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Integrating the Constructs of Anosognosia and Metacognition: a Review of Recent Findings in Dementia

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Abstract The current review integrates recent findings regarding the construct of self-awareness in dementia from both clinical and cognitive perspectives. We present the predominant theoretical models of awareness and summarize both traditional and emerging approaches to assessing awareness from clinical and meta-cognitive perspectives. In this review, we focus primarily on findings from recent studies in anosognosia and meta-cognition in the context of neurodegenerative disease with special emphasis on Alzheimer's disease and frontotemporal dementia. Emerging trends in the study of awareness, including examination of the longitudinal course of anosognosia, and investigation of the neural substrates underlying meta-cognitive abilities are addressed. Finally, the practical importance of studying and assessing awareness from both theoretical and clinical angles is emphasized.

Keywords Anosognosia · Awareness · Meta-cognition · Aging · Dementia · Self

This article is part of the Topical Collection on *Dementia*

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Introduction

In the context of dementia, the term self-awareness is generally used to refer to an individual's knowledge of a single or multiple aspect(s) of the self, with regard either to current functioning or changes that have occurred to the self over a period of time. Deficits in self-awareness observed in some patients with dementia often entail compromised awareness of one's disease status or its resultant cognitive deficits such as memory loss [1, 2•] or socio-emotional deficits such as personality changes [3]. In more severe stages of dementia, deficits in self-awareness may progress such that individuals lose a fundamental aspect of self-identity, becoming disoriented to person [4]. It is increasingly recognized that deterioration to self-awareness can occur independently from deficits in primary cognitive abilities (i.e., attention, memory, executive functioning) suggesting that self-awareness is a distinct construct (e.g., [5]). In patients with dementia, compromised self-awareness can be observed both at a clinical level (i.e., anosognosia) [2•, 6] as well as upon formal tests of meta-cognition [1, 7]. In this review, we integrate recent data from both perspectives.

Clinicians including neurologists, neuropsychologists, and psychiatrists have long studied the nature, causes, and correlates of "anosognosia," a term first used by neurologist Joseph Babinski in 1914 to describe unawareness of limb weakness or paralysis following stroke [8], but subsequently used more widely in reference to unawareness of deficits of any kind across a range of clinical populations. In a separate and parallel line of research conducted primarily within the field of cognitive psychology, self-awareness has long been studied under the rubric of meta-cognition. Meta-cognition has been defined as "knowledge about one's perceptions, memories, decisions, and actions" [9] or the "reasonable or realistic perception or appraisal of a given aspect of one's situation,

functioning or performance, or of the resulting implications, which may be expressed explicitly or implicitly" [10]. Usually "good" or accurate meta-cognition refers to the idea that people are able to accurately assess the goodness of their learning, cognition, or their memory for example, both in general and knowing which particular items they will and will not perform correctly. Historically, the vast majority of meta-cognitive research has examined the phenomenon of self-reflection in the healthy brain, and young adults in particular [11, 12]. In recent years, meta-cognition has also advanced to study older adults [2•, 13•], especially those with clinical deficits and across a range of clinical populations [14–16]. Not only does meta-cognitive work provide the foundation for understanding how the self operates, it also informs wide-ranging practical issues such as the development of optimal educational strategies, and the variables to be considered when evaluating or relying on eyewitness testimony in forensic settings. Efforts to understand meta-cognition are based on the idea that self-reflection can serve as a "bridge between decision making and memory, between learning and motivation, and between learning and cognitive development" [9]. Indeed, meta-cognition has considerable practical importance, insofar as it has been demonstrated that people's subsequent behavior is determined by their meta-cognition. Hence, faulty meta-cognition has consequences for remediation.

Efforts are increasingly underway to understand the intersection between the cognitive construct of meta-cognition and the clinical construct of anosognosia and to use knowledge about one to inform the other [2•, 17]. Taken together, the decades of research investigating self-awareness have recognized it to be a multifaceted, complex construct. Growing evidence supports the "common sense" notion that impaired self-awareness has real-life implications for important behaviors in individuals with dementia such as treatment adherence, financial management, and decisions about whether or not to stop driving [5, 18]. This review will address important concepts in the study of self-awareness, highlighting studies in the past 5 years examining the etiology, nature, and consequences of disordered self-awareness in dementia, particularly in Alzheimer's disease (AD) and frontotemporal dementia (FTD).

