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Critical Review

Disturbances in higher order consciousness encountered in neuropsychological rehabilitation and assessment

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Abstract

Objective: The purpose of this invited paper was to summarize my clinical research on disturbances of higher order consciousness (i.e., primarily on self-awareness but including anosognosia and impaired awareness of another person's cognitive/emotional state) that contributed to my receiving the Distinguished Career Award from the International Neuropsychology Society. **Methods:** I reviewed my early clinical encounters with disturbances in higher order consciousness and then a series of studies performed with various colleagues over the last 45 years to better understand the nature of these disturbances. The findings obtained are also discussed within the context of other researchers' observations during this time frame. **Results:** Disturbances in higher order consciousness include classic anosognosia, impaired self-awareness, denial of disability, and denial of ability. Proposed diagnostic features of each of these disturbances are outlined and a model for understanding their complex relationships suggested. Different treatment/rehabilitation approaches for these disturbances are also summarized. **Conclusion:** Disturbances in higher order consciousness are often revealed when exploring with the person their subjective experiences of their neurological and neuropsychological functioning following different brain disorders. These subjective experiences have diagnostic value and lead to different rehabilitation approaches. The neuropsychological investigation of disturbances in higher order consciousness should include integrating knowledge from the neurosciences with nonbiological understandings of how cultural and personality features of the person may also influences their subjective experiences associated with a known or suspected brain disorder.

Keywords: Anosognosia; impaired self-awareness; denial of disability; denial of ability; neuropsychological rehabilitation; psychological care

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Introduction

In the early to mid-1970s, the training of clinical neuropsychologists emphasized the importance of obtaining objective measurements of cognitive, motor, and language functioning to arrive at a diagnostic impression. Level and pattern of performance on such measures dictated the interpretation of whether an underlying brain disorder was present and the most likely regions of the brain that were compromised. It really did not matter if you subscribed to a "fixed battery" or a "flexible battery" of psychometric tests (Barr, 2017). The emphasis was on objective measurements or at least reliable classifications of observable behavioral performance. The subjective experience of the patient did not appear to have diagnostic value for many clinical neuropsychologists. At that time, scientific literature did not exist on disorders of impaired self-awareness (ISA).

Books on the assessment of disturbances of higher cerebral functions did not discuss disturbances in subjective awareness. Critchley's (1953) classic book on the parietal lobes only noted the phenomenon of anosognosia as it related to disturbances in body-schema. Hécaen and Albert (1978) briefly referenced the phenomenon of anosognosia under their discussion of "disorders of somesthesis and somatognosis." Heilman & Valenstein (1979) discussed anosognosia as it related to the phenomena of neglect. It was not until Stuss and Benson's (1986) influential book on the frontal lobes appeared that the term "self-awareness" was described as the "highest attribute of the frontal lobes" (pg. 248). Luria (1976), however, years earlier noted the importance of the "patient's attitude" toward their illness as having potential diagnostic significance. He emphasized the role of various regions of the frontal lobes in "regulation of vigilance." As such, patients with frontal lobe lesions may not self-observe/report their disturbed neurocognitive functioning.

Weinstein and Kahn's (1955) book: Denial of Illness: Symbolic and Physiological Aspects was the only book in the 1970s to provide a comprehensive discussion of disturbances in self-awareness. Unfortunately, it concluded that denial (i.e., subjective reporting of no neurological impairment that was readily observed by clinicians) seemed to be a method of psychological coping with neurological impairments rather than a direct consequence of their brain disorder. This led many well-known neurologists (and later clinical neuropsychologists) to become less interested in this topic.

