


A Systematic Review of Metacognitive Differences Between Alzheimer's Disease and Frontotemporal Dementia

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Abstract

Clinicians often have difficulty distinguishing between various forms of dementia to achieve a correct diagnosis. Little research has been done to examine whether awareness of one's cognitive deficits, or metacognitive monitoring, might differ between dementia diagnoses, thereby providing an additional means of differentiating between dementia subtypes. We review articles examining metacognitive comparisons between two of the most common dementia subtypes: Alzheimer's disease and frontotemporal dementia. Greater monitoring deficits were apparent in frontotemporal dementia than in Alzheimer's disease, and participants with frontotemporal dementia were less likely to utilize task experience to update and improve the accuracy of subsequent monitoring judgments. Results provide evidence for the utility of metacognitive measures as a means of distinguishing between Alzheimer's disease and frontotemporal dementia.

Keywords

Alzheimer's, dementia, frontotemporal dementia, anosognosia, metacognition, metamemory, diagnosis

Metacognition, or "cognitions about cognitions,"¹ can influence our everyday lives, as these cognitions play an important role in decision making.²⁻⁴ Metacognition consists of monitoring or assessing one's knowledge and controlling or regulating this knowledge³. Monitoring and control of our cognitive processes may be involved in even the simplest of tasks. For example, suppose an individual needs to remember to purchase groceries on her way home from work. She might monitor her memory by deciding whether or not she is likely to remember these items. She could then use these monitoring judgments to control her memory (Nelson and Leonesio⁵ but see Koriati, Ma'aayan, & Nussinson⁶) either using strategies to modify her memory—such as rehearsing her grocery list aloud—or by choosing not to modify her memory at all. If these judgments were accurate, she is likely to remember the items on her grocery list. However, if monitoring is inaccurate, inaccurate decisions may be made.^{5,7,8} Although forgetting to remember milk may be trivial, forgetting one's medication, for example, is less so and can result in significant self-harm (for a detailed review of these implications, see the study by Cosentino et al⁹). Up to 81% of individuals with Alzheimer's disease (AD), the most frequent form of dementia,¹⁰ have impaired awareness of their functional or cognitive impairments, or anosognosia, a symptom common to many types of dementia that has not yet been clearly defined or understood.¹¹ When individuals with dementia make decisions based upon inaccurate assessments of their impairments, these decisions are likely to be impaired as well.¹² Everyday behaviors such as medication management, traveling to doctors' appointments, and preparing meals provide risks that could

result in severe consequences. Anosognosia, therefore, poses a significant safety risk to affected individuals.¹³

Frequently misdiagnosed as AD, frontotemporal dementia (FTD) is the second most common type of dementia¹⁰ and may similarly hazard the safety of affected individuals. The necessity of achieving a correct dementia diagnosis is particularly important, as a common pharmacological medication for AD—anticholinesterase—often fails to benefit, and may even harm, individuals with FTD.¹⁴ Individuals with FTD generally demonstrate a faster rate of cognitive decline than individuals with AD and shorter survival rates from initial diagnosis (4.2 vs 6.0 years¹⁵), highlighting the importance of achieving proper diagnoses and treatment sooner rather than later. Unfortunately, although FDA-approved medications exist for AD, no FDA-approved medications currently exist for FTD, frequently resulting in the use of AD medications—including anticholinesterase—by individuals with FTD.¹⁴

Although some research suggests an ability to differentiate between AD and FTD on a neural basis, such as through

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structural imaging,¹⁶ these methods are expensive and time consuming. Such difficulties may be addressed through metacognitive assessment, a low-cost means of identifying cognitive deficits. In a recent review, Cosentino¹⁷ discussed the advances made by metacognitive assessment in understanding awareness in AD. However, no review currently exists regarding metacognition in FTD or whether metacognition differs between AD and FTD. Accordingly, in the current article, we sought to review the literature comparing metacognitive awareness between individuals with AD and FTD. The primary purpose of this review is to identify differences in metacognition that can be used to differentiate between individuals with AD and those with FTD, aiding in correct diagnoses. As secondary purposes of this review, first, we aim to increase knowledge of anosognosia as a whole by understanding how anosognosia affects individuals with AD and FTD. Lastly, we are also interested in whether metacognition differs by the means in which these judgments were collected (ie, subjective vs objective measures). To be considered for inclusion, our review criteria required each study to include both individuals with AD and individuals with FTD and to possess some form of participant self-report or self-assessment regarding cognitions or behavior.

