI, although research specific to MCI in this regard is limited.

Relatively brief clinical visits to medical providers require patients to efficiently organize, articulate, and understand complex medical discussions and choices in order to make treatment decisions that adequately reflect their care goals and values. While still usually deemed capable of making such decisions, patients with MCI have been shown to score significantly lower on measures of "understanding, appreciation, and reasoning" than do cognitively normal peers.[10] For example, a study examined older adults' response to information about fictitious medications and found that those with MCI were more responsive to the

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way the information was framed than were their healthy counterparts. Specifically, when positive information was conveyed using positive wording, or negative information with negative wording, those with MCI judged the sham medications similarly to healthy counterparts. However, when positive information was framed using negative wording, or negative information with positive wording, adults with MCI were more influenced by the way the information was framed than were the healthy older adults, responding more to the tone of the message than to the information itself.[11] This suggests that how information is expressed when delivering it to adults with cognitive impairment is critically important and may influence their health care decisions. Therefore, for health care providers, understanding the communication profiles of people with MCI can help ensure that they receive comprehensible diagnostic information, fully understand their medical care options, and make well-considered treatment decisions, according to their personal goals of care.

To our knowledge, there has been only a single topic that included communication deficits in older adults with MCI.[12] The present systematic review focused exclusively on studies of participants with MCI, identified using standard diagnostic criteria,[1] excluding studies of subjects with dementia (unless included as a comparison group with MCI participants). Communication relies on multiple dimensions of cognitive abilities, including executive function (verbal fluency), memory (semantic memory), and language. Communication difficulties described in this review were classified into expressive and receptive domains.[7] Expressive communication refers to the output of communicative messages, or the use or production of language, and includes verbal fluency (semantic fluency and phonemic fluency), semantic memory (especially word retrieval and access to semantic knowledge), and expressive discourse. Studies examining motor speech production (strength, speed, control, and agility of the speech mechanisms including the lips, tongue, larynx, etc) were also included with the expressive communication studies because of their focus on communication output. Receptive communication refers to understanding of messages and encompasses sentence comprehension, receptive discourse, and reading comprehension. We also reviewed cognitive interventions that targeted outcomes related to communication deficits. Of note, almost all such interventions are cognition driven. We are aware of one study targeting communication deficits using physical exercise as the intervention,[13] which was not included in this review but was described in the discussion. We summarize this article with a discussion about how neuroplasticity influences communication abilities in patients with MCI and by making recommendations for future research directions in this area.

## METHODS

### Literature review

For this systematic review, the literature search was filtered both by age (65 years or older) and by English language. Studies examining samples that were not specifically identified as having any subtypes of MCI based on Peterson criteria[1] described earlier were excluded. Reference lists of relevant studies provided additional sources for this review. Studies with publication dates prior to 1999 were excluded, as the MCI criteria were not yet fully validated.[14] Two searches were conducted in PubMed. The first search was conducted for observational studies, using terms "mild cognitive impairment" in combination with "communication disorders" (109 citations), "aphasia" (37 citations), or "discourse" (2 citations). The second search was conducted for cognitive intervention studies that targeted communication outcomes, using the terms "mild cognitive impairment," "Alzheimer's disease," "cognitive therapy," "cognitive intervention," "cognitive training," and "communication." Various combinations of these terms yielded 160 articles. Two researchers (M.J. and F.L.) independently examined the relevant articles. Information about the study design and findings related to communication difficulties are presented in Tables 1 (observational studies) and 2 (intervention studies).

## RESULTS

### Observational studies

A total of 29 observational (25 cross-sectional and 4 longitudinal) studies described the communication difficulties in MCI (see Table 1).

#### *Expressive communication impairments*

*Verbal fluency*

Verbal fluency tasks can be subdivided into 3 types: semantic fluency (generating items in a category), phonemic fluency (generating items beginning with a specific letter), and verb fluency (generating as many verbs as possible).[35] These tasks are generally measured as the number of items elicited within a time limit (eg, 1 minute). Sixteen cross-sectional studies consistently found that individuals with MCI had significantly worse performance in verbal fluency than their healthy counterparts.[11,15,17-21,25,26,28,33,37,50] Specifically, the patterns of verbal fluency deficits in individuals with MCI included production of fewer subcategories, and fewer items within those categories, than those of healthy counterparts.[37] Six studies demonstrated better verbal fluency performance by those with MCI than by those with AD.[15,17,23,30,33,34]

| TABLE 1 Observational Studies With Communication Variables | | | | |
|---|---|---|---|---|
| References | Subjects | Communication Domain(s) | Communication Measurement(s) | Principal Findings |
| Cross-sectional studies: Expressive language domains | | | | |
| Adlam et al (2006)[15] | MCI = 10<br>AD = 11<br>NCI = 30 | Semantic memory, verbal fluency | Portions of the Cambridge Semantic Battery (3 semantic fluency tasks, picture naming, word to picture matching), concrete and abstract synonym test, PPT test of associative semantic knowledge, phonemic fluency task, and a multi-component battery of semantic knowledge constructed by the authors | Phonemic fluency: MCI = NCI > AD; semantic fluency: AD < MCI < NCI. MCI not statistically different from NCI on any other measures of semantic memory, better than AD on picture naming, word-picture matching, word synonyms, PPT test. |
| Ahmed et al (2008)[16] | MCI = 32<br>NCI = 37 | Semantic memory | GNT, GFT, GBT | MCI < NCI on all tasks. In both groups, scores on GNT > GBT > GFT; 31% of MCI participants impaired on 1 test, 28% impaired on 2 tests, 28% impaired on all 3 tests, 13% impaired on none; 13% of controls impaired on 1 test, 87% impaired on none. Combination of all 3 tasks correctly predicted 78.1% of MCI participants, 100% of controls. |
| Baek et al (2011)[17] | Korean subjects: MCI = 112<br>AD = 97<br>NCI = 53 | Semantic memory, verbal fluency, expressive and receptive discourse | BNT, COWAT (semantic and phonemic fluency), immediate and delayed story recall, and story recognition test | Semantic memory, verbal fluency, immediate and delayed story recall tests: AD < MCI < NCI. Story recognition task: AD < MCI = NCI. Sensitivity and specificity of story recall for identifying MCI and AD were low in participants with ≤6 y of education but acceptable in those with ≥7 y of education. |