Clinicians involved in the rehabilitation of persons with brain disorders, however, recognized the importance of the person's subjective experiences in patient care. Goldstein (1942) brought attention to the importance of disturbances in the "abstract

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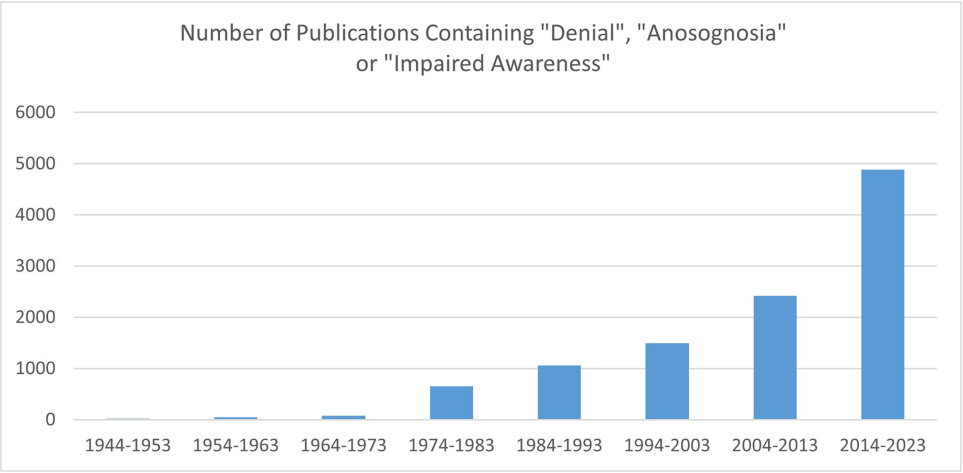

Figure 1. Number of publications containing "denial", "anosognosia" or "impaired awareness".

attitude" following various brain disorders. He introduced the term "catastrophic reaction" to describe the emotional reactions of patients when they discovered they could not carry out a function they were previously able to do with ease while undergoing rehabilitation. The patients' emotional reactions emerge when they suddenly become consciously aware of an impairment that they did not subjectively report or previously experience. This phenomenon was repeatedly observed in holistic rehabilitation programs inspired by Goldstein (1942) and later further developed by Ben-Yishay and Diller (2011). Now the patient's emotional reactions and conscious experiences had to be taken into consideration when deciding how and in which ways a brain disorder affected a person and how to help them.

In February of 1980, I had the good fortune to establish a neuropsychologically oriented, holistic rehabilitation program for post-acute persons who suffered primarily from severe traumatic brain injuries (TBIs) (Prigatano et al., 1984). That program allowed me to work with (in conjunction with a team of interdisciplinary therapists) six to eight patients, six hours a day, four days a week for 6–12 months. I interacted with these individuals during formal rehabilitation activities as well as in unstructured activities (i.e., social events within the rehabilitation program and during lunch periods). Those interactions forced upon me a perception that was not discussed in scientific literature or during my training.

Despite efforts to gently and humanely help the patients to understand how their brain disorder affected their cognitive abilities and behavioral characteristics, many had trouble realistically appraising themselves. This appeared to be different from a disturbance in the "abstract attitude" (Goldstein, 1942). In contrast with their ability to perceive changes in sensory and motor functioning, post-acute patients with TBI did not report, or at least minimized, their cognitive and behavioral limitations. Was this phenomenon a reflection of the presence of denial (as Weinstein & Kahn, 1955 suggested) or was it an "organic" or neurologically based disturbance in self-awareness? The answer to this question was not merely of theoretical or scientific interest. Patients who could become realistically aware of their cognitive and behavioral limitations often were willing to compensate for them and thus had a positive rehabilitation outcome (Prigatano et al., 1984). In contrast, those patients who had persistent and unyielding unrealistic perceptions of themselves had negative outcomes. Thus, I became preoccupied by a problem I initially called unrealistic appraisal of the self (Prigatano et al, 1986, pg. 4), subsequently renamed "altered self-awareness (Prigatano, 1988), and then impaired self-awareness (Prigatano & Schacter, 1991 and Prigatano, 1991) after a brain disorder.