Methods

The 2009 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) review protocol guidelines were followed for this review (www.prisma-statement.org). We combined search results from the MEDLINE (PubMed; 1950-present), PsycInfo (1887-present), and ScienceDirect (1995-present) databases (through January 2015) using the terms metacognition and Alzheimer OR metacognition and frontotemporal dementia (404 articles). We limited these search results (see Figure 1) by removing articles which appeared in multiple searches (68 excluded), which were not written in English (34 excluded), which were review articles or book chapters (98 excluded), which did not include both individuals with AD and those with FTD (198 excluded), for a total of 6 studies remaining for review. Moreover, although review articles and book chapters were not included, we examined their references, in addition to the references reported in the included articles, to ensure we included any critical articles. This resulted in a total of 2 additional studies, for a total of 8 articles in our review. Given the specificity of our interests, we did not expect to identify relevant unpublished articles; therefore, our search was conducted only on published articles. Data from all articles were independently extracted by the first author and subsequently reviewed by the second author. When interpretations of data conflicted, the authors discussed the data in question to arrive at consensus.

Within these studies, FTD was primarily described either as a broad category or was further broken down into the 3 primary clinical FTD variants or subtypes: behavioral variant FTD (bvFTD), primary progressive aphasia, and semantic dementia

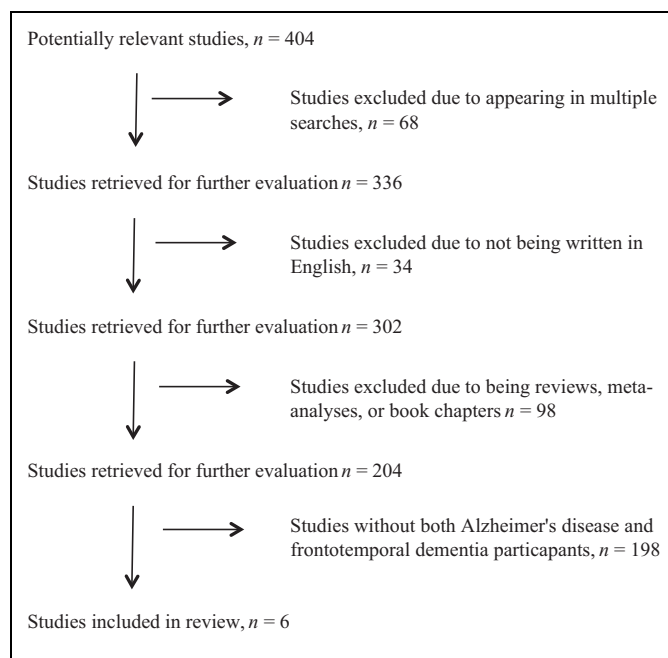


Figure 1. A study flow diagram of the review selection procedure.

(SD¹⁸). Our review includes results for both FTD and all subtypes. No distinction is made among severity of AD diagnoses (eg, probable AD, mild to moderate AD, etc). Outcomes included awareness of changes in everyday behavior as well awareness of cognition. Measures of metacognitive awareness were collected through several methods: semistructured interviews, patient–informant discrepancies, and judgments of test performance. Principle summary measures consisted of differences in means: between individuals with AD and FTD and between both individuals with AD and FTD compared to older adult controls. Results were organized by the similarity of study design.

Results and Discussion

This review aims to identify metacognitive differences between individuals with AD and those with FTD. As metacognition is measured using different methodologies throughout the included studies (addressing such varied items as memory, behavioral changes, and tasks of everyday functioning), results are presented in the form of a qualitative review, in which only those measures and statistics relevant to the focus of this article are discussed. A total of 8 studies compared metacognition between individuals with AD and FTD, using a variety of techniques (see Table 1). Among these techniques, participant–informant discrepancy ratings were common,^{19,20,21} in which both participants and their informant (typically a caregiver or spouse) provided assessments of the participant's ability to function on a variety of tasks. Informant ratings were then compared to those of the participant, and discrepancies between these ratings indicated the severity of the participant's anosognosia or the unawareness of his or her deficits. Another

Table 1. Summary and Quality Assessment of Empirical Studies That Met Inclusion Criteria.

