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**CRITICAL REVIEW**

# Metacognitive theory and assessment in dementia: Do we recognize our areas of weakness?

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**Abstract**

Anosognosia, disordered awareness of cognitive and behavioral deficits, is a striking and common symptom of Alzheimer's disease (AD), yet its etiology, clinical correlates, and prognostic value are unclear. Historically, disordered awareness has been a conceptually challenging phenomenon, evidenced by the numerous and diverse theories that aim to explain the manner in which this syndrome arises. We review many of these theories, focusing on the neuroanatomic substrates of awareness, and highlighting the potential roles of critical regions such as the right prefrontal and parietal cortices in enabling self-awareness. We then address methodological limitations such as use of subjective measurement tools that likely contribute to the conceptual ambiguity surrounding anosognosia. We argue that metacognitive techniques used in healthy adults, such as the *Feeling of Knowing* task, offer models for dissecting awareness into clear and identifiable cognitive components in patients with AD. We critique several studies that have pioneered such tasks in AD, and offer guidelines for future implementation of such methods. A final goal of this review is to advocate for a multidimensional approach to studying metacognitive skills that will facilitate the objective investigation of deficit awareness as it relates to a variety of disease variables such as prognosis, neuropsychological profile, neuropathological distribution, psychiatric symptoms, and clinical course. (*JINS*, 2005, *11*, 910–919.)

**Keywords:** Metacognition, Anosognosia, Dementia, Insight, Awareness, Alzheimer's disease

## INTRODUCTION

Few neuropsychological deficits are as intriguing or perplexing as *anosognosia*, that is, unawareness of cognitive or functional impairment. While certain manifestations of anosognosia such as Anton's syndrome, hemispatial neglect, and Wernicke's aphasia are somewhat rare, disordered awareness is a marked and relatively common symptom of Alzheimer's disease (AD) (Neary et al., 1986; Reed et al., 1993; Smith et al., 2000). Depending on the precise criteria applied and the severity of the group under study, as many as 81% of patients with AD have been reported to display anosognosia (Reed et al., 1993). In fact, a recent study showed that 60% of patients with isolated memory impairment sufficient for a diagnosis of Mild Cognitive Impairment (MCI), a condition believed to herald the onset of AD, also showed poor awareness of their memory impairment (Vogel et al., 2004). This figure is particularly concerning given that the diagnosis of MCI also requires subjective memory complaint (Petersen, 2004).

The practical relevance of anosognosia is apparent. It challenges early identification and diagnosis of AD, threatens treatment compliance, poses a safety risk to patients (Cotrell & Wild, 1999), and increases caregiver burden (DeBettignies et al., 1990). However, many questions remain regarding anosognosia's etiology, correlates, and relevance for disease course (Kaszniak & Zak, 1996; McGlynn & Schacter, 1989; Pia et al., 2004; Schacter, 1990; Vuilleumier, 2004). Tto answer these questions, it is first necessary to appreciate the complexity of this syndrome and its rich theo-

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retical history. Second, it is crucial to evaluate the usefulness of traditional assessment tools in characterizing components of anosognosia.

We target the above theoretical and methodological issues in this review, and propose techniques for advancing conceptualization and assessment of anosognosia in AD. Specifically, we argue for the development of methods that will elucidate the cognitive components of awareness. Tasks used frequently by cognitive psychologists in the study of *metacognition*, knowledge of one's own cognitive abilities (Brown, 1978; Flavell & Wellman, 1977; Metcalfe & Shimamura, 1994), offer ideal models for task development. Ultimately, modified versions of such tasks may clarify the relationship between specific elements of awareness, and their relationship to disease variables such as prognosis, neuropsychological profile, neuropathologic distribution, psychiatric symptoms, and clinical course.