A PubMed search of articles that used the terms "anosognosia, impaired self-awareness or denial" in their title between 1964 and 1973 revealed only 78 publications. As clinicians doing diagnostic and rehabilitation work became more sensitive to this class of disturbances, the number of papers with those words in the title exponentially increased to 4887 publications between the years 2014–2023 (see Figure 1).

My research on this topic has not followed a linear path. Different ideas regarding disturbances in self-awareness led to different projects with different patients with different colleagues from different countries over the last 45+ years. I will attempt to trace out some of the more important observations and conclusions from my perspective.

First clinical encounters

Three memorable encounters with disturbances in higher order consciousness stimulated my research interest in this field of study. The first occurred before establishing a neuropsychological rehabilitation program. Dr Richard Carpenter, a neurologist, allowed me to attend rounds with him at St Anthony's Hospital in Oklahoma City, OK. I observed him evaluating a woman in her 70's who recently suffered a stroke and was paralyzed on the left side of her body. Dr. Carpenter asked her what brought her into the hospital, and she could not answer him. He asked if she had difficulty moving her hands and arms. She reported "not that I know." He then asked her to raise both hands, and she raised only the right hand. When asked about the left hand/arm, she appeared to ignore his question and showed no emotional reaction. It quickly became apparent she was not aware of her left hemiplegia. This was the first time I witnessed anosognosia for hemiplegia (AHP) with associated anosodiaphoria.

A second encounter occurred during the neuropsychological rehabilitation of a young man with a history of severe TBI. Neuroimaging revealed large bilateral frontal lobe contusions, but he performed amazingly well on many neuropsychological tests, including the Halstead Category Test. He was calm and congenial, showing none of the irritability or impulsiveness often seen in

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young men several months post severe TBI. He was cooperative with all rehabilitation activities but occasionally would ask why he was in this rehabilitation program. He felt he had completely recovered from his TBI. One afternoon I observed him trying to talk to a young female physical therapist. She acknowledged his comments but quickly turned her head away, attempting to discourage any further dialogue. He did not pick up the social cues, continuing to speak with her and making somewhat inane comments. Eventually she became openly irritated with him, but he seemed perplexed by her reaction. When later talking with him about the incident, he did not perceive that he had done anything to make the young woman socially uncomfortable. His response was "you psychologists look for problems everywhere." He was clearly unaware of his socially inappropriate behavior, although he did not appear emotionally upset with my inquiry. This was the first time I witnessed impaired self-awareness (ISA) after severe TBI.

The third memorable encounter occurred during the neuropsychological rehabilitation of a 37-year-old woman who also suffered a severe TBI. She was densely amnestic. When asked about her memory difficulties, she smiled, saying she had no problems with her memory. Her only difficulty, from her perspective, was her inability to walk. When pressed about her memory impairments, she became anxious, angry, and insisted that "my memory is just fine!!!!!" Her response seemed to reflect something more than just ISA. I later referred to this phenomenon as denial of disability (DD).

Initial research efforts on ISA after severe TBI

Since ISA seemed to be prevalent in many of the patients with a history of moderate to severe TBI enrolled in the neuropsychological rehabilitation program, the first step was to collect "some data" on this problem. Using a question borrowed from Dr Yehuda Ben-Yishay, I asked the patient to rate on a scale from 0 (not aware at all) to 10 (totally aware): "How aware are you today of how your TBI has affected you? Patients who underwent intensive neuropsychological rehabilitation and were considered "treatment successes" stated they were not totally aware. The rehabilitation team who had worked with them for several months independently agreed with their ratings. In contrast, "treatment failures" insisted that they were "totally aware," while the staff's ratings considered them to demonstrate persistent and severe difficulties with self-awareness.