First Author	Year	Participants	Summary of Relevant Findings	Quality Assessment
Banks and Weintraub ¹⁹	2008	N = 40; 11 participants with bvFTD, 14 participants with PPA, 15 participants with prAD, and 15 older adult controls	Individuals with PrAD, bvFTD, and PPA were poor at assessing behavioral changes. Individuals with bvFTD and prAD were poor at assessing memory. Individuals with PPA individuals performed similarly to controls on all cognitive domains (behavior, naming, and memory). Monitoring judgments did not differ from pretest to posttest	Aims, participant characteristics, and outcomes clearly described. Participants with dementia were enrolled in the Clinical Core registry of the Northwestern Alzheimer's Disease Center and were diagnosed according to research diagnostic criteria by consensus of a group of neuropsychologist and behavioral neurologist specialists. Participants with dementia and healthy controls were recruited from the same clinical center. Participants with dementia were excluded if their MMSE scores were less than 15/30. Both participants with dementia and controls provided judgments of test performance on cognitive domains, and participants with dementia only provided additional judgments for behavior. All individuals were blind to one another's performance and judgment accuracy. No dropouts were noted. Newcastle–Ottawa Scale = 7
Eslinger et al ²⁰	2005	N = 49; 27 participants with probable FTD (12 social-dysexecutive, 15 aphasic), 11 participants with prAD, and 11 age-matched older adult controls	Individuals with FTD demonstrated multidomain deficits in awareness, whereas AD deficits were constrained to memory and apathy	Aims, participant characteristics, and outcomes clearly described. Participants with dementia were recruited through clinical services and possessed diagnoses according to standard criteria. Controls were recruited through local advertisements for volunteers, and participant caregivers served as informants for behavioral changes. Participants and caregivers completed the Brock Adaptive Functioning Inventory. Participants and controls assessed their test performance on a range of cognitive tests. All individuals were blind to one another's performance and judgment accuracy. No dropouts were noted. Newcastle–Ottawa Scale = 7
Fernandez-Duque and Black ²¹	2007	N = 36; 10 participants with bvFTD, 12 participants with early AD (6 AD and 6 MCI), and 14 age-matched older adult controls	Across multiple measures, individuals with bvFTD demonstrated poorer awareness of deficits than individuals with AD. When comparing to that of younger adults, individuals with bvFTD lowered estimates of their own performance to a lesser extent than individuals with AD	Aims, participant characteristics, and outcomes clearly described. Participants with dementia were recruited at Sunnybrook Health Science Center at the University of Toronto. Controls were age matched, but no description of recruitment was provided. Participants with dementia were excluded after an MMSE cutoff score of 24. MRI scans ruled out alternative pathologies. Individuals with bvFTD and their informants further completed the Frontal Behavioral Inventory. Participants with dementia completed a semistructured interview regarding their deficits. Participants with dementia and their informants completed the Cognitive Failure Questionnaire and the Dysexecutive Questionnaire. Participants with dementia and controls assessed their test performance on a range of cognitive tests. All individuals were blind to one another's performance and judgment accuracy. No participants dropped out. Newcastle–Ottawa Scale = 7
Massimo et al ¹⁶	2013	N = 122; 49 participants with bvFTD and 72 participants mild to moderate AD	For individuals with bvFTD, posttest judgments of test performance on a series of cognitive tasks (Boston Naming Test [BNT], Test of Receptive Grammar [TROG], and Rey Free Recall) were not correlated with actual test performance. For individuals with AD, actual and predicted performance were correlated on BNT and TROG	Aims, participant characteristics, and outcomes clearly described. Participants with dementia were classified according to published criteria and were recruited and evaluated by a cognitive neurologist. Two or more trained reviewers confirmed diagnostic criteria and further described participants with dementia as either AD or an FTD variant through review of patient and family reports and neurological and mental status evaluations, with 85% inter-rater reliability agreement. Consensus on diagnoses was reached via committee for the 15% at question. Participants were excluded if other neurological or psychiatric conditions existed. All participants judged their performance on a series of cognitive tasks after test completion. Individuals were blind to one another's performance and judgment accuracy. Due to technical or scheduling difficulties, a number of participants failed to complete all tests. The number of participants lost approximated 15% or less for all tests except for the Test of Receptive Grammar (TROG), in which 39%–49% of participants were lost. Newcastle–Ottawa Scale = 7

(continued)

Table 1. (continued)