## Anosognosia

More than a century of research has sought to uncover the neurobiology of anosognosia. Many theories are briefly reviewed herein; however, we refer readers to several seminal works for in depth discussion of such theories (Critchley, 1953; Heilman, 1991; McGlynn & Schacter, 1989; Prigatano & Schacter, 1991; Schacter, 1990; Vuilleumier, 2000, 2004). Von Monakow first described unawareness of deficit due to brain lesion (von Monakow, 1885), and Babinski later introduced the term *anosognosia* to describe unawareness of hemiplegia (Babinski, 1914). Anosognosia has since been recognized as a broad spectrum of disordered awareness associated with a variety of clinical syndromes (Bisiach et al., 1986), and the term is now used more generally to describe unawareness of impairment associated with any neurologic compromise (Loring, 1999). Herein, we apply the terms *anosognosia* and *disordered awareness* synonymously. Several other phrases are frequently used to describe this syndrome, such as "denial of deficit" and "poor insight," but we refrain from using those, as they less clearly convey the syndrome's neurologic nature.

Although we focus here on neurologically based accounts of anosognosia, a variety of other theories exist. For example, several researchers have advocated motivational theories of anosognosia based on observations that patients who explicitly deny deficits generally had premorbid tendencies to regard illness as an imperfection, deny perceived inadequacies, and seek the esteem of others (Ullman et al., 1960; Weinstein & Kahn, 1955; Weinstein & Kahn, 1953). We also know that sociocultural factors such as minimization of distress contribute to individuals' perceptions of illness (Saravanan et al., 2004; Sussman, 2004; White et al., 2000). Although the role of these psychological and cultural variables cannot be dismissed, such factors cannot account for repeated neuroanatomic evidence linking anosognosia to specific neurologic syndromes and cortical regions such as the right prefrontal and parietal cortices (Heilman, 1991; Vuilleumier, 2004).

## Neuroanatomic Perspectives

Neurologic accounts of anosognosia evolved largely in the context of unawareness for hemiplegia. Although severity of primary sensory loss was initially thought to be a primary factor driving unawareness of motor deficit, growing evidence suggested that awareness level and injury severity were frequently dissociated (Cutting, 1978). As such, researchers began to conceptualize anosognosia as a deficit in the higher order processing of a specific skill. For example, the *discovery theory* posits that direct personal experience with the deficit *plus* a specific type of mental flexibility may be needed to recognize impairment, and to adjust behavior based on this experience (Levine, 1990; Levine et al., 1991). That is, individuals must discover loss through observation, or infer loss through indirect means. There may be many means by which this discovery is disrupted; indeed, different neurologic injuries appear to alter phenomenological experience in unique ways, and consequently distort different aspects of self-awareness.

Centuries of work on brain injury and stroke have underscored the role of the right parietal cortex in supporting various aspects of self-awareness, particularly awareness for left hemiplegia (Bisiach et al., 1986; Heilman, 1991; Marcel et al., 2004; Meador et al., 2000; Rainville et al., 2003). Given its association with right parietal damage, anosognosia has been theorized to reflect a number of different abnormalities including a disordered body schema (Critchley, 1953; Head & Holmes, 1911), a severe disturbance in attention to the body (Mark et al., 1988), and a disconnection syndrome preventing information from reaching speech centers in the left hemisphere (Geschwind, 1965). While persuasive, such hypotheses were unable to explain why patients frequently remained unaware of hemiplegia even when the paralyzed left arm was brought into the right visual field and patients were asked specifically to attend to the left arm (Heilman, 1991; Heilman et al., 1993; Ramachandran, 1995).

Conceptualizing anosognosia grows even more complex when taking into consideration the large body of research in patients with traumatic brain injury (Stuss et al., 1992), stroke (Feinberg, 2001; Feinberg et al., 1999), schizophrenia (Koren et al., 2004), and frontotemporal dementia (FTD; Grossman, 2000) that highlights the prefrontal cortex as a second neurologic area relevant to personal and social awareness. Interestingly, prominent behavioral disturbances in FTD (Miller et al., 1993) and "disorders of the self" such as delusional misidentification and reduplication syndromes (Feinberg, 2001; Feinberg et al., 1999) have been associated particularly with right rather than left prefrontal compromise. Further, while a thorough discussion of functional neuroimaging studies in healthy adults is beyond the scope of this review, we point out that such studies implicate the right prefrontal cortex as a critical region underlying aspects of self-awareness, such as recognizing one's own face (Platek et al., 2004) and making judgments about one's own memory abilities (Kikyo et al., 2002; Platek et al., 2004; Schnyer et al., 2004).