(*continues*)

| TABLE 1 Observational Studies With Communication Variables (*Continued*) | | | | |
|---|---|---|---|---|
| **References** | **Subjects** | **Communication Domain(s)** | **Communication Measurement(s)** | **Principal Findings** |
| Balthazar et al (2008)[18] | aMCI = 16<br>Mild AD = 16<br>NCI = 16 | Semantic memory, verbal fluency | BNT, semantic fluency (animal naming) task | BNT total score (with cues): AD < aMCI = controls. BNT spontaneous naming (without cues): AD < aMCI < controls. Verbal fluency scores: AD < aMCI < controls. |
| Brandt and Manning (2009)[19] | MCI = 74<br>aMCI-sd = 25<br>aMCI-md = 27<br>naMCI = 22<br>AD = 29<br>NCI = 40 | Verbal fluency | Multiple semantic and phonemic fluency tasks | aMCI-sd showed no difference between semantic and phonemic fluency, similar to NCI. aMCI-md had poorer semantic fluency than phonemic fluency, similar to AD. |
| Bschor et al (2001)[20] | MCI = 34<br>Mild AD = 21<br>Moderate-severe AD = 20<br>NCI = 40 | Expressive discourse, semantic memory, verbal fluency | BDAE-3, Cookie Theft Picture, BNT, semantic and phonemic fluency tasks | All groups produced similar numbers of words on picture description (expressive discourse); task did not differentiate between MCI and mild AD or MCI and NCI. Semantic memory and verbal fluency: AD < MCI < NCI. |
| Carter et al (2012)[21] | MCI = 17<br>Probable mild AD = 15<br>NCI = 13 | Verbal fluency, semantic memory | Phonemic and semantic fluency tasks, GNT, language portions of ACE-R, and Face Place Test | Phonemic and semantic fluency: AD < MCI < NCI. Semantic memory: AD = MCI < NCI. Less challenging language section of ACE-R showed AD < NCI; did not discriminate MCI. |
| Chapman et al (2002)[22] | MCI = 20<br>Mild AD = 24<br>NCI = 25 | Expressive and receptive discourse, reading comprehension | 578-word narrative with gist- and detail-level probes, read aloud by the examiner, with the participant following along | Production of accurate inferences from the story: AD = MCI < NCI. Main idea and lesson from the story, and statement of important information: AD < MCI < NCI. |

(*continues*)

**TABLE 1 Observational Studies With Communication Variables (*Continued*)**

| References | Subjects | Communication Domain(s) | Communication Measurement(s) | Principal Findings |
|---|---|---|---|---|
| Cuetos et al (2009)[23] | MCI = 40<br>Probable AD = 40<br>SCI = 20<br>NCI = 40 | Semantic memory, verbal fluency | Naming famous faces and objects, semantic and phonemic fluency tasks, definition-word matching, synonym matching | Naming faces, definition-word matching, semantic fluency: MCI < NCI. Naming faces and objects, semantic fluency and definition-word matching: AD < MCI. Naming faces, definition-word matching, and semantic fluency were good predictors of SCI vs MCI vs AD. |
| Duong et al (2006)[24] | MCI = 61<br>Probable AD = 39<br>NCI = 60 | Semantic memory | Psycholinguistic Assessment of Language picture naming task, semantic probes (answering questions about pictures), 2 lexical decision tasks (word vs nonword), Stroop, and Stroop-picture naming task | MCI group impaired relative to NCI on picture naming and semantic probes but not lexical decision; AD group impaired on all probes relative to MCI. MCI group impaired on Stroop picture naming but not Stroop. |
| Economou et al (2007)[25] | aMCI = 37<br>Mild AD = 15<br>NCI = 27 | Verbal fluency | Semantic fluency task | AD < aMCI < NCI |
| Fernaeus et al (2008)[26] | MCI = 82<br>AD = 58<br>NCI = 45 | Verbal fluency | 3 tests each of phonemic and semantic fluency | AD < MCI < NCI. MCI and NCI performed better on semantic fluency than on phonemic fluency. |
| Fleming and Harris (2008)[27] | MCI = 8<br>NCI = 8 | Semantic memory, expressive discourse | BNT, and complex, elicited discourse sample ("Trip to New York"), analyzed for 13 thematic core concepts | MCI performed similarly to NCI on BNT. MCI scored poorer than NCI on discourse length and quality but not on syntactic complexity. |
| Hall et al (2011)[28] | MCI = 97<br>VD = 97<br>AD = 249<br>NCI = 45 | Verbal fluency | Semantic fluency task, scored over four 15-s blocks | After 15 s, MCI performed significantly better than AD or VD. After 30 s, MCI performed significantly poorer than NCI. |
| Harris et al (2008)[29] | MCI = 10<br>PWND = 10<br>NCI (younger) = 30<br>NCI (older) = 22 | Expressive discourse, semantic memory | "Trip to New York" discourse task analyzed for 13 thematic core concepts, and BNT | MCI provided less thematic information than all other groups. MCI and PWND provided more irrelevant comments and were more verbose than NCI groups. Semantic memory: MCI = PWND < NCI. |