Self-Awareness Across Neurodegenerative Diseases

In the context of neurodegenerative disease, the bulk of anosognosia and meta-cognitive research has focused on individuals with AD and FTD reflecting the clear disorders in self-awareness that are seen in a subset of individuals with these dementias. In AD, wherein diagnosis relies largely on the presence of memory loss, the focus on self-awareness is frequently on the extent to which individuals are aware of their memory loss; that is, the integrity of their memory awareness, or meta-memory [1, 19]. In the context of FTD, especially the behavioral variant subtype (bvFTD), wherein the clinical diagnosis in part includes the presence of impaired insight into one's behavioral and personality changes, the focus of meta-cognitive research often includes awareness of social, emotional, and behavioral symptoms [3, 14, 20]. Moreover, given that AD and FTD, and other neurodegenerative diseases, include other cognitive deficits (e.g., executive function and language), such domains are increasingly becoming the focus of metacognitive research in dementia and its precursor, Mild Cognitive Impairment (MCI) [3, 21]. In the past decade, there has also been increasing examination of the integrity of self-awareness in populations not typically characterized by profound disturbances in awareness such as Parkinson's disease [22, 23] and essential tremor [15], with evidence suggesting that elements of self-awareness may deteriorate in these conditions as well.

Course and Predictors of Self-Awareness in Dementia

When considering the entire disease spectrum from MCI to severe dementia, both cross-sectional [24, 25] and longitudinal research [26, 27•] conducted primarily in the context of AD has revealed that self-awareness degrades with advancing disease. On average, patients with MCI and mild AD have higher clinically rated awareness than those with moderate to severe AD [26, 28]. A longitudinal study examining individuals with incident dementia showed that, on average, awareness of memory functioning declined in the 2–3 years before dementia onset [26]. In a separate study wherein individuals with MCI and mild AD were followed for 24 months, increasing discrepancy scores between self-report and informant report regarding memory functioning were associated with declining global cognition over time [29]. Despite the overarching association between self-awareness and disease severity, it is important to note that at any given point along the continuum of MCI to moderate AD, considerable variability in awareness exists across individual patients. The prevalence of anosognosia, in mild AD, has been estimated to range from 21% on the low end [30] to 81% [31] on the high end, with similar variable rates reported in MCI [21, 32, 33]. Moreover, not all studies show an association between cognition and awareness over time [34–36]. In fact, a recent longitudinal study that followed individuals with mild AD for 36 months found that some individuals showed improved awareness despite cognitive decline, whereas in others, awareness remained stable or declined along with cognition [37].

Theoretical Models of Self-Awareness

The complexity and multidimensionality of self-awareness as a construct is evident in the various meta-cognitive models that have been proposed to explain how individuals maintain or lose awareness of their cognitive functioning. The Levels of

Awareness framework takes a biopsychosocial approach to conceptualizing awareness of a variety of symptoms or experiences (e.g., memory loss, pain, motor dysfunction) in various clinical disorders including dementia and by considering its social and environmental contributors. This model proposes that awareness consists of four levels of increasing complexity which may interact and are not necessarily hierarchical—(1) *registration* of sensory information (e.g., attending to stimuli on a memory test), (2) *monitoring* of specific task performance (e.g., detecting errors on a memory test), (3) *evaluative judgments* regarding cognitive abilities more broadly (e.g., appreciating level of memory functioning), and (4) *meta-representation* of the relevant construct at its broadest level (i.e., recognizing the presence of AD or understanding the implications of a specific diagnosis that one has been given) [38]. It has been proposed that each level of awareness may be uniquely influenced by *characteristics of the individual* (e.g., level of cognitive functioning, personality, attitudes and beliefs, motivation); *contextual*, *task-specific factors* (e.g., whether or not feedback is provided during a memory test that the individual is performing, for example, or whether the individual has had prior exposure to the task); and *broader environmental factors* (e.g., culture). An advantage of this model is that it is holistic in its appreciation of the entire phenomenon of human experience and how such experiences may influence the way people perceive and/or report disease symptoms.