It is clear that both anterior and posterior portions of the right hemisphere support important aspects of self-awareness, and anosognosia is often seen with injuries spanning the right parietal and frontal lobes (Venneri & Shanks, 2004). In trying to tease apart the role of various cortical areas, Prigatano (Prigatano, 1991) articulately argued that self-awareness is unlikely to be a function of a specific cortical area. Extending Mesalum's (1985) suggestion that the cerebral cortex can be best understood in terms of the type of stimuli to which it responds, Prigatano proposed that various cortical areas likely support awareness for different types of information such that "if one is exploring self-awareness about social judgment, the ability to anticipate change, and so on, the prefrontal regions may be important. In contrast, self-awareness of body and body image may be more influenced by the inferior parietal lobe" (p. 121).

One possible explanation for the importance of the right hemisphere in both prefrontal and parietal syndromes of disordered awareness is that this hemisphere plays a critical role in affective functioning. Emotion has been hypothesized to activate the cognitive appraisal needed to adjust behavior and beliefs according to novel contingencies (Tiedens & Linton, 2001b). To the extent that emotional feedback is disturbed, an individual may not engage in normal verification procedures when confronted with a cognitive or behavioral deficit (Vuilleumier, 2000). Indeed, several studies cite apathy as the main correlate of anosognosia (Derouesne et al., 1999; Ott et al., 1996; Starkstein et al., 1996; Tiedens & Linton, 2001a; Vogel et al., 2004). This conceptualization is reminiscent of Babinski's (1914) and Critchley's (1953) descriptions of *anosodiaphoria*, lack of concern for hemiplegia, as a more mild manifestation of anosognosia.

It is not clear whether anosognosia in AD is associated with specific cortical changes in the right hemisphere, or whether disordered awareness results from global cortical deterioration. However, striking dissociations in awareness across patients with mild AD suggest that disordered awareness may indeed result from early compromise to a critical brain region or network. In fact, anosognosia in AD has been linked to right hemisphere abnormalities such as reduced perfusion in the right prefrontal cortex (Reed et al., 1993; Starkstein et al., 1995; Vogel et al., 2005) and increased plaque density in the right prosubiculum region of the hippocampus (Marshall et al., 2004). It will be important to further investigate the potential roles of the anterior and posterior regions of the right hemisphere in supporting processes of awareness as measurement of such processes becomes more objective.

The issue of measurement is highly critical to the discussion of anosognosia in AD. As will be detailed below, most of the research regarding the nature, etiology, and correlates of anosognosia in AD has been plagued by inconsistent findings. Discrepant findings certainly reflect the complex nature of anosognosia, but we suggest that methodological limitations are also to blame. Reconsideration of traditional assessment tools may facilitate investigation of anosognosia, and lead to more precise and consistent answers across studies.

## Assessing Awareness in Alzheimer's Disease: Methodological Limitations

Nearly 15 years ago, emerging work suggested that some patients with dementia denied their deficit, although it was unclear to what extent such denial was motivationally based (McGlynn & Schacter, 1989). At that time, McGlynn and Schacter (1989) wrote the first integrative review of unawareness of deficit in dementia and other neuropsychological syndromes, criticizing studies for their "lack of conceptual clarity concerning anosognosia" (p. 154) and arguing that "much more attention needs to be paid to defining concepts operationally and devising systematic measurement techniques" (p. 145). In particular, the authors urged researchers to quantify the assessment of anosognosia and to consider this phenomenon as a spectrum rather than a unitary disorder.