The correlates of ISA after TBI

The first research attempt to explore the possible neuropsychological correlates of ISA after moderate to severe TBI employed the Patient Competency Rating Scale (PCRS, Prigatano et al., 1986). Prigatano and Altman (1990) classified 64 traumatically brain injured patients into three groups: Group 1 overestimated their behavioral competencies on the PCRS compared to relatives' ratings of the patients' functional abilities (on the PCRS-Relatives form). Group 2 patients' PCRS ratings were at a level similar to the PCRS-R ratings. Group 3 underestimated their behavioral competencies compared to relative's ratings of them. Group 1 was considered to represent the group who showed primarily ISA. Many neuropsychological tests were administered, and group comparisons made. Of the many neuropsychological tests administered, only the performance on the Halstead finger tapping test (HFTT) separated the groups, with those who showed primarily ISA demonstrating the worst tapping speeds in the left hand. The paper concluded that there was not a simple or straightforward relationship between ISA and neuropsychological test performance. Findings appeared compatible with the existing literature linking behavioral indicators of right cerebral hemisphere dysfunction with disturbances in self-awareness. It also suggested (for the first time) that ISA might reflect a disturbance in the integration of thinking and feeling. Standardized neuropsychological tests were not able to measure this complex interaction. Using Mesulam's (1985) conceptualization of the brain regions associated with the integration of feeling and thinking, it was proposed that ISA may be related to disturbances in "heteromodal cortex." Furthermore, evaluation of neuroradiographic findings among the groups noted that those who demonstrated primarily ISA showed many more lesions in their brain than did those who rated themselves similarly or worse compared to relatives' ratings of them. This basic finding was later replicated by Sherer et al. (2003).

The finger tapping findings were not always replicated, and the issue of sampling bias has repeatedly occurred when attempting to do clinical research on ISA in patients with TBI using convenience samples (e.g., Prigatano & Leathern, 1993; Prigatano et al., 1997).The research by Dikmen et al. (1995), however, unequivocally demonstrated that speed of finger tapping using the HFTT strongly correlated with initial severity of TBI.

This led to repeated observations that the initial severity of TBI was related to the severity of ISA several months post TBI. In a cross-cultural study with Spanish speaking individuals, ISA as measured by the PCRS, correlated r=+ 0.41 with the period of post traumatic amnesia (Prigatano et al., 1998). Other investigators later also reported similar findings (Sandhaug et al, 2012; Sherer et al, 2003). It is important to note, however, that the severity of injury often accounts for less than 25% of the variance and has not been replicated in every study (Ciurli et al, 2011).

Functional imaging correlates of self-reflection and ISA after TBI

Johnson et al. (2002) explored the functional imaging correlates of self-reflection in adults without known neurological injury. "Individual analyses revealed consistent anterior medial prefrontal and posterior cingulate activation for all participants" (pg. 1808) when performing a self-reflection task. This was the first neuroimaging study to suggest that brain structures associated with self-reflection (i.e., self-awareness) involve brain circuitry associated with both cognitive and affective information processing and problem solving. Using the same research paradigm, Schmitz et al. (2006) later concluded that individuals with TBI and with ISA showed fMRI findings implicating disruption of the medial and right dorsal prefrontal cortex.

At the time of these studies, the concept of "functional neural networks" was starting to appear. Raichle et al. (2001) described the "default mode network" (DMN). Carhart-Harris and Friston (2010)'s later review of the DMN concluded that, when an individual is involved in self-reflection, there is high blood flow activity in "the medial prefrontal cortex, the posterior cingulate cortex, the inferior parietal lobe, the lateral inferior temporal cortex and the medial temporal lobes" (pg. 1286). A subsequent study from Ham et al. (2014) reported that ISA following TBI clearly was associated with reduced functional connectivity of the fronto-parietal network and related limbic structures. Collectively, these findings were compatible with the hypothesis that ISA associated with severe TBI reflects disruption of "heteromodal" cortex.