Another popular model, the Cognitive Awareness Model (CAM), provides a neurocognitive explanation of unawareness, acknowledging the likely heterogeneous bases of awareness deficits [6, 39]. This modular model attempts to account for deficits at different stages of information processing, each of which would result in a particular type of awareness error. Briefly stated, the CAM posits that an *executive anosognosia* can arise when errors are either not detected or not perceived as affectively salient. Other researchers have also pointed to an important role for emotional dysregulation in producing unawareness as errors may require an affective signature to motivate self-monitoring [40, 41]. In the CAM, a *mnemonic anosognosia* can occur when there is a failure to update one's autobiographical knowledge regarding cognitive abilities in light of cognitive failures. Thus, the individual retains an outdated representation of the self's ability. The most recent revision of the model further suggests a distinction between explicit versus implicit information processing, leading to a potential dissociation between the conscious versus unconscious monitoring of cognitive failures, respectively. As such, one may have preserved the ability to detect cognitive failures, but due to a breakdown in the integration between explicit and implicit systems, the individual may not exhibit explicit awareness of such errors (referred to as a *primary anosognosia*). Such an individual may show preserved implicit monitoring wherein the person adjusts or adapts his everyday functioning to accommodate their cognitive deficiencies or demonstrates emotional reactions that suggest implicit monitoring of cognitive failures [39]. Overall, compared to the other models, the CAM provides a detailed explanation of how bottom-up processes such as impairments in specific meta-cognitive processes can influence awareness. Future work is needed to determine the extent to which the components and pathways of the model map onto known neuronal networks, and how top-down processes such as personality, beliefs, attitudes, and culture may influence or interact with the constructs in the model.

Although many of these models were developed to explain anosognosia within a particular condition (e.g., dementia or stroke) [6, 42], the models continue to evolve to better address meta-cognition as it applies more broadly across various clinical contexts and symptoms [39]. Future work should continue to test the assumptions and hypotheses of each model and examine the extent to which the models are equally applicable to different illnesses, or rather, specific to a clinical condition (e.g., unawareness of memory in AD versus unawareness of chorea in Huntington's disease). Moreover, additional work is needed to clarify the neuropathological signatures of disordered awareness and widen our examination of the factors that influence awareness by examining its sociocultural correlates.

Measuring Self Awareness: Clinical and Meta-Cognitive Approaches

As indicated above, knowledge about self-awareness in dementia derives from two broad lines of research, most easily categorized as clinical studies of anosognosia and experimental cognitive studies examining meta-cognition, although many recent studies have begun to combine these approaches. Anosognosia is popularly measured with clinical ratings of awareness along an ordinal scale or through the calculation of discrepancy scores between self-reports of symptoms and the reports of knowledgeable informants, both of whom rate the patient across a variety of cognitive and or functional abilities [2•, 17, 43•]. These measures of awareness are largely subjective (i.e., awareness is determined on the basis of another's subjective impression) and capture awareness in an *offline* fashion (i.e., awareness of functioning in general; not when engaged in a specific cognitive task). Clinical ratings of awareness, or anosognosia, have been shown to map onto clinically relevant behaviors including decision making, depression, dangerous behaviors, and caregiver burden [18, 28, 44, 45]. Insofar as there is an absence of well-standardized, normed, meta-cognitive tests to evaluate self-awareness, it may be advantageous to collect information from several collateral sources such as the clinicians and caregivers along with the patients' self-report [34]. In this way, heterogeneous, real-life aspects of functioning, not easily captured when meta-cognition is measured *online* (i.e., when actually performing

a specific cognitive task or related functional activity), can be gauged. However, drawbacks to using subjective measurements are that caregivers and clinicians may over or underestimate a patient's abilities secondary to caregiver burden, potential reporting biases, or limited interaction with the individual [38].