Assessment of anosognosia became increasingly quantitative throughout the 1990s with implementation of clinician rating scales (Derouesne et al., 1999; McDaniel, 1995; Reed et al., 1993; Zanetti et al., 1999) and discrepancy scores between patient and caregiver report of patient functioning (DeBettignies et al., 1990; Derouesne et al., 1999; Kotler-Cope & Camp, 1995; Mangone et al., 1991; Michon et al., 1994; Smith et al., 2000). The *Anosognosia Rating Scale* (Reed et al., 1993) is an example of a rating scale consisting of two initial interviews by a neurologist and psychologist who determine the patient's level of functioning. The patient's level of awareness is rated on a four-point ordinal scale covering: ready admission of memory loss, shallow awareness (inconsistent recognition, or recognition of trivial loss), no awareness (bland denial), and angry denial of impairment. Such categorical ratings are certainly valuable in that they provide a broad picture of the patient's awareness level. However, the spectrum of disordered awareness represented by such scales is significantly restricted in range preventing appreciation of more finely graded levels of awareness.

Calculation of discrepancy scores between patient and caregiver report of patient functioning have also been used to quantify anosognosia. Such scales have been informative in that they directly reflect patients' perceptions of their abilities. However, it is not clear that comparing this report with that of a caregiver accurately portrays patient awareness. Even though patients may endorse significant dysfunction, he or she would be characterized as having poor awareness if the caregiver reports a far higher level of dysfunction. Further, it is far from clear that caregiver report is an unbiased standard of accuracy.

Traditional methodologies such as rating scales and discrepancy scores are also less than ideal in that they generally assess awareness as a unitary phenomenon when in fact it may be multi-faceted. That is, patients may display varying degrees and forms of awareness for specific abilities and/or deficits. Starkstein and colleagues (1996) dissociated elements of cognitive and behavioral unawareness in AD, showing that cognitive unawareness was associated with more severe intellectual decline, higher frequency of delusions, more severe apathy, and less depression, while behavioral unawareness was related to higher disinhibition scores and pathological laughing. It is possible that anosognosia can be deconstructed into even more precise components; however, assessment tools must first be designed to capture these components.

Given the limitations of traditional methodologies, and the variable operational definitions of anosognosia used across studies, it is not surprising that findings regarding awareness in AD have been ambiguous (Derouesne et al., 1999; Duke et al., 2002). For example, although some investigations have demonstrated a positive correlation between dementia severity and anosognosia (Barrett et al., 2005; Feher et al., 1994; Lopez et al., 1994; Mangone et al., 1991; Migliorelli et al., 1995a, 1995b; Sevush & Leve, 1993; Starkstein et al., 1996), several studies fail to support this finding (DeBettignies et al., 1990; Michon et al., 1994; Reed et al., 1993; Smith et al., 2000; Zanetti et al., 1999). It appears most likely that anosognosia progresses in severity over the course of the disease in all patients; however, the time at which awareness becomes disrupted varies significantly across individuals. It has been hypothesized that disordered awareness is greater in patients with executive dysfunction (Fernandez-Duque et al., 2000; Lopez et al., 1994; Michon et al., 1994; Reed et al., 1993; Shimamura, 2000; Vilkki et al., 1998); however, this association has not been consistently observed (Dalla Barba et al., 1995; Starkstein et al., 1996; Vogel et al., 2004). Further, there has been no strong consensus for the hypothesized relationship between anosognosia and psychiatric symptoms such as depression and psychosis in AD (Reed et al., 1993; Sevush & Leve, 1993; Smith et al., 2000; Starkstein et al., 1997; Verhey et al., 1993).

It is very possible that studies have produced inconsistent results given the wide variety of subjective methodologies implemented to study anosognosia in AD. We suggest that implementing objective measures of awareness may overcome the limitations of traditional methodologies, and offer consistent metrics to be used across studies. Once this has been accomplished, researchers may begin to uncover the relationship of specific components of anosognosia to disease variables such as prognosis, neuropsychological profile, disease duration, patterns of neuropathology, and the presence of psychiatric symptoms.