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Impaired awareness in various brain disorders

As my direct clinical work in neuropsychological rehabilitation came to an end, I became more involved in the neuropsychological evaluation of a wide range of persons with various brain disorders. I observed unique patterns of impaired self-awareness in different patient groups (Prigatano, 2014). I noted, for example, that patients with multiple sclerosis (Prigatano et al., 2014) and Parkinson's disease (Prigatano et al., 2010; Maier et al., 2012) demonstrated ISA for different features of their neurological/neuropsychological impairments. One dramatic case involved AHP in which there was preserved awareness of complete cortical blindness following intracranial hemorrhage (Prigatano et al., 2011). It became increasingly clear that Anton's (1898) original observations and those echoed and expanded upon by Bisiach et al. (1986) were extremely important. Namely, "..... unawareness of the failure of a particular function betrays a disorder at the highest levels of organization of *that* function." (pg. 478).

The strong implication was that subjective awareness of different cognitive (and perhaps affective, motor, language, behavioral etc.) functions may be "modularly" organized. Namely one can be aware of one functional limitation and at the same time not aware of another functional limitation. Bisiach and Geminiani (1991) emphasize that, when there is a disturbance of *any* brain-behavioral connection, there is some negative alteration of the conscious experience or self-awareness of that functional disconnection. This makes the entire study of impaired self-awareness and anosognosia extremely complex; my research has only touched on a very small portion of this important area of study.

Denial and impaired self awareness

Efforts at both neuropsychological rehabilitation and neuropsychological assessment brought me face to face with the phenomena of denial of both disability and ability. Is denial (as a psychological defense mechanism) truly different from unawareness (as a neuropsychological disturbance)? Can they be separated to aid clinical diagnosis and treatment? The early work of Weinstein and Kahn (1955) provided many convincing clinical examples of apparent denial of neurological conditions. Denial is, of course, a hypothetical construct that attempts to explain behavioral phenomena repeatedly observed in the practice of medicine, including neurology and psychiatry. The patient shows overwhelming behavioral evidence of significant limitations or impairments in some domain of functioning and reports no such impairments exist. The easiest examples come from addictions. The person is an alcoholic but reports alcohol poses no specific threat to his life or health, even when confronted with evidence of cirrhosis of the liver and the fact he has lost three jobs in the last two years because he was intoxicated. We also see denial of ability. The person is functioning quite well in life and yet reports significant cognitive impairments when none can be found on neuropsychological examination (Denney & Prigatano, 2019). When presented with psychometric evidence of normal cognitive functioning, the patient often doubts the findings and considers them inadequate measures of their impairments in everyday life (Prigatano, 2012).

Early clinical impressions, working in neuropsychological rehabilitation, were that denial had a "defense" quality, while ISA did not. Prigatano and Klonoff (1998) attempted to operationalize behavioral features that were observed in patients with TBI who appeared to be denying their neuropsychological impairments versus those with ISA as a direct result of their brain injury. While one study provided empirical support for the proposed observations by Prigatano and Klonoff (1998) (e.g., Kortte et al., 2003), a more recent attempt could neither confirm nor disconfirm their suggestions (Terneusen et al., 2022). Again, the problem of sample bias was encountered. Individuals with TBIs who tended to get upset when talking about their disabilities/impairments often declined participating in community-based research on ISA and denial. This is what Prigatano & Klonoff (1998) suggested would be common in persons with denial of disability (DD).

From a phenomenological perspective, the differences observed in impaired self-awareness as a direct effect of a brain disorder versus alterations of self-awareness as a direct effect of psychological distress (Prigatano, 2019, pg. 159) are listed in Table 1.