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**TABLE 1 Observational Studies With Communication Variables (*Continued*)**

| References | Subjects | Communication Domain(s) | Communication Measurement(s) | Principal Findings |
|---|---|---|---|---|
| Hudon et al (2006)[30] | MCI = 20<br>AD = 14<br>NCI = 26 | Expressive discourse, reading comprehension | Recall of detail and gist information from narrative text | Detail and gist measures: AD < MCI < NCI |
| Joubert et al (2010)[31] | aMCI = 15<br>Early-stage AD = 16<br>NCI = 16 | Semantic memory | Naming 20 objects, 20 animals, and 30 faces, and answering questions about them | Naming objects and faces; on semantic knowledge (answering questions about named objects and faces): AD = MCI < NCI |
| Kawano et al (2010)[32] | Japanese subjects:<br>MCI = 123<br>AD = 345 AD | Verbal fluency | 1 semantic fluency and 1 phonemic fluency task | MCI produced more words than AD. Level of education influenced performance on semantic fluency but not on phonemic fluency in MCI and AD participants. |
| Lonie et al (2009)[33] | aMCI = 47<br>Early-stage AD = 35<br>NCI = 24<br>Depression = 18 | Verbal fluency | 1 semantic fluency and 1 phonemic fluency task | AD < aMCI < NCI. aMCI and early-stage AD patients show a greater discrepancy between semantic and phonemic fluency than controls (semantic scores < phonemic scores). |
| Midi et al (2011)[34] | MCI = 15<br>Early-stage AD = 15<br>Moderate AD = 8<br>NCI = 15 | Verbal fluency, verbal reaction time, and motor speech | Phonemic fluency, semantic fluency, multidimensional voice parameters, maximum phonation time, DDK rate, spectrogram | MCI produced more words with faster reaction times than AD on verbal fluency tasks; not significantly different from NCI. No statistically significant difference on DDK rate in MCI as compared with early-stage AD (moderate-severe AD were slower). MCI had faster sentence repetition than those with moderate AD; not statistically different from NCI. MCI produced more intense (louder) speech than AD; not statistically different from NCI. |

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**TABLE 1 Observational Studies With Communication Variables (*Continued*)**

| References | Subjects | Communication Domain(s) | Communication Measurement(s) | Principal Findings |
|---|---|---|---|---|
| Ostberg et al (2005)[35] | MCI = 60<br>AD = 57<br>SCI = 40 | Verbal fluency | Phonemic, semantic, and verb fluency tasks | Verb fluency scores: AD < MCI < SCI. MCI subjects performed poorer on verb fluency than on other verbal fluency tasks. |
| Ostberg et al (2009)[36] | Medical record reviews of:<br>MCI = 89<br>AD = 58<br>SCI = 60<br>Frontotemporal dementia = 13<br>Progressive nonfluent aphasia = 7<br>Semantic dementia = 9 | Motor speech | DDK rate | Only 10% of MCI participants showed impaired motor speech performance. DDK rates for MCI were not significantly different from any group, except were significantly faster than for PNFA. |
| Price et al (2012)[37] | aMCI = 33<br>NCI = 33 | Verbal fluency, semantic memory | 2 semantic fluency tasks, BNT-2 (15 item form) | aMCI produced smaller clusters, fewer subcategories, and a nonsignificantly fewer number of switches than NCI. Semantic memory: MCI = NCI. |
| Schmitter-Edgecombe and Creamer (2010)[38] | aMCI = 23<br>NCI = 23 | Expressive and receptive discourse, reading comprehension | Two 20-line stories read by participants 1 line at a time, giving them a chance to "think aloud" to help them remember, and then asked 5 factual and 5 inferential questions | MCI participants were more impaired than controls on production of inferences and story retelling. |
| Zamarian et al (2010)[11] | MCI = 18<br>Mild AD = 18<br>NCI = 18 | Verbal fluency, semantic memory, reading comprehension | Semantic fluency task, BNT (short form), Aachner Aphasie Test | MCI scored poorer than NCI on verbal fluency and semantic memory tasks and better than AD on semantic memory. No difference between groups on reading comprehension task. |

(*continues*)

**TABLE 1 Observational Studies With Communication Variables (*Continued*)**

| References | Subjects | Communication Domain(s) | Communication Measurement(s) | Principal Findings |
|---|---|---|---|---|
| Cross-sectional studies: Receptive language domains | | | | |
| Baek et al (2011)[17] | Korean subjects: MCI = 112<br>AD = 97<br>NCI = 53 | Semantic memory, verbal fluency, expressive and receptive discourse | BNT, COWAT (semantic and phonemic fluency), immediate and delayed story recall, and story recognition test | Semantic memory, verbal fluency, immediate and delayed story recall tests: AD < MCI < NCI. Story recognition task: AD < MCI = NCI. Sensitivity and specificity of story recall for identifying MCI and AD were low in participants with ≤6 y of education but acceptable in those with ≥7 y of education. |
| Chapman et al (2002)[22] | MCI = 20<br>Mild AD = 24<br>NCI = 25 | Expressive and receptive discourse, reading comprehension | 578-word narrative with gist- and detail-level probes, read aloud by the examiner, with the participant following along | Recognition and remembering of story details: AD < MCI < NCI |
| Schmitter-Edgecombe and Creamer (2010)[38] | aMCI = 23<br>NCI = 23 | Expressive discourse, reading comprehension | Two 20-line stories read by participants 1 line at a time, giving them a chance to "think aloud" to elicit inferences and aid memory, and then asked 5 factual and 5 inferential questions | Story comprehension: MCI < NCI |
| Hudon et al (2006)[30] | MCI = 20<br>AD = 14<br>NCI = 26 | Expressive discourse, reading comprehension | Recall of detail and gist information from narrative text | Detail and gist measures: AD < MCI < NCI |
| Zamarian et al (2010)[11] | MCI = 18<br>Mild AD = 18<br>NCI = 18 | Verbal fluency, semantic memory, reading comprehension | Semantic fluency task, BNT (short form), Aachner Aphasie Test | MCI scored poorer than NCI on verbal fluency and semantic memory tasks and better than AD on semantic memory. No difference between groups on reading comprehension task. |
| Longitudinal studies: Expressive language domains | | | | |
| Bennett et al (2002)[39] | Catholic clergy:<br>MCI = 211<br>NCI = 587<br>Assessed 1 time per year for an average of 4.5 (range, 1-7) y | Semantic memory (conceptualized as a composite of semantic memory, verbal fluency, comprehension of sentences and paragraphs, and reading comprehension) | Composite *z*-score of: BNT, verbal fluency task, "Complex Ideational Material" subtest of BDAE, Extended Range Vocabulary Test, National Adult Reading Test | MCI persons scored poorer at baseline and declined faster than controls in semantic memory. |