In meta-cognitive research, as alluded to earlier, aspects of self-awareness in dementia are operationalized in a highly objective manner [1, 7, 14, 46–50]. These studies employ a variety of different techniques, a full discussion of which is beyond the scope of this review (for a more in-depth review of these techniques, see [2•, 43•]). In essence, however, patients are asked to make online estimations of their performance (i.e., estimate on an ordinal rating scale how well they think they performed immediately prior to and/or following a specific task), and these estimations are compared directly with objective performance on corresponding cognitive measures. Some investigators have adopted traditional experimental meta-cognitive tasks such as Judgment of Learning (JOL) and Feeling of Knowing (FOK) that measure an individual's predictions about whether he or she will recall (JOL) or recognize (FOK) particular to-be-remembered stimuli. Please see Table 1 for an explanation of FOK, JOL, and other frequently used methods to examine aspects of self-awareness. Although these tasks measure similar constructs, they rely on different types of judgments that are likely to be influenced by different factors (e.g., [51]).

The utility of meta-cognitive task frameworks such as JOL and FOK is that they enable the calculation of numerous *objective*, continuous meta-cognitive scores. These scores can be calculated at either an item level (i.e., what are the individual's expectations for performance on specific test items) or a global level (i.e., what are the individual's expectations for performance on a test overall). Item-level meta-cognition can be measured in terms of both relative accuracy (i.e., resolution) and absolute accuracy (i.e., calibration). Relative accuracy reflects the extent to which individuals are able to accurately adjust their predictions for cognitive performance on each item in line with actual changes in their cognitive performance and is typically operationalized with a rank order *correlation* such as the gamma statistic examining the association between predictions and cognitive performance [52]. A deficit in relative accuracy shows that an individual's expectations for performance deviate from their actual performance, but information about the direction of deviation is not provided.

Absolute accuracy (i.e., calibration), like relative accuracy (i.e., resolution), can also be measured throughout the test at the individual-item level (either before or after performance on the item) and reveals the directionality of a meta-cognitive deficit. In this context, absolute accuracy reveals whether an individual is over or under confident in their predictions (or post-dictions) for item-level performance. It is generally operationalized as the *discrepancy* between predictions and performance, with negative scores (significantly different from zero) reflecting under-confidence and positive scores (significantly different from zero) reflecting over confidence.

An individual can have perfect absolute accuracy (i.e., be neither under nor over confident) but have very poor relative accuracy, and vice versa. For example, on a hypothetical two-item test, an individual might predict that he or she will get the first answer right and the second answer wrong, that is, that he or she will get half of the items right. However, he or she may get the first answer wrong and the second one right, exhibiting, in terms of relative accuracy, the opposite pattern of accuracy on testing as compared to prediction. In this case, while absolute accuracy is perfect, the relative accuracy is very poor, indeed. To our knowledge, there is no existing work that directly addresses the extent to which these meta-cognitive abilities are dissociated in patient populations, or whether the clinical implications of impaired meta-cognition (discussed later in this chapter) differ according to the specific type of deficit.

However, emerging work is suggesting that absolute and relative accuracy may rely differentially on separate neuroanatomical structures [53]. Specifically, a recent study from our lab in cognitively diverse older adults, including those with AD, demonstrated that absolute accuracy on a meta-memory test was associated with cortical thickness of midline structures including the right medial prefrontal cortex and the right precuneus. Resolution was unrelated to the thickness of any of these identified regions of interest. In contrast, previous work from our lab documented an association between relative accuracy in this same sample and the volume of the right insula. Future work is needed to more clearly define how these processes tap into different meta-cognitive abilities and neurocognitive substrates, and whether each type of deficit may have different clinical or diagnostic implications.

Meta-cognition can also be measured at a global level to examine confidence regarding one's performance *as a whole* (e.g., How many of these ten words do you think you will remember?) Indeed, many researchers in the field of neuropsychology have applied this type of global measurement outside of traditional meta-cognitive paradigms, taking somewhat of a hybrid approach to assessing self-awareness. In these studies, researchers typically administer a global self-rating scale prior to and/or following standard clinical neuropsychological tests (i.e., asking subjects to estimate their performance on a neuropsychological task using a percentile ranking, or to mark their level of confidence in their performance on a visual scale [47, 48]). In this context, meta-cognition is operationalized as a discrepancy score that compares online self-estimations to actual performance and is used to assess the degree to which an individual or patient group on average is under confident or overconfident in their cognitive performance.