First Author	Year	Participants	Summary of Relevant Findings	Quality Assessment
Mendez and Shapira ²²	2011	N = 24; 12 participants with bvFTD and 12 participants with AD	Individuals with bvFTD demonstrated less awareness and concern regarding their deficits than individuals with AD. After being informed of their deficits, individuals with bvFTD demonstrated awareness but remained unconcerned	Aims, participant characteristics, and outcomes clearly described. Participants with AD and bvFTD were both recruited from the UCLA FTD & Neurobehavior Clinic. Participants with bvFTD were diagnosed according to international criteria, whereas participants with prAD were diagnosed through clinical, neuropsychological, and neuroimaging evaluations. Participants with dementia completed Structured Insight Interviews, and results were scored by 2 clinicians (inter-rater reliability = 65%). Individuals were blind to their own and each other's results. No data were provided for dropouts. Newcastle-Ottawa Scale = 6
Rosen et al ²³	2014	N = 61; 12 participants with bvFTD, 14 participants with AD participants, and 35 older adult controls	Across a variety of measures of memory awareness, both individuals with bvFTD and AD demonstrated deficits. Individuals with bvFTD demonstrated deficits across a greater proportion of measures than individuals with AD and were less likely to update their assessments after feedback	Aims, participant characteristics, and outcomes clearly described. Participants with dementia were recruited from a variety of sources and were diagnosed according to published criteria in conjunction with neurological, neuropsychological, and laboratory evaluation, nursing assessment, and panel consensus. Controls were recruited from the community and were excluded if their scores on 2 or more cognitive tasks were more than 1 standard deviation below that of age-matched norms. All individuals completed a series of memory tests and judgments of performance. Individuals were blind to one another's results. No dropouts were recorded. Newcastle-Ottawa Scale = 8
Souchay et al ²⁴	2003	N = 38; 6 participants with FTD, 16 participants with prAD, and 16 older adult controls	Pretest judgments of memory performance were similar in accuracy for individuals with FTD and AD. Posttest judgments were less accurate for individuals with FTD than individuals with AD	Aims, participant characteristics, and outcomes clearly described. Participants with dementia were diagnosed according to published criteria and were excluded if they had a history of major medical illness. Participants with dementia were recruited from hospitals in and around Paris, and controls were recruited from the surrounding community. An age difference between participants with AD and FTD was identified and controlled for. All individuals completed a series of cognitive tests and judgments of performance. Individuals were blind to one another's results. No dropouts were recorded. Newcastle-Ottawa Scale = 8
Williamson et al ²⁵	2010	N = 30; 10 participants with bvFTD, 10 participants with prAD participants, and 10 older adult controls	Discrepancies between actual and judged test performance were greater for individuals with bvFTD than AD	Aims, participant characteristics, and outcomes were clearly described. Participants with dementia were diagnosed according to published criteria and were recruited from the Memory and Aging Center at the University of California, San Francisco. Controls were recruited from the community. All individuals completed a series of cognitive tests and judgments of performance. Individuals were blind to one another's results. No dropouts were recorded. Newcastle-Ottawa Scale = 7

Abbreviations: AD, Alzheimer's disease; bvFTD, behavioral variant frontotemporal dementia; FTD, frontotemporal dementia; MCI, mild cognitive impairment; MMSE, mini-mental state examination; MRI, magnetic resonance imaging; PPA, primary progressive aphasia; prAD, probable Alzheimer's disease; SD, semantic dementia.

technique consisted of semi-structured interviews,^{21,22} in which participants were interviewed regarding awareness of their deficits, according to a previously arranged series of questions. These interviews were then scored to provide a numerical assessment of the participants' unawareness of deficit. Lastly, a third commonly used technique consisted of judgments of test performance.^{16,19,21,23-25} In this technique, participants were asked to make pretest or posttest judgments of their performance on a test. Rather than measuring test performance, the focus is placed on the accuracy of these test judgments as an indicator of monitoring awareness.

The objectivity of 2 of these 3 primary techniques has become a concern¹⁶ (for a recent review, see Cosentino¹⁷). For example, as noted by Massimo et al,¹⁶ informants (typically caregivers or family members) may not be completely unbiased when providing an estimate of an individual's awareness. Issues such as the difficulty (or ease) of caring for an individual may skew the informant's rating of their abilities. Further, self-report scales cannot differentiate between participants' overestimations and informants' underestimations of the participant's abilities.²⁶ In an effort to reduce this potential bias, Eslinger et al²⁰ compared participant-informant discrepancy ratings with those of controls and their informants. Only discrepancy scores differing significantly from those of the controls were included in further analyses of participants' unawareness of deficit, in order to reduce informant bias. In addition to the issue of informant bias, subjective measures may be influenced by participants' ability to use the rating scales. In an effort to address this potential problem, Banks and Weintraub¹⁹ had participants and their informants additionally rate the self-related domains of weight and eyesight, which are not cognitively or behaviorally related but which may provide an idea of whether participants are capable of making self-relevant judgments. That is, if participants are unable to make accurate judgments of self, measuring these noncognitive and nonbehavioral domains may indicate whether factors other than anosognosia (eg, personal bias or difficulty utilizing the judgment scales) contribute to this inaccuracy. In contrast, if participants make accurate judgments for their weight and eyesight, researchers may be more confident that judgments indicating cognitive or behavioral anosognosia reflect anosognosia itself, rather than unrelated factors. As a final point of contention, it has been argued that interviews cannot provide a truly representative idea of an individual's everyday deficits¹⁶ (for a detailed discussion of potential confounds using clinical interviews, see Kaszniak and Edmonds²⁷). Therefore, recent work has touted the use of objective judgments of task performance as a means of examining metacognitive errors in impaired individuals.^{12,23} In addition to being objective, such measures have been shown to relate to clinical measures of awareness, suggesting that while avoiding the pitfalls of subjective assessment, they additionally capture something specific to self-assessment.¹² Given these perspectives of prior methodology, this review is organized into subjective and objective measures of awareness, followed by an integrated discussion of these results.