(*continues*)

**TABLE 1 Observational Studies With Communication Variables (*Continued*)**

| References | Subjects | Communication Domain(s) | Communication Measurement(s) | Principal Findings |
|---|---|---|---|---|
| Fleming and Harris (2009)[40] | MCI = 8<br>Assessed at baseline and 6 mo | Expressive discourse | BNT and complex, elicited discourse sample ("Trip to New York"), analyzed for 13 thematic core concepts | No significant decline in expressive discourse after 6 mo. |
| Hodges et al (2006)[41] | MCI = 10<br>NCI = 24<br>Assessed 1 time per year for 6-10 y | Verbal fluency, semantic memory, semantic knowledge, syntactic knowledge | 8 semantic fluency tasks, 3 phonemic fluency tasks, picture naming, PPT test of associative semantic knowledge, Test for the Reception of Grammar | Compared with NCI, MCI showed impairments only in semantic fluency throughout the study period and for phonemic fluency at year 6. All other tests showed no significant differences between groups after statistical adjustment for multiple comparisons. |
| Nordlund et al (2010)[42] | MCI = 260<br>N = 205<br>assessed at both baseline and 2-y time points | Sentence comprehension. semantic memory, abstraction (similarities) | Token Test (Subtest V), Assessment of Subtle Language Deficits repetition, BNT, Similarities subtest of the Weschler Adult Intelligence Scale–Revised | After 2 y, 47 (23%) of MCI group had dementia and 9 (5%) demonstrated normal cognitive function; 62% of MCI participants who progressed to dementia were initially impaired on semantic memory, and 40% on auditory comprehension. |
| Longitudinal studies: Receptive language domains | | | | |
| Nordlund et al (2010)[42] | MCI = 260<br>N = 205<br>Assessed at baseline and 2 y | Sentence comprehension. semantic memory, abstraction (similarities) | Token Test (Subtest V), Assessment of Subtle Language Deficits repetition, BNT, Similarities subtest of the Weschler Adult Intelligence Scale–Revised | After 2 y, 47 (23%) of MCI group had dementia and 9 (5%) demonstrated normal cognitive function; 62% of MCI participants who progressed to dementia were initially impaired on semantic memory, and 40% on auditory comprehension. |

*Abbreviations: ACE-R, Addenbrooke's Cognitive Examination–Revised; AD, Alzheimer disease; aMCI, amnestic MCI; BDAE, Boston Diagnostic Aphasia Examination; BNT, Boston Naming Test; COWAT, Controlled Oral Word Association Test; DDK rate, diadochokinetic rate (a measure of articulatory agility measured by repetitions of the syllables "pa-ta-ka"); GBT, Graded Buildings Test; GFT, Graded Faces Test; GNT, Graded Naming Test; MCI, mild cognitive impairment; md, multiple domain; naMCI, nonamnestic MCI; NCI, no cognitive impairment; PPT, Pyramids and Palm Trees; PWND, persons with neurological damage; SCI, subjective cognitive impairment; sd = single domain; VD, vascular dementia.*

Several factors influenced the verbal fluency performance in MCI, including the specific category or letter being assessed, the subtype of MCI, and level of education. In one study, subjects with MCI were able to name more animals than words beginning with the letter "F" but fewer vegetables than words beginning with the letter "S."[17] By combining results across 3 phonemic and 2 semantic fluency tasks, Brandt and Manning[19] found that participants with single-domain aMCI performed similarly to healthy counterparts, with no discrepancy between semantic and phonemic tasks, whereas participants with multiple-domain MCI performed similar to those with AD, with more difficulty with the semantic fluency than phonemic fluency tasks. In addition, the level of education affected scores on semantic fluency tasks more than on lexical fluency tasks in Japanese subjects with MCI.[32]

Only one longitudinal study examined verbal fluency.[41] The researchers assessed verbal fluency annually in individuals with MCI and found that they were impaired relative to healthy counterparts on semantic fluency tasks from baseline throughout the 10-year study period. In contrast, phonemic fluency was intact at baseline but became impaired at year 6.[41]

#### Semantic memory

Semantic memory refers to general knowledge, including factual information, the meanings of words, and general information,[51] and not only is often measured by tests of word retrieval or naming of objects but also includes tests of naming of proper nouns, synonyms, word associations, similarities, and definition-word matching, among others. A total of 17 cross-sectional studies examined semantic memory in individuals with MCI, 12 of which found impairments relative to healthy counterparts.[11,16-18,20,21,23,24,29,31,39,40,42] However, 3 studies found no difference between participants with MCI and healthy counterparts on semantic memory tasks.[15,27,37,41,50] Seven studies showed significantly better performance for participants with MCI than for those with AD,[11,15,17,18,20,23,24] whereas 2 studies demonstrated no difference between the MCI and AD groups on semantic memory.[21,31]