Table 1 Meta-cognitive measurement frameworks

Gold standard	Nature of self-assessment	Measurement	Description	Task examples
Subjective impression	Offline	Clinical rating	Clinician's rating of awareness based on interview	Please tell me about your memory abilities [55]
		Informant-based discrepancy score	Discrepancy between self and informant ratings	30-item rating scale covering various memory abilities [55]
Objective performance	Online	Global Judgment of Learning	Predicted likelihood that an entire list of words will be recalled	Subject is taught 20 word pair associates and asked how many he or she will be able to recall
		Item-based Judgments of Learning (JOL)	Predicted likelihood that particular items will be recalled	Subject is taught 20 word pair associates and asked on an item-by-item basis to judge the likelihood of later *recalling* each target word when presented with its cue
		Feeling of Knowing (FOK)	Predicted likelihood that specific information will be recognized (usually non-recallable information)	Subject is taught 20 word pair associates and for items that are non-recalled at test, asked on an item-by-item basis to judge the likelihood of *recognizing* the target (i.e., knowing it when they see it)
		Retrospective confidence; Feeling of Confidence (FOC); Judgment of Confidence (JOC)	Estimation of confidence in the accuracy of an item-level response (can also be measured at a global level in regard to total test performance)	Subject is taught 20 word pair associates and after testing, asked on an item-by-item basis to judge the likelihood that each response they provided was accurate
	Online or offline	Self-rating vs. performance on neuropsychological tests	Discrepancy between self-rating and objective performance	Subject is asked online to estimate their performance on a neuropsychological test; OR subjects are asked offline about their abilities in certain cognitive domains and these ratings are compared to test performance

Summary of Findings: Self-awareness and Meta-Cognitive Accuracy in AD and bvFTD

A growing number of studies are using the above meta-cognitive paradigms to more clearly characterize and quantify the precise nature of awareness deficits in individuals with neurodegenerative disease. In this section, we integrate results of select studies conducted in the past 5 years that have propelled our understanding of self-awareness in dementia, and we suggest potentially fruitful directions for building upon these studies. In general, when studied at a group level, both patients with AD and those with FTD (primarily bvFTD) display impaired meta-memory (i.e., awareness of memory abilities) when asked to make either global or item-level predictions about their ability to remember newly learned (i.e., episodic) information [1, 14, 46, 54]. Studies using both clinical and meta-cognitive approaches suggest that this inaccuracy derives primarily from a tendency to overestimate their memory functioning. Individuals with AD have been shown to overestimate their memory in both online (i.e., while performing a memory task) [55] and offline contexts (i.e., when asked to estimate abilities in general) [17, 43•]. Analogously, FTD patients tend to overestimate aspects of executive and social-emotional functioning (e.g., cognitive flexibility and empathy) when measured against informant report [49, 56] and to overestimate performance on measures of memory and language [47, 48]. Consistent with the clinical syndromes of FTD, overestimation in this group is driven primarily by individuals with bvFTD as compared to primary progressive aphasia patients [49].

When compared against each other, and, across studies, bvFTD patients tend to show more severe meta-cognitive impairments than AD patients [46, 48, 50, 57] consistent with the historical idea that the PFC plays a critical role in self-awareness [41, 58]. As an example, Rosen and colleagues (2014) have shown that as compared to AD patients and controls, bvFTD patients are particularly impaired in adjusting their predictions for future memory performance based on examiner feedback about their prior performance. In that study, participants were provided with feedback regarding their overall performance on a memory task and then asked to make a prediction for a similar upcoming task (e.g., "You correctly remembered 10 of the 20 word pairs. If I gave you a similar list of 20 word pairs to remember, how many do you think you would remember?"). On average, AD patients were better able to make use of global feedback when making predictions for a hypothetical but similar memory test.