## Judgment of Learning and Feeling of Knowing Tasks

Nearly 10 years ago, Kaszniak and Zak (1996) encouraged dementia researchers to employ established metacognitive assessments such as *feeling of knowing* and *judgment of learning* tasks used extensively in healthy adults. Metacognitive assessment focuses on uncovering the mechanisms by which individuals "know what they know," and is characterized by multiple objective techniques that have the potential to inform the study of awareness in AD (Hart, 1965; Leonesio & Nelson, 1990; Metcalfe & Shimamura, 1994; Nelson & Narens, 1990; Nelson & Narens, 1980, 1984; Schacter, 1983; Shimamura & Squire, 1986). While the term *metamemory* is generally used to refer specifically to people's knowledge about their memory abilities and may be especially appropriate for discussing deficits in AD (Metcalfe & Shimamura, 1994), we use *metacognition* as a more general term throughout this paper to cover knowledge regarding a wider range of cognitive skills.

To a large extent, metacognitive studies have investigated the nature of two complementary processes, *monitoring* and *control*, each of which serves a specific regulatory function (Nelson & Narens, 1990). *Monitoring* refers to the mechanism by which individuals evaluate the correctness of potential responses. This process is based on a collection of information about one's own knowledge and performance, and involves the flow of information from the object level to the metalevel (Shimamura, 2000). *Control* refers to the self-regulation of behavior, such as the allocation of study time, the initiation of certain cognitive strategies, and the decision to volunteer the best available candidate answer (Klatzky & Erdelyi, 1985).

In advancing the study of anosognosia in AD, we find monitoring processes of particular interest to the extent that they reflect patients' abilities to judge their own cognitive abilities, or more specifically, to recognize their memory deficit. Two commonly used methods of evaluating monitoring processes are *Judgment of Learning* (JOL) and *Feeling of Knowing* (FOK) tasks (Metcalfe & Shimamura, 1994). These tasks are presented in conjunction with memory tests in an attempt to assess individuals' beliefs about how readily they will learn, remember, or recognize information. JOL tasks require subjects to predict, at the time information is being studied, the likelihood of subsequently recalling recently studied items (Nelson & Narens, 1990). Alternatively, FOK tasks involve making judgments, after the recall phase of a memory task, about the likelihood of subsequently recognizing nonrecalled semantic information (Hart, 1965) or episodic information (Schacter, 1983). Monitoring accuracy is then determined on an item-by-item basis, by correlating individual judgments and memory scores. Significant evidence suggests that both JOL and FOK ratings reliably predict memory performance in healthy individuals (Hart, 1965; Leonesio & Nelson, 1990; Nelson et al., 1984). Notably, however, these ratings pertain to two qualitatively different memory functions (free recall and recognition), and are only weakly correlated with one other (Leonesio & Nelson, 1990; Souchay et al., 2004).

## Modifying JOL and FOK Tasks for Use in Alzheimer's Disease

A handful of innovative studies over the past two decades have applied JOL, FOK, and other objective metacognitive methodologies to studies in AD. In the following section, we review several of such studies, highlighting potential pitfalls and advising researchers to consider a number of issues in future investigations including: (1) How does the timing of the metacognitive judgment affect results?; (2) Is the metacognitive task clearly and consistently defined, and dissociated from the primary cognitive task?; (3) Is the metacognitive rating scale feasible for patients with cognitive impairment?; and (4) Does the primary cognitive task allow for a range of metacognitive judgments?

## 1. TIMING THE METACOGNITIVE JUDGMENT

The relevance of the metacognitive judgment is determined in part by the time at which the judgment is acquired. Consequently, the research question should dictate timing of the judgment. For example, preestimates of performance on an upcoming memory task are generally suited to assessing an individual's level of sustained awareness (general knowledge) of his or her memory functioning. However, if subjects are unsure of upcoming task demands, they may have difficulty generating predictions. As such, it is important to expose subjects to several practice items prior to requesting a preestimate of performance. Post-task estimates are more likely to reflect subjects' on-line processing of memory functioning, and may better capture subjects' ability to appreciate memory failure when confronted with poor performance.