Subjective Measures of Awareness (n = 5)

In one measure of awareness—discrepancy scores—both participants and informants (eg, caregivers and spouses) completed questionnaires rating the participant's everyday performance.^{19,20,21,25} For example, several of the studies^{19,21} used the Frontal Behavioral Inventory (FBI²⁸), which is a 24-item behavioral questionnaire on items such as impulsivity, insight, distractibility, and so on. Informant ratings are then typically used as a control to compare participant ratings, against, as a measure of that participant's monitoring deficits or changes in awareness.

When compared to their informants' assessments, both individuals with AD and FTD were poor at assessing their everyday deficits.^{20,25} Eslinger et al²⁰ gave participants and their informants a series of neurological assessment batteries surveying everyday cognitive, social, and emotional behaviors. Metacognitive accuracy was examined by subtracting each informant's rating from the rating of their charge (same-different analyses). Consistent with the presupposition that healthy older adults possess relatively accurate awareness of their abilities, all control-informant discrepancy ratings failed to reach significance. Relative to their informants' ratings of their abilities, individuals with FTD overestimated their abilities in 47% of the assessed domains, whereas individuals with AD overestimated their abilities in only 12% of the assessed domains. However, when FTD estimations were examined by subtype (described in terms of deficits, rather than clinically defined FTD variants), it was apparent that nonaphasic patients with social-behavioral and dysexecutive impairments (SOC-DYSEX) overestimated their performance in 59% of the assessed domains, whereas the other FTD subtypes (aphasic, composed of progressive nonfluent aphasia [PNFA] and semantic dementia [SD]) overestimated at levels comparable to those of individuals with AD (12% overall; 6% and 18%, respectively).

Similarly, Williamson et al²⁵ examined discrepancies between participant-informant ratings of everyday behavior (collapsed across individuals with AD and FTD; same-different analyses) and correlated these discrepancies with discrepancies between participants' actual and predicted performance on tasks of everyday function from the Neuropsychological Assessment Battery (NAB). As participants judged their NAB performance both prior to and after completing the NAB (pretest and posttest judgments; discussed subsequently), this resulted in 2 correlations: participant-informant discrepancies on everyday behavior versus pretest NAB judgments and participant-informant discrepancies on everyday behavior versus posttest NAB judgments. Discrepancies between participant-informant responses were positively and significantly correlated with discrepancies between estimated and actual percentile rankings ($r = .65$ and $.59$ for pretest and posttest discrepancies, respectively). As noted by Williamson et al,²⁵ these correlations indicated that participants who were poor at estimating their performance on the NAB modules were also poor at assessing their performance in everyday life.

When compared to each other, individuals with FTD were worse than individuals with AD at assessing their everyday deficits,²⁰ although Williamson et al²⁵ reported these differences

only as trends. Eslinger et al²⁰ found that, relative to their informants' assessments, individuals with AD were able to detect changes in behavior, but that all individuals with FTD were poor at assessing changes in their behaviors, particularly within the SOC-DYSEX subtype. Banks and Weintraub¹⁹ had participants assess performance on 2 cognitive domains (Boston Naming Test or Naming and Rey Auditory Verbal Learning Test or Memory) and one behavioral domain (FBI), both before and after completing each test (pretest and posttest judgments). In addition to the participants, each participants' informant likewise completed the FBI to report their charge's behavior, and this informant response was used as a measure of participants' actual behavior. For both the cognitive measures (Memory and Naming), participant judgments of their performance were compared to their actual performance on those tests. For posttest judgments, or judgments made after each test regarding their test performance, individuals with bvFTD were poorer at assessing Behavior than Naming, whereas individuals with AD were poorer at assessing Behavior than either Memory or Naming.