This disproportionate level of meta-cognitive deficit in FTD is consistent with the seemingly universal deficit in self-monitoring observed at a clinical level in bvFTD patients as compared to AD patients. While self-awareness (i.e., degree of anosognosia) is quite variable in early AD, bvFTD patients generally display a lack of emotional concern over their deficits or about their diagnosis, and its associated consequences (sometimes referred to as "frontal anosodiaphoria") [44]. The characteristics of the AD patients in each study, specifically, the extent to which individuals with anosognosia are included, likely impact average meta-cognitive differences seen across groups. Indeed, dissociations in meta-cognition certainly appear to exist as a function of anosognosia across FTD subtypes (e.g., bvFTD versus PPA; [50]) as well as within AD [5, 59]. It would be informative for future studies comparing FTD and AD, or other clinical populations, to consider clinical levels of self-awareness, or anosognosia. For example, comparing bvFTD patients against AD patients with anosognosia will allow a direct characterization of potential differences in the nature, etiology, and consequences of meta-cognitive disturbances in different clinical conditions.

In this vein, our lab has taken the approach of characterizing meta-memory in individuals with AD who have anosognosia (a deficit in self-awareness by clinical standards), rather than combining such participants with those who have preserved self-awareness, potentially diluting our understanding of the kind of meta-cognitive impairment that occurs in AD. For example, a recent study in our lab examined the extent to which individuals with AD who are unaware of their memory loss (i.e., who have anosognosia) exhibit specific meta-cognitive disturbances outlined by the CAM, including the following:

1. *Executive disturbance*: difficulty detecting memory or other cognitive errors
2. *Mnemonic disturbance*: difficulty integrating memory or other cognitive errors
3. *Primary disturbance*: difficulty accessing such errors in conscious awareness

The overall pattern of performance in the unaware group appeared most consistent with a primary anosognosia in which memory errors are not available in explicit awareness [59]. Individuals did not improve the accuracy of their self-estimations when allowed to rate their memory performance after test (which would have been consistent with a mnemonic disturbance), nor did they improve their meta-cognitive accuracy when provided with examiner feedback (which would have been consistent with an executive disturbance). However, additional work is needed to distinguish whether or not the key deficit was in the conscious perception of errors or perhaps that memory errors lost their affective signature and thus did not have the appropriate level of influence on self-estimations. In addition, in line with the levels of awareness framework (Clare 2011), the contributing role of other factors such as personality characteristics and mood to self-awareness should also be considered. Clearly delineating the meta-cognitive errors that give rise to the clinical symptom of anosognosia, as well as determining the relative contributions of other person-specific characteristics (e.g., mood and personality) to level of self-awareness, will enable the development of tailored interventions to preserve self-awareness at the earliest end of the disease spectrum and extend a patient's independence for as long as possible.

When the study of self-awareness is expanded to other neurodegenerative disorders, interesting findings, some parallel to those seen in AD, are emerging. For example, in PD patients, it has been recently shown that self-ratings of executive functioning, particularly in those with executive dysfunction, were higher and less accurate than informant ratings [16]. Similar to AD and FTD patients, those with PD irrespective of the presence of global cognitive impairment have impaired meta-memory for episodic information [22, 23, 60]. Clearly, more studies are needed to elucidate the nature of deficits in other clinical populations such as PD and ET.

Neuroanatomic Substrates of Self-Awareness

Given the presence of impaired self-awareness across several clinical groups, it is not surprising that recent structural and functional neuroimaging studies of self-awareness deficits have implicated multiple cortical networks and substrates spanning prefrontal, temporal, and parietal regions [3, 61–65]. Midline and subcortical networks including the frontal gyri; the insular and cingulate cortices; and components of the limbic system, thalamus, and basal ganglia (putamen and caudate), have been implicated in supporting awareness [13•, 62, 66]. It has thus been proposed that a broad, heterogeneous network compromising temporo-parietal-frontal networks may be involved in meta-cognition [62]. However, recent evidence points to a particularly important role for the right insula in supporting memory awareness in a cognitively diverse group of older adults (91% right handed) including those with AD [13•, 67]. The right insula has previously been implicated in the conscious detection of errors and as a structure that is critical in re-representing aspects of experience ranging from primary interoceptive functions such as heart rate and temperature to higher level cognitive and emotional experience [68–70]. From a broad perspective, the right-sided laterality of the association between the insula and meta-memory is consistent with naturalistic lesion-based studies (e.g., those examining anosognosia for hemiplegia) and imaging studies in AD, FTD, and other dementia samples that have highlighted the differential contribution of right hemisphere regions to self-awareness [3, 13•, 62].