The specific task demands of the measures influenced the performance on semantic memory tests in individuals with MCI. Participants with aMCI scored comparably with healthy counterparts on the Boston Naming Test, although when spontaneous naming was examined (ie, no semantic or phonemic cues provided), the participants with aMCI scored lower than their healthy counterparts but superior to those with mild AD.[16] In addition, on a 3-part assessment of semantic memory including naming famous buildings, celebrity faces, and objects, participants with MCI named significantly fewer items on each test than their healthy counterparts. Furthermore, 13% of the healthy counterparts were impaired on all tests whereas 87% of subjects with MCI were impaired on at least one of the tests. Both groups of participants named fewer proper nouns (faces and buildings) than objects. The combination of the 3 tasks correctly predicted group membership 78.1% of the time for those with MCI and 100% of the time for the healthy counterparts.[16] Finally, intentional access to semantic memory (word retrieval) was found to be impaired in adults with MCI relative to the healthy counterparts, but automatic access (eg, deciding whether items were words or nonwords) remained intact; both intentional access and automatic access were impaired in participants with AD compared with those with MCI.[24]

Three longitudinal studies examined semantic memory over time in individuals with MCI.[39,41,42] In 2 of them, semantic memory was a significant predictor of progression from MCI to AD.[39,42] The third study did not find any significant difference between the participants with MCI and the healthy counterparts in semantic memory, on measures of word retrieval, or semantic associations.[41]

#### Expressive discourse

A total of 7 cross-sectional studies examined expressive discourse. Discourse, also called connected language, can be thought of as a "window into the flow or misflow of information that may occur … as the speaker translates his or her thoughts into language."[22(p178)] Measurements of expressive discourse in this review included picture description,[20] verbal descriptions of an imaginary trip,[27,29] and story recall and inferencing.[17,22,30,38] Of note, although story recall is often conceptualized as a measure of episodic memory ability, it was considered as a measure of discourse in this review, as story recall and inferencing appear to mirror the cognitive demands of daily discourse, including conversation, and are influenced by a person's language abilities.[17] In addition, expressive discourse measures encompass receptive discourse demands. That is, in order for a story to be accurately recalled and retold, it must have first been comprehended, synthesized, and integrated by the participant (see the "Receptive discourse" section).

Expressive discourse ability was found to be impaired in individuals with MCI when compared with healthy counterparts in 6 studies,[17,27,29,30,38] whereas 1 study found no difference between the 2 groups.[20] Four studies found that subjects with MCI performed better on story recall tasks than did those with AD.[17,20,22,30]

In the only longitudinal study examining expressive discourse, Fleming and Harris[40] found that there was no significant decline in expressive discourse skills between baseline and 6 months in 8 participants with MCI.

#### Motor speech

Motor speech production skills were examined in 2 cross-sectional studies, measured by diadochokinetic rate, a test of articulatory agility measured by rapid, successive repetitions of the syllables "pa-ta-ka"[36] and by speed of sentence repetitions and vocal loudness.[34] Both studies found that motor speech remained largely unaffected in adults with MCI when compared with their healthy counterparts and individuals with MCI performed significantly better than those with AD.[34,36]

### Receptive communication impairments

Receptive communication impairments have been less thoroughly studied than the expressive areas described earlier. Nevertheless, patterns of deficit have been found in subjects with MCI.

*Sentence comprehension*

Sentence comprehension refers to the understanding of single statements and was assessed in only one longitudinal study, using the Token Test, Subtest V, a measure of comprehension of commands of increasing complexity. Their results showed that, of the 23% of the original sample participants who developed dementia after 2 years, 40% showed initial impairments on the Token Test.[42]

*Receptive discourse*

Receptive discourse refers to one's ability to comprehend connected narrative productions. As described earlier, this domain is difficult to fully separate from expressive discourse, as most tasks measuring discourse include both receptive and expressive components. In this review, 2 cross-sectional studies measured receptive discourse by eliciting recall and recognition of both gist and detail information from a narrative text.[17,22] Adults with MCI showed poorer ability to recall and recognize details from a narrative story than did their healthy counterparts but performed better than the subjects with AD on these tasks.

*Reading comprehension*

Three cross-sectional studies examined reading comprehension, which refers to the understanding of written narratives.[11,30,38] In one study, the subjects completed a reading comprehension test and there were no significant differences between those with MCI, those with AD, and the healthy counterparts.[11] In the other 2 studies, subjects were required to read a text and then to verbally state the details and gist of the passage. To successfully accomplish this task, subjects needed to be able to understand what they had read.[30,38] In both studies, subjects with MCI performed poorer on this task than their healthy counterparts. In the study by Hudon and colleagues,[30] participants with AD were also included and performed significantly worse than those with MCI.