Results of structured interviews again revealed that individuals with FTD were poorer at assessing their impairment than individuals with AD.^{21,22} Mendez and Shapira²² questioned individuals with AD and bvFTD on their awareness of having a disorder and its impact on themselves and on others. Participants were given corrective feedback after each of these 3 questions and subsequently completed an interview probing their awareness of this disorder. Individuals with bvFTD were less likely than individuals with AD to be aware of their disorder and, after corrective feedback, were less likely than individuals with AD to demonstrate either awareness or concern regarding the impact of their disorder upon themselves and others. Fernandez-Duque and Black²¹ had individuals with AD, bvFTD, controls, and their caregivers complete a series of behavioral assessment inventories. Participants were then interviewed on their awareness of their deficits and any subsequent impact and concerns it had brought upon themselves or others. Individuals with bvFTD were less likely than individuals with AD to indicate awareness of their current deficits.

Objective Measures of Awareness ($n = 7$)

A frequent means of examining metacognition for memory performance is in terms of global or item-by-item judgments (see Dunlosky and Metcalfe³⁰). Global judgments are made as assessments of overall performance (eg, predicting the number of items that will later be recalled at test³¹), whereas item-by-item judgments are made separately for each item (eg, predicting the likelihood of recalling a particular study item on a future test; for a review, see Rhodes³²). Global judgments have been examined extensively in metacognitive research on memory in AD¹² and to a lesser extent, in FTD. As such, we discuss global judgments first, as they comprise the majority of our results. Although few studies examined item-by-item judgments, we present them separately to highlight their importance.

Global judgments. Within the studies presented, participants were asked to judge or assess their overall test performance (e.g.,

number of items recalled or performance relative to others). Judgments made after a test reflect monitoring of task performance,³¹ whereas judgments made prior to study reflect beliefs about memory and factors affecting memory performance.²⁴ Accuracy of prestudy judgments was poor, with both individuals with AD and FTD overestimating their memory performance,^{19,24} whereas Eslinger et al²⁰ simply reported that results were highly varied, even among control subjects. These results suggest that beliefs about memory are inaccurate prior to test. Notably, however, both AD and FTD judgments demonstrated sensitivity to factors affecting memory performance.^{21,23} That is, memory can be affected by cues inherent to the stimuli (intrinsic cues; eg, difficulty of the to-be-learned material) or by cues inherent to the testing (extrinsic cues; eg, type of test^{31,33}). Consistent with the common finding that performance is higher in recognition tests than in free recall, both individuals with AD and FTD utilized this extrinsic cue to accurately predict higher future performance for recognition than for free recall tests.²³ Similarly, consistent with the finding that memory performance deteriorates with age, when asked to judge the accuracy of their future test performance, both individuals with AD and FTD gave lower predictions when assessing their performance relative to that of younger adults, than relative to healthy older adult peers, although individuals with FTD lowered these predictions less than either individuals with AD or control participants. Thus, although both individuals with AD and FTD demonstrate inaccurate beliefs about memory, they also demonstrate an ability to utilize available cues to enhance the accuracy of their memory beliefs.

Most important, we examined the accuracy of posttest judgments, indicated by how closely these judgments reflected actual test performance (eg, correlations or mean difference). Overall, both individuals with AD and FTD made less accurate posttest judgments than older adult controls.^{19,24,25} However, for judgments made immediately after study (but prior to test), Rosen et al²³ did not find the differences between groups to be significant. Notably, individuals with FTD made less accurate posttest judgments than individuals with AD.^{16,20,23,25} For example, Massimo et al¹⁶ reported that individuals with FTD (but not AD) failed to produce significant correlations between actual and judged test performance on all 3 tests of cognitive functioning administered. Further, individuals with FTD were poorer than individuals with AD at accurately adjusting their monitoring judgments, either as estimates of future performance or in relation to the performance of other individuals.^{21,23} Relative to judging their performance to that of others their own age, when comparing their performance to that of younger adults, individuals with FTD lowered posttest judgments of their performance less than individuals with AD or controls. Similarly, when given explicit feedback on their test performance and then asked to predict their performance on a similar test in the future, Rosen et al²³ reported that individuals with FTD (but not AD) failed to make predictions commensurate with their test performance. Overall, these findings indicate that individuals with FTD demonstrate greater monitoring deficits than individuals with AD.

Item-by-item judgments. Only one study, by Rosen et al,²³ examined judged performance for individual items by individuals with AD and FTD; however, judgments were collected on 2 measures: feeling-of-knowing and retrospective confidence. For feeling-of-knowing judgments, participants rated the likelihood of recognizing individual word pairs at test, which they had previously failed to recall. After this recognition test, participants then rated their confidence in the correctness of their individual responses (retrospective confidence ratings). Feeling-of-knowing judgments were positively associated with recognition accuracy for controls and individuals with AD but not for individuals with FTD. Both individuals with AD and FTD demonstrated impaired feeling-of-knowing accuracy relative to controls, with the difference between individuals with AD and bvFTD approaching significance ($p = .08$). All adjustments for potential confounding variables revealed significant associations between judgments and performance for individuals with AD and control participants but no significant associations between judgments and performance for individuals with bvFTD.