Implications for Studying Self-Awareness

In older adults, especially those with cognitive impairments, the ability to make healthy and safe, real-life decisions is heavily influenced by aspects of self-awareness. The knowledge or awareness that one is having memory problems serves as a cue for a patient to adopt compensatory strategies such as making notes, using a planner or a memory app, or seeking assistance from others with certain tasks [5]. Conversely, individuals who are unaware of their cognitive deficits are vulnerable to making decisions that may endanger themselves and their caregivers, both physically (e.g., leaving the stove on, driving unsafely) and financially (e.g., falling victim to scams) [45, 71]. Indeed, one study found that individuals with mild AD who had reduced awareness of their memory abilities were less likely to implement compensatory strategies for managing their medications [18]. Another study found that, per caregiver report, about 23% of AD individuals who had reduced self-awareness exhibited dangerous behaviors including those involving potential physical harm as opposed to only 8–9% of individuals with preserved self-awareness [45]. Similarly, the relatively few studies that have examined self-awareness in relation to cognition, emotional functioning and functional restrictions in other clinical populations have found that higher self-awareness is related to better outcomes such as return to work [72]. Finally, level of self-awareness has multiple implications for treatment and rehabilitation. In cognitive or behavioral rehabilitation settings, unawareness of deficits can lead individuals to set unrealistic activity goals and select maladaptive or inappropriate strategies [73]. Conversely, higher levels of self-awareness can enhance rehabilitation outcomes including independent daily functioning, social functioning, and safety adherence [74, 75]. Although not well known in research concerned with dementia, a link between self-awareness and poor rehabilitation and functional outcomes has been established in patients with stroke wherein those with right hemisphere lesions—often associated with self-awareness deficits—are known to have worse outcomes as compared to those with left hemisphere lesions [76]. For example, a recent study found that, in a group of right-hemispheric stroke patients, awareness of cognitive deficits was one of the most critical predictors of deficits in everyday activities such as counting money, copying an address, or filling out a form [77]. From a broader perspective, special care in treatment and rehabilitation efforts must be taken early for people with self-awareness deficits. Some of these may include being extra vigilant when taking self-reports from the patient in a clinic, increasing the level of surveillance when the individual is living alone, and encouraging the individual to assign a healthcare proxy, developing a living will, and making end-of-life decisions early in the disease process. In terms of intervention strategies for enhancing the safety and overall quality of life of patients with neurodegenerative disorders, clinicians may benefit from gathering information from several collateral sources and utilizing an individualized approach to manage the impact of awareness deficits on specific activities such as meal preparation or transportation.

Conclusions and Future Directions

In summary, deficits in self-awareness are common in dementia and have the potential to harm or disrupt everyday functioning. Future work integrating both clinical and metacognitive perspectives have the potential to advance understanding of the etiology, nature, and consequences of disordered self-awareness in dementia. Such research is needed to address unanswered questions such as genetic variables place individuals at risk for impairment in aspects of self-awareness, whether or not self-awareness influences presentation to the clinic in the earliest stages of disease, and whether or not self-awareness influences the many high-level decisions that patients make on a day to day basis with regard to cooking, shopping, transportation, financial management, and money management. Considering the tremendous implications from both the clinician's and patient's perspectives, the significance of studying and understanding disordered self-awareness cannot be overstated, particularly as the field moves toward identifying individuals in a pre-clinical disease state when independent functioning and decision making are preserved and when strategies to bolster self-awareness may have the greatest impact.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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