### Cognitive interventions with communication outcomes

Limited intervention studies have been conducted on communication outcomes in individuals with MCI. Seven cognitive intervention studies were identified (see Table 2).[43-49] Three studies used weekly small group sessions ranging from 90 to 120 minutes in duration; the remaining 4 used individual computerized cognitive training (CCT) sessions for 13 to 100 minutes per day, 4 to 5 days per week. Intervention durations ranged from 3 weeks to 1 year. Cognitive interventions were generally categorized into memory, attention, processing speed, executive function-focused, or multimodal interventions.[52] Two studies were memory interventions. One study of 25 subjects with MCI and 17 healthy counterparts focused on memory strategy training[53] and did not demonstrate improvement on story recall, a measure of receptive and expressive discourse, in either group. The other study targeted memory through education regarding memory, relaxation training, memory skills training, and psychoeduction on structuring memory-related beliefs, but the intervention group (9 subjects with MCI) did not improve receptive and expressive discourse (story recall) compared with the control group (10 subjects with MCI).[46]

Auditory processing speed and accuracy were targeted using CCT in one study; no significant differences were found between the treatment (22 subjects with MCI) and control (25 subjects without MCI) groups on measures of semantic memory and verbal fluency at postintervention.[43]

The remaining 4 intervention studies applied multimodal approaches, simultaneously targeting multiple cognitive domains.[45,47-49] Wenisch et al[49] targeted memory, executive function, and visuospatial skills by teaching cognitive strategies and demonstrated no significant changes in the measure of verbal fluency in either the 12 subjects with MCI or the 12 healthy counterparts following the intervention. Cipriani et al[45] used CCT for attention, memory, perception, visuospatial cognition, and language skills training but did not elicit improvement on verbal fluency tasks in 10 subjects with MCI, although the 10 subjects with AD did improve on the phonemic fluency task. Talassi and colleagues[48] combined CCT with occupational therapy and behavioral training, targeting "mood symptoms,"[(p392)] and found no statistically significant difference in the intervention groups (30 with MCI, 24 with mild dementia) on verbal fluency or discourse (story recall) as compared with the active control groups (7 with MCI, 5 with mild dementia). Rozzini and colleagues[47] examined the effects of CCT alone (addressing attention, memory, abstract reasoning, visuospatial skills, and language) on subjects with MCI (n = 22), as well as in combination with cholinesterase inhibitors (n = 15), to a no treatment control group (n = 22), and demonstrated significant improvement for the group receiving the combined intervention on story recall (receptive and expressive discourse) but not on verbal fluency measures. The CCT-only group and the control group did not show any significant improvements on either language measure.

## DISCUSSION

The purpose of this systematic review was to examine observational and intervention studies addressing the communication characteristics of older adults with MCI by dividing the communication into expressive and receptive domains. Before further discussing any results, some limitations should be acknowledged. First, this systematic review was limited only to a PubMed search. Other databases that may contain studies related to communication difficulties (eg, PsycINFO) were not reviewed. Second, communication is an everyday skill highly relying on multiple cognitive abilities, especially language, executive

**TABLE 2** Cognitive Intervention Studies with Communication Outcomes

| References | Sample | Communication Domain(s) | Measure(s) | Design | Intervention | Communication Results |
|---|---|---|---|---|---|---|
| Barnes et al (2009)[43] | MCI = 47<br>I = 22<br>C = 25 | Verbal fluency, semantic memory | Repeatable Battery for Assessment of Cognitive Status language domain score, Controlled Oral Word Association Test, Boston Naming Test | RCT; baseline and postintervention assessments | Home-based computerized training exercises to improve auditory processing speed and accuracy 100 min/d, 5 d/wk, for 6 wk | No statistically significant difference between intervention and control on communication measures |
| Belleville et al (2006)[44] | MCI = 25<br>I = 17<br>C = 8<br>NCI = 17<br>I = 9<br>C = 8 | Receptive and expressive discourse (episodic memory) | Immediate and delayed story recall | Quasi-experimental; baseline and postintervention assessments | Memory strategy training; 8 weekly sessions of 120-min duration in small groups of 4-5 participants | Story recall did not significantly improve in either MCI or NI participants |
| Cipriani et al (2006)[45] | MCI = 10<br>AD = 10<br>MSA = 3 | Verbal fluency (phonemic and semantic) | Phonemic and semantic fluency tasks | Quasi-experimental; baseline and 3-mo follow-up assessments | Multimodal CCT of attention, memory, perception, visuospatial cognition, language; two 4-wk periods of training separated by ~6 wk break. Subjects trained 4 d/wk for 13-45 min | MCI group did not improve on language measures from baseline to follow-up; AD group improved on phonemic fluency; MSA group showed no change |
| Rapp et al (2002)[46] | MCI = 19<br>I = 9<br>C = 10 | Receptive and expressive discourse (episodic memory) | Immediate and delayed story recall | RCT; baseline, postintervention and 6-mo follow-up assessments | Memory intervention including education regarding memory impairment, relaxation training, memory skills training, "cognitive structuring of memory-related beliefs"(p5); 6 weekly 120-min group sessions | No statistically significant change in communication measure in the I or C group |
| Rozzini et al (2007)[47] | MCI = 59<br>Cog I = 22<br>Pharm + Cog I = 15<br>C = 22 | Verbal fluency (semantic and phonemic), receptive and expressive discourse (episodic memory) | Phonemic and semantic fluency tasks, story recall | RCT; baseline and 1-y follow-up assessments | Multimodal CCT of attention, memory, abstract reasoning, visuospatial skills, language; 3 blocks of training (with 2-mo breaks between blocks) of 1 h/d, 5 d/wk for 4 wk | Pharm + Cog training group improved on discourse (story recall) following intervention; no change in other groups or on verbal fluency measures |

(*continues*)