Summary and Conclusion

In this review, we examined whether individuals with AD and FTD differ in their monitoring judgments. Awareness of deficit was reported either as subjective or objective judgments. Subjective measures revealed that individuals with FTD were less likely than individuals with AD to report awareness of their deficits and were less concerned by the effects of their deficits upon themselves and others. Similar results were found using objective measures. Most importantly, results from studies using objective judgments of awareness demonstrated a similar pattern in both global and item-by-item judgments. That is, individuals with FTD were less aware of their memory deficits than individuals with AD and less able to update the accuracy of their monitoring judgments, even after receiving explicit feedback. This failure to update suggests that in contrast to individuals with AD, individuals with FTD may possess a stability bias or a failure to sufficiently change or update their preexisting judgments when new knowledge is provided.³⁴

Although we have reviewed a number of studies, due to subtype variations within FTD, it is unlikely that these findings would hold for all variations in FTD. Although impaired insight is considered a primary feature of bvFTD,³⁵ it is less typically associated with the aphasia presentations of this disease (for a review of these differences across subtypes, see Snowden et al³⁶). As such, there may not be metacognitive studies documenting this association (but see Eslinger et al²⁰). In particular, Eslinger et al²⁰ reported metacognitive differences between individuals with FTD and AD but discovered this was driven by the results of one subtype of FTD, whereas all other examined subtypes performed similarly to individuals with AD. Accordingly, given the small number of existing studies (and the disparity of their means of metacognitive measurement), one possibility is that metacognitive performance in FTD may vary more (or less) than these studies

indicate. Future research should continue to examine this as the literature grows. Additionally, further work should examine questions such as whether there is a specific cutoff in metacognitive performance that would be more indicative of FTD than AD or the reliability of metacognitive measures in distinguishing between FTD and AD (as confirmed by postmortem diagnoses). The current study, however, provides initial evidence for the use of metacognition measures as part of a larger assessment when evaluating the presence of dementia.

Authors' Note

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References

1. Flavell JH. Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *Am Psychol*. 1979;34(10):906-911.
2. Nelson TO, Dunlosky J. When people's judgments of learning (JOLs) are extremely accurate at predicting subsequent recall: The "delayed-JOL effect". *Psychol Sci*. 1991;2(4):267-270.
3. Nelson TO, Narens L. Metamemory: A theoretical framework and some new findings. In Bower GH, ed. *The Psychology of Learning and Motivation*. Vol 26. San Diego, CA: Academic Press; 1990: 125-173.
4. Nelson TO, Narens L. Why investigate metacognition? In Metcalfe J, Shimura APV, eds. *Metacognition: Knowing About Knowing*. Cambridge, MA: MIT Press; 1994:185-206.
5. Nelson TO, Leonesio RJ. Allocation of self-paced study time and the "labor-in-vain" effect. *J Exp Psychol Learn Mem Cog*. 1988; 14(4):676-686.
6. Koriati A., Ma'aayan H, Nussinson R. The intricate relationships between monitoring and control in metacognition: Lessons for the cause-and-effect relation between subjective experience and behavior. *J Expl Psychol Gen*. 2007;135(1):35-69.
7. Rhodes MG, Castel AD. Memory predictions are influenced by perceptual information: evidence for metacognitive illusions. *J Expl Psychol Gen*. 2008;137(4):615-625.
8. Rhodes MG, Castel AD. Metacognitive illusions for auditory information: Effects on monitoring and control. *Psychon Bull Rev*. 2009;16(3):550-554.
9. Cosentino S, Metcalfe J, Cary MS, De Leon J, Karlawish J. Memory awareness influences everyday decision making capacity about medication management in Alzheimer's disease. *Int J Alzheimers Dis*. 2011;2011:1-9.