Studies have found that subjects with AD make different estimations of their abilities at pre- and post-task intervals (Barrett et al., 2005; Duke et al., 2002), and that this may vary by cognitive domain (Barrett et al., 2005). Duke and colleagues (2002) provided subjects with normative data to use in estimating their performance (e.g., "The average person of your age remembers 7 words. How many of the 12 words do you think you will remember?") While subjects overestimated their performance prior to the first learning trial, they effectively updated their post-trial estimates based on actual performance. However, after a 20-minute delay, subjects once again overpredicted their performance, suggesting that they had been unable to permanently update their beliefs about their own memory based on poor task performance. This study illustrates the difference between temporary and sustained awareness of deficit, a distinction that is critical to appreciate when exploring deficit awareness in clinical populations with severe memory loss. It would be inappropriate to conclude that patients with severe memory loss are aware of such deficits over time based on accurate metacognitive judgments made at the time of task performance.

## 2. DEFINING THE METACOGNITIVE SKILL

To conceptualize and measure metacognition in AD effectively, the metacognitive skill of interest must be clearly defined. Moulin and colleagues (2000a) were among the first to pioneer metacognitive tasks in patients with AD, and consequently encountered several methodological obstacles related to defining the metacognitive skill of interest. The authors used a JOL task that required subjects to rate "how easy the word was to *remember*" on a five-point scale ranging from "very hard" to "very easy". Unlike healthy controls, the AD group did not rate words as easier to remember as a function of increased repetition. In their conclusions, the authors state that patients' explicit "rating of how well they have *learned* the item is insensitive to repetition", and that while "their explicit memory performance and their study time are affected by repetition of items, the AD patients do not appear to be aware of this when they judge how likely it is that they will *recall* an item" (p. 754). In drawing these various conclusions, the authors use the terms *learn, remember*, and *recall* synonymously. Although these abilities are similar, it is possible that subjects would have made different judgments about their ability to perform each skill. A related issue is that "remembering" is an ambiguous term as it might entail either recall or recognition processes. A solution to these semantic hurdles is to obtain an unambiguous judgment from the subject (e.g., how easy will it be to recall this word in 10 minutes), and to make interpretations based solely on the metacognitive judgment required of the subject (e.g., subjects' predictions regarding their recall abilities were less accurate than those of normal controls).

In defining the metacognitive skill of interest, it is also important to dissociate the metacognitive skill from the primary cognitive demands of the task. This distinction is not necessarily easy to make in clinical populations, as can be seen in a second original study of metacognitive processes operating at the encoding stage of a verbal list-learning task in patients with AD (Moulin et al., 2000a). The authors undertook this study in part to explore "why patients with AD do not benefit from repetition" of words across a list learning task in the same manner that healthy subjects do, hypothesizing that "a lack of *awareness of repetition* may exacerbate the episodic memory impairment found in AD" (p. 748). While the author's made an innovative attempt to isolate the relevant metacognitive processes at encoding, they unfortunately confounded their study of memory and metacognitive processes. That is, *unawareness of repetition* is not dissociable from *impaired memory* for repetition in patients with a primary encoding deficit. Contrary to the authors' speculations, unawareness of repetition is likely a *manifestation* of the episodic memory impairment. Future studies should give careful consideration to these complex issues, and aim to create methodologies capable of separating the cognitive and metacognitive abilities inherent to the task.

## 3. CONSTRUCTING THE METACOGNITIVE SCALE

Assessment of metacognition is also inherently confounded by the process of cognitive estimation. While this is fairly benign in a healthy population with intact estimation abilities, it can be problematic in patients with AD who have deficits in such areas (Brand et al., 2003). In order to reduce the role of cognitive estimation, rating scales should be relatively simple. For example, Backman and Lipinska (1993) evaluated monitoring abilities for stored general knowledge in patients with moderate AD using a Feeling of Knowing technique. Subjects were presented with 48 general information questions and asked to make FOK judgments using a four-point scale for all questions which they could not answer (*definitely don't know; probably don't know; could recognize the answer if shown;* or *could recall the answer with hints and more time*). Subjects' ratings were as accurate as those of the normal controls; the authors later replicated these findings and further demonstrated that FOK was intact for both dated (1935–1950) and contemporary information (1980–1993) in patients with AD.