**TABLE 2 Cognitive Intervention Studies with Communication Outcomes (*Continued*)**

| References | Sample | Communication Domain(s) | Measure(s) | Design | Intervention | Communication Results |
|---|---|---|---|---|---|---|
| Talassi et al (2007)[48] | MCI = 37<br>I = 30<br>C = 7<br>Mild dementia = 29<br>I = 24<br>C = 5 | Verbal fluency (semantic and phonemic), receptive and expressive discourse (episodic memory) | Phonemic and semantic fluency tasks, Rivermead Behavioural Memory Test story recall | Quasi-experimental; baseline and postintervention assessments | Multimodal intervention including CCT, occupational therapy, and behavioral training; 30- to 45-min sessions for each activity, 4 d/wk for 3 wk | No statistically significant changes in communication measures in either MCI or AD I group; AD C group improved on semantic verbal fluency task |
| Wenisch et al (2007)[49] | MCI = 12<br>NCI = 12 | Verbal fluency (semantic and phonemic) | Semantic and phonemic fluency tasks | Quasi-experimental; baseline and postintervention assessments | Multimodal intervention for memory, executive function and visuospatial skills using cognitive strategy training delivered over 10 weekly 90-min small group sessions | No statistically significant change in verbal fluency |

*Abbreviations: C, control; Cog, cognitive; CCT, computerized cognitive training; I, intervention; MCI, mild cognitive impairment; MSA, multisystem atrophy; NCI, no cognitive impairment; Pharm, pharmacological; RCT, randomized controlled trial.*

function, and semantic memory, and many of these cognitive abilities are highly interrelated; thus, some of the distinctions made here on the categories of communication may be somewhat artificial and incomplete.[17,22] Third, communication difficulties in the clinical application may include psychosocial aspects. Communication is the "process of creating shared meaning" between a sender and a receiver and includes all of their thoughts, perspectives, ideas, history, and biases.[54] Examination of these psychosocial and interpersonal aspects of communication in older adults with MCI was beyond the scope of this review but would be useful to incorporate into future studies, especially when designing interventions to address communication challenges in MCI.

## Observational studies

The first purpose of the study was to characterize the communication deficits of MCI in observational studies. First, motor speech production, representing a fundamental aspect of communication (ie, the ability to produce the motor movements necessary to formulate intelligible speech), was largely unaffected in older adults with MCI. Regarding higher-order cognitive domains that are related to communication, in general, individuals with MCI perform worse than their healthy counterparts but better than those with AD in expressive communication within the domains of verbal fluency, semantic memory, and expressive discourse. However, there are several exceptions that warrant further exploration. First, individuals with MCI may perform differently even within the same communication domain, depending on the format of the measures. For example, although both semantic and phonemic fluency tasks test verbal fluency, individuals with MCI performed better on the former.[19] Similarly, although 9 of the studies in this review used the Boston Naming Test to examine semantic memory, differences in performance were found when alternate tasks were used. In one study, adults with MCI were able to name common objects more easily than famous buildings and famous faces, suggesting that naming of proper nouns may have somewhat different neural underpinnings than naming of objects.[16] Second, individuals with multiple-domain MCI may have more impairment than those with single-domain MCI in expressive communication, at least in the domain of verbal fluency.[19] This finding adds support to the notion that communication is an everyday function relying on multiple cognitive abilities. Thus, individuals with multiple cognitive deficits, as seen in multiple-domain MCI, may experience greater communicative impairments. Third, although education is assumed to be one of the most consistent factors influencing cognitive abilities, its influence on the different communication domains and measures varies. For example, the level of education was found to influence performance on semantic fluency but not on phonemic fluency tasks.[32]

Of note, discourse may be a particularly rich area for differentiating the different levels of communication functioning between individuals with MCI and those with dementia or those without cognitive impairment. Discourse can be measured in a variety of ways and entails a complex interweaving of receptive and expressive language skills, as well as executive function, required for such tasks as planning narrative productions and generating inferences, among others.[22] Discourse is integral to human interaction, such as between medical providers and patients; thus, it may be a vital mechanism in understanding how communication difficulties impact the quality of medical care by examining MCI patients' interactions with health care providers.

Receptive communication characteristics of older adults with MCI have been less thoroughly described, although a few studies demonstrated impairments in individuals with MCI compared with their healthy counterparts in the areas of sentence comprehension, receptive discourse, and reading comprehension. More studies, especially prospectively examining the degenerative process from normal aging to MCI to AD, are needed to lead to strong conclusions as to the distinguishing features of receptive communication in MCI.

Of note, the studies describe within this review do not represent all communication domains. For instance, no studies examined written communication in older adults with MCI. Written description tasks of complex pictures were found to differentiate cognitively normal adults from those with probable AD.[55]

## Cognitive intervention studies

The second purpose of this review was to examine cognitive intervention studies with communication outcomes. As mentioned earlier, communication skills are interdependent on various domains of cognitive function and all of the intervention studies reviewed here addressed communication by targeting different cognitive domains. Despite all that is known about communication impairments in MCI, and the current high degree of interest in cognitive training as a potential means for slowing cognitive decline in aging and MCI,[6,52] only 7 cognitive intervention studies were identified that included communication outcomes in the areas of verbal fluency, semantic memory, and expressive and receptive discourse. Of these studies, using a variety of approaches, only one, incorporating a combination of cognitive training and pharmacological treatment, resulted in improvement in receptive and expressive discourse (story recall) in MCI participants.[47]

In addition to the small sample sizes (n = 12-59 MCI participants), a major reason that may explain the lack of treatment effect in most of the reviewed intervention studies is that most of the interventions did not target domains of communication directly or the transferring effect from the primarily targeted cognitive domain to communication-related domains is not strong enough. The latter point is discussed later in the "Neuroplasticity" section. The study by Rozzini et al[47] was the only study that achieved a significant intervention effect in the MCI participants and the only study directly targeting communication by including a language component within its CCT intervention. There have been studies conducted with other types of participants that are illustrative for future interventions in MCI. In one, expressive discourse measures were found to decline more slowly in patients with mild-moderate AD who received both pharmacological and 8 weekly multimodal communication treatment sessions composed of education, communication strategies, and assistance in developing a "Life Stories Book."[56] In addition, in a study in which subjects received "lexical-semantic training" exercises in group setting twice per week for 3 months, improvements were seen in all communication measures (phonemic and semantic fluency, semantic memory, story recall) in participants with early-stage probable AD as compared with healthy counterparts.[57] These studies point to the potential for improvement in communication skills when they are specifically targeted in the intervention design.