10. Ratnavalli E, Brayne C, Dawson K, Hodges JR. The prevalence of frontotemporal dementia. *Neurol.* 2002;58(11):1615-1621.
11. Cosentino S, Stern Y. Metacognitive theory and assessment in dementia: Do we recognize our areas of weakness? *J Int Neuropsychol Soc.* 2005;11(7):910-919.
12. Cosentino S, Metcalfe J, Butterfield B, Stern Y. Objective metamemory testing captures awareness of deficit in Alzheimer's disease. *Cortex.* 2007;43(7):1004-1019.
13. Cotrell V, Wild K. Longitudinal study of self-imposed driving restrictions and deficit awareness in patients with Alzheimer disease. *Alzheimer Dis Assoc Disord.* 1999;13(3):151-156.
14. Kerchner GA, Tartaglia MC, Boxer AL. Abhorring the vacuum: Use of Alzheimer's disease medications in frontotemporal dementia. *Exp Rev Neurother.* 2011;11(5):709-717.
15. Rascovsky K, Hodges JR, Knopman D, et al. Sensitivity of revised diagnostic criteria for the behavioural variant of frontotemporal dementia. *Brain.* 2011;134(pt 9):2456-2477.
16. Massimo L, Libon DJ, Chandrasekaran K, et al. Self-appraisal in behavioural variant frontotemporal degeneration. *J Neurol Neurosurg Psychiatr.* 2013;84(2):148-153.
17. Cosentino S. Metacognition in Alzheimer's disease. In: *The Cognitive Neuroscience of Metacognition*. Berlin, Heidelberg: Springer; 2014: 389-407.
18. Silveri MC. Frontotemporal dementia to Alzheimer's disease. *Dialogues in Clinical Neurosci.* 2007;9(2):153-160.
19. Banks S, Weintraub S. Self-awareness and self-monitoring of cognitive and behavioral deficits in behavioral variant frontotemporal dementia, primary progressive aphasia and probable Alzheimer's disease. *Brain Cogn.* 2008;67(1):58-68.
20. Eslinger PJ, Dennis K, Moore P, Antani S, Hauck R, Grossman M. Metacognitive deficits in frontotemporal dementia. *J Neurol Neurosurg Psychiatry.* 2005;76:1630-1635.
21. Fernandez-Duque D, Black SE. Metacognitive judgment and denial of deficit?: Evidence from frontotemporal dementia. *Judgm Decis Mak.* 2007;2(5):359-370.
22. Mendez MF, Shapira JS. Loss of emotional insight in behavioral variant frontotemporal dementia or "frontal anosodiaphoria." *Conscious Cog.* 2011;20(4):1690-1696.
23. Rosen HJ, Alcantar O, Zakrzewski J, Shimamura AP, Neuhaus J, Miller BL. Metacognition in the behavioral variant of frontotemporal dementia and Alzheimer's disease. *Neuropsychol.* 2014;28:436-447.
24. Souchay C, Isingrini M, Pillon B, Gil R. Metamemory accuracy in Alzheimer's disease and frontotemporal lobe dementia. *Neurocase.* 2003;9(6):482-492.
25. Williamson C, Alcantar O, Rothlind J, Cahn-Weiner D, Miller BL, Rosen HJ. Standardised measurement of self-awareness deficits in FTD and AD. *J Neurol Neurosurg Psychiatry.* 2010;81(2):140-145.
26. Trosset MW, Kaszniak AW. Measures of deficit unawareness for predicted performance experiments. *J Intl Neuropsychol Soc.* 1996;2(4):315-322.
27. Kaszniak AW, Edmonds EC. Anosognosia and Alzheimer's disease: Behavioral studies. In: *The Study of Anosognosia*, New York, NY: Oxford University Press; 2010; 189-228.
28. Kertesz A, Davidson W, Fox H. Frontal behavioral inventory: Diagnostic criteria for frontal lobe dementia. *Can J Neurol Sci.* 1997;24(1):29-36.
29. Roberson ED. Frontotemporal dementia. *Curr Neurol Neurosci Rep.* 2006;6(6):481-489.
30. Dunlosky J, Metcalfe J. *Metacognition*. Thousand Oaks, CA: Sage Publications; 2008.
31. Connor LT, Dunlosky J, Hertzog C. Age-related differences in absolute but not relative metamemory accuracy. *Psychol Aging.* 1997;12(1):50-71.
32. Rhodes MG. Judgments of learning. In Dunlosky J, Tauber SK, eds. *The Oxford Handbook of Metamemory*. New York: Oxford UP; In press.
33. Koriati A. Easy comes, easy goes? The link between learning and remembering and its exploitation in metacognition. *Mem Cogn.* 2008;36(2):416-428.
34. Kornell N, Bjork RA. A stability bias in human memory: Overestimating remembering and underestimating learning. *J Exp Psychol Gen.* 2009;138(4):449-468.
35. Neary D, Snowden JS, Gustafson L, et al. Frontotemporal lobar degeneration a consensus on clinical diagnostic criteria. *Neurol.* 1998;51(6):1546-1554.
36. Snowden JS, Neary D, Mann DM. Frontotemporal dementia. *Brit J Psychiatry.* 2002;180(2):140-143.