In contrast to these two studies, Pappas and colleagues (1992) reported impaired FOK for general knowledge in a small group of patients with moderate AD. The discrepancy may partially reflect differences in the metacognitive estimation scales. In contrast to the four-point scale used by Backman and Lipinska (1992), Pappas and colleagues implemented a six-point FOK scale including *definitely wrong, probably wrong, possibly wrong, possibly right, probably right, and definitely right*. This group of moderately demented patients may have had difficulty conceptualizing the dimensions of this finely graded scale.

It will be important to investigate AD subjects' capacity to use a range of estimation scales as a first step to evaluating metacognition. It may be that two- or three-point scales are most useful since the demands on working memory and abstraction necessary for estimating are lower, facilitating the subject's ability to maintain set for both the cognitive and metacognitive tasks. Every metacognitive study should establish subjects' ability to comprehend and make use of the implemented scale. This can be done by creating a separate, more basic, cognitive task preceding the metacognitive assessment in which subjects are required to make judgments using each point on the scale. Comparison of performance with that of normal controls should be sufficient to demonstrate that subjects are able to use the estimation scale in a valid way.

## 4. TAILORING THE COGNITIVE TASK DEMANDS

Our final guideline is for researchers to tailor the cognitive task so as to allow for a range of cognitive performance and metacognitive judgments. Moulin and colleagues (2000b) astutely raise the issue of floor effects when discussing the advantages of FOK designs as compared to JOL tasks; the latter are embedded in free recall measures, on which patients with AD generally perform at floor level. In such an event, item by item correlations used to generate metacognitive accuracy are hampered by reduced variability in both objective memory performance and metacognitive judgments.

Pappas and colleagues (1992) encountered this obstacle in a novel attempt to measure FOK for newly presented *episodic* information in the second part of their study. Subjects listened to 25 sentences, and were later asked to provide the last word of each sentence. For those sentences which they could not complete correctly, subjects were asked to rate their ability to recognize the correct answer from six alternative endings. Interestingly, neither the control group nor the AD group made accurate predictions, but instead clustered their ratings into a single category for both correct and incorrect answers. Reduced variability in FOK ratings consequently prevented the authors from reliably calculating gamma correlations in either group.

This problem seems to have resulted in part from the structure of the cognitive task. The authors acknowledged that in the absence of repeated learning trials, there appeared to be a reduced "range in memory strength and hence the range of judgment about this variable" (p. 163). It will be important to determine an appropriate stimulus set size and adequate number of learning trials for episodic FOK tasks that will eliminate both floor and ceiling effects.

### Broadening Objective Metacognitive Assessment in AD

As early episodic memory impairment is the signature cognitive deficit in AD (Greene et al., 1996; Welsh et al., 1991), studies assessing episodic FOK may have particular potential to inform the study of anosognosia in AD. However, episodic FOK and recognition of memory impairment on a more global level are certainly not synonymous. Additional research is needed to explore the relationship between performance on FOK tasks, performance on other metacognitive tasks, and clinical impressions of anosognosia in patients. In working toward this goal, we suggest that multiple objective approaches be used to capture a range of metacognitive functions.

Several studies evaluating monitoring and control processes in patients with schizophrenia, a disease often marked by poor insight (Amador et al., 1994), implemented creative methodologies that may be used to broaden metacognitive assessment in AD. Danion and colleagues (2001) administered forced-response and free-report versions of a general knowledge test, and asked subjects to rate their confidence in each response. The design of this study allowed the authors to evaluate several interesting issues. First, when subjects were encouraged to answer only those questions in which they were confident (free-report condition), they improved their accuracy scores to the level of controls. However, as compared to control subjects, the schizophrenia group demonstrated higher confidence levels for incorrect responses, lower accuracy in assessing the correctness of their judgments, and reduced use of confidence judgments to guide their decisions of whether to volunteer a response during the free-report trial.

Koren and colleagues (2004) later studied these metacognitive phenomena in greater detail using a modified version of the Wisconsin Card Sort Test (Nelson, 1976).