Although only cognitive intervention studies were included in this review, there may be other types of behavioral interventions that may be beneficial for managing communication difficulties in MCI. One randomized controlled trial was located that used physical exercise (walking and hand and face exercises) and resulted in improvements in a measure of semantic fluency in participants with MCI.[13] Furthermore, in a quasi-experimental study examining the effects of a 4-year program that included volunteer work or other community activities, physical exercise, verbal fluency, and conversational stimulation treatment, 4 subjects with mild-moderate AD maintained or improved on a number of expressive discourse measures.[58] Other types of behavioral interventions, for example, physical exercise, or a combination of different types of behavioral interventions warrant further exploration in individuals with MCI.

## Neuroplasticity

It is important to note that the observable and behavioral aspects of communication difficulties in MCI may be closely related to the structural and functional changes that are occurring within the brain. For example, one study demonstrated that both MCI and early-stage AD participants were impaired in semantic memory and both groups had cortical atrophy of the anterior temporal lobe and inferior prefrontal cortex.[31] In another study of a group of patients from very MCI to AD, the researchers found that impaired verb fluency was predicted by temporal lobe hypoperfusion (as assessed using single-photon emission computed tomography) whereas noun fluency was predicted by parietotemporal-occipital hypoperfusion.[59] In addition, de Zubicaray and colleagues[60] demonstrated that a network including the left anterior temporal lobe, posterior temporal lobes, posterior inferior parietal lobes, as well as 2 frontal lobe connective pathways was critical for semantic memory function in healthy older adults. Thus, although the brain structure and function underlying the communication difficulties in MCI have not been fully explored, it is possible to surmise that they are influenced by a broad frontal-temporal-parietal network. Importantly, these brain regions are affected earliest in the neurodegenerative process.[61]

In applying behavioral interventions to improve communication functioning in patients with MCI, it is important to consider the potential mechanisms by which behavioral interventions may influence the development of neuroplastic alterations (ie, changes of brain properties) that are related to the communication deficits. Neuroplastic changes occur within the brain as a result of interactions with the environment.[62] Accumulated studies with a focus on executive function have demonstrated that different types of behavioral interventions, especially cognitive training, induce measurable changes in structure and function (eg, cerebral blood flow, glucose metabolism rate) of the brain regions that are closely related to targeted executive function in patients with MCI.[63,64] It is unclear whether communication-oriented behavioral interventions would induce similar neuroplastic changes.

The Scaffolding Theory of Aging and Cognition of Park and Reuter-Lorenz[65] may provide a theoretical framework for further understanding neuroplasticity and communication functioning in patients with MCI. The theory proposes that compensatory scaffolding helps maintain high-functioning behavior/cognition in the aging process. Compensatory scaffolding refers to the recruitment of additional neural circuitry to offset the brain structural and functional changes due to normal aging. The frontal lobe, especially the prefrontal cortex, plays an important role in the process of compensatory scaffolding. Communication skills are used continuously throughout the life span, therefore likely resulting in a robust and durable neural network.[65] However, as people age, these original networks, especially in the frontal-temporal-parietal region, break down, which results in the need for compensatory scaffolding mechanisms. For example, in one study, performance on a semantic memory test was compared between younger and older groups.[66] Using functional magnetic resonance imaging, the authors found increased activation of the inferior frontal cortex in the older group, even during the test with low difficulty level, as compared with the younger adults. Similarly, Meinzer and colleagues[67] observed increased activation of inferior frontal cortex across different difficulty levels of verbal fluency tasks in an older group as compared with a younger group.

During the neurodegenerative process, as seen in MCI, the neural pathology (eg, amyloid-β accumulation in the frontal lobe) disrupts the protective function of the compensatory scaffolding. As hypothesized, cognitive training may provide a way to enhance or prevent the disruption of the compensatory scaffolding of the brain due to such pathological changes, especially during the early stage of decline, as seen in MCI. However, the current task is to find the most appropriate training program that can help with the scaffolding to compensate for the communication impairments seen in MCI. In a newly published study, healthy older adults demonstrated direct improvement in working memory, which is primarily controlled by the prefrontal cortex, following training of working memory. This training also effectively improved the untargeted communication-related domains of auditory and reading comprehension.[68] While not conducted with adults with cognitive impairment, this study is supportive of the notion that cognitive training directly targeting prefrontal cortex may most effectively and directly enhance compensatory scaffolding and, ultimately, may affect other untargeted brain regions that are related to communication domains. As mentioned earlier, most of the intervention studies we reviewed did not directly target communication domains but they did not target cognitive functions that are directly related to prefrontal cortex either. This may help explain why those studies failed to find any significant transfer effect from trained cognitive domains to untrained communication domains. Nevertheless, the Scaffolding Theory of Aging and Cognition may provide an entirely new pathway for developing cognitive interventions that may effectively address communication difficulties in individuals with MCI, through a potential transferring effect from the enhancement of the prefrontal cortex, where the compensatory scaffolding occurs, to the communication-related domains.

## CONCLUSIONS

Communication difficulty is an important component of the MCI profile that differentiates individuals with MCI from cognitively healthy elderly individuals and patients with AD and may therefore be a key target for intervention efforts designed to improve multiple domains of well-being in individuals with MCI.

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