Participants rated their confidence in each card sort, and decided if they wanted the sort to count toward their overall score. Each correctly volunteered sort was rewarded with 10 cents, while incorrectly volunteered sorts were penalized by subtracting this amount. Six metacognitive variables were calculated including: *Accuracy Score* (*AS*) = proportion of correct responses out of those volunteered; *Free Choice Improvement* (*FCI*) = difference between accuracy and quantity scores; *Global Monitoring* (*GM*) = difference between total number of correct sorts and those asked to be counted; "the veridicality of one's overall sense of knowledge" *Monitoring Resolution* (*MR*) = extent to which confidence judgments distinguished between correct and incorrect sorts; *Control Sensitivity* (*CS*) = degree to which the control process was dependent on the monitoring process; and *Monetary Gains* (*MG*) = amount of monetary reward. Four of the above variables (FCI, GM, MR, & CS) correlated significantly with various aspects of insight as outlined in the Scale of Unawareness of Mental Disorder (Amador & Strauss, 1990). Further, multiple regression analyses revealed that the metacognitive variables accounted for a significant portion of variance in measures of poor insight. In general, free-choice performance accuracy was found to be a more important mediator between basic level cognitive skills and the clinical phenomenon of poor insight than were the forced choice measures.

## Conclusions and Future Directions

Deficit awareness varies considerably across patients in the mild to moderate stages of Alzheimer's disease, raising interesting questions regarding the etiology, correlates, and prognostic implications of disordered awareness in AD. Historically, anosognosia has perplexed clinicians and researchers; the wide variety of neurologic syndromes in which it presents spawned a multitude of theories to explain disorders of awareness. Over a century of research has been unable to establish a coherent conceptualization of anosognosia, although neuroanatomic studies have consistently highlighted the role of the right hemisphere, particularly the prefrontal cortex and parietal lobe, as integral to aspects of self-awareness. Relatively recent approaches have eloquently suggested that anosognosia is not a unitary disorder with one etiology; rather, it is likely that various cortical areas support awareness for different types of information (Prigatano & Schacter, 1991; Vogel et al., 2004; Vuilleumier, 2004).

The complexity of anosognosia has seemingly been magnified by the frequent use of subjective methodology to characterize disordered awareness such as clinician rating scales and discrepancy scores. However, there have been important conceptual and methodological advances to deconstruct the concept of awareness, implement increasingly quantitative measures, and apply traditional metacognitive tasks in dementia populations. In line with a recent review by Vuilleumier ( 2004) we argue that increasingly objective experimental tasks are needed to further clarify the neurocognitive mechanisms responsible for awareness in healthy individuals as well as failures of awareness in clinical populations. Such tasks are less susceptible to bias and restricted range than are subjective measures, and offer meaningful ways of relating cognitive components of awareness to a host of disease variables.

We point to metacognitive studies in healthy adults and patients with schizophrenia for examples of useful and creative methodologies. Building on the first objective studies of metacognition in AD, we urge researchers to consider at least four important issues in implementing future studies: (1) Is the metacognitive judgment appropriately timed to assess the skill of interest?; (2) Is the metacognitive skill clearly and consistently defined, and dissociable from the primary cognitive skill?; (3) Has it been established that subjects can use the estimation scale in a valid manner in a separate task administered prior to the metacognitive assessment?; and (4) Do the cognitive and metacognitive tasks allow for a range of metacognitive judgments?

With these basic considerations in mind, it is possible to develop a variety of objective metacognitive assessment tools that will provide complementary information and establish a comprehensive approach to studying awareness in AD. Both monitoring and control processes can be assessed as part of a standard neuropsychological evaluation by creatively modifying traditional tasks in areas such as episodic verbal and nonverbal memory, language, executive skills, or visuospatial processing. Investigating the relationship between performances across such domains may reveal important dissociations in metacognition. Ultimately, neuropsychological batteries might incorporate a small set of valid and reliable metacognitive tests that will yield an overall profile of patients' awareness including relative strengths and weaknesses. Such tests may better equip investigators to systematically explore the relationship between metacognitive abilities and aspects of an individual's clinical presentation including psychiatric symptomatology, neuropsychological profile, neuropathologic distribution, and disease duration.

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