Table 1. Clinical features of persons with impaired self-awareness due to a brain disorder versus psychological distress

Alterations of Self-Awareness as a Direct Effect of a Brain Disorder	Alterations of Self-Awareness as a Direct Effect of Psychological Distress
1. Brain lesions occur in regions known to be important for that function (e.g., occipital lobe for vision, temporal lobe for hearing, etc.) (Anton, 1898, see Forstl et al, 1993).	1. If a brain lesion is present, it is not in a region known to be important for that function.
2. Patient has adequate cognitive skills to understand the evidence presented to them about the existence of an impaired neurological or neuropsychological function (Anton, 1898).	2. Patient has adequate cognitive skills to understand the evidence presented to them about the existence of an impaired neurological or neuropsychological function (Anton, 1898)
3. The patient discards or discounts any objective evidence that he or she has lost his or her functional capacity (Anton, 1898).	3. The patient discards or discounts any objective evidence that he or she has lost his or her functional capacity (Anton, 1898).
4. The patient's emotional reaction to feedback regarding their clinical condition is "blunted." They show "diminished concern of illness or disability (Babinski, 1914; Heilman & Harciarek, 2010). The often appear apathetic	4. The patient's emotional reaction to feedback regarding their clinical condition is not "blunted." The patient typically shows signs of anxiety and/or anger when receiving this feedback. They are not apathetic.
5. The patient does not avoid answering the questions the examining clinician poses concerning their illness or disability.	5. The patient actively avoids answering the questions of the examining clinician poses concerning their illness or disability.
6. The patient does not appear "defensive" in their reactions to feedback regarding their clinical condition. They do not behave in a manner that discourages further questions from the clinician.	6. The patient does appear "defensive" in their reactions to feedback regarding their clinical condition. They do behave in a manner that discourages further questions from the clinician.
7. The patient does not resist efforts at treatments. The patient often passively accepts treatment recommendations while showing signs of cognitive confusion or perplexity as to why the treatment is necessary.	7. The patient often actively resists efforts at treatment and often emphatically states it is not needed! With time the patient may accept treatments, but at the same time state they do not really feel they need any further treatment (or rehabilitation).

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One major difference is the patient's emotional reactions to feedback regarding their clinical condition. In anosognosia, the patient shows "blunted" affect with little or no concern over the feedback received. In contrast, there are often signs of anxiety and/or anger when hearing the feedback in denial. The patient in denial often behaves in a manner that discourages the clinician from asking further questions about their clinical condition. In "organically mediated unawareness," the patient does not avoid or discourage discussion of their situation. They are more indifferent than defensive. Another clinical cue comes from neuroimaging studies. When ISA is present, neuroimaging studies often show brain lesions in regions known to be important for the functional impairment the patient reports not experiencing. In contrast, if a brain lesion is present in someone with DD, it is not in a region associated with that function.

Since ISA frequently (but not always) involves frontal lobe neural networks, these patients may have difficulty following new instructions and picking up social cues. For example, they may not know when they have said or done something that upsets someone else. Prigatano et al. (2024) suggested that this latter characteristic should be considered when screening for denial in patients with neurodegenerative memory impairments who are thought to be anosognosic of their memory difficulties.

Cross-cultural considerations

An early cross-cultural study by Gainotti (1975) reported that Swiss patients with "lack of awareness" of the memory impairments secondary to Alzheimer's disease had a higher incidence of denial than Italian patients. The prevailing idea that stimulated this study was that a person's attitude toward their health influenced the self-reporting of any cognitive impairment that may reflect a "character weakness" or psychiatric disorder. I conducted my first cross-culture study on ISA in New Zealand with this idea in mind (Prigatano & Leathern, 1993). In Maori culture, emotional, and cognitive difficulties are not viewed as a sign of personal weakness or lack of moral character. Instead, they are viewed with the same attitude as any physical illness. We anticipated observing fewer "denial" or "unawareness" indicators in patients with TBI with Maori ancestry compared to New Zealanders with non-Maori (English) ancestry. Using a translated version of the PCRS, we observed that Non-Maori English ancestry persons with TBI reported greater competency than their relative's ratings of them while Maori ancestry patients did not. Cultural factors did appear to influence the self-reporting of severity of cognitive and behavioral symptoms after TBI. A second cross-cultural study on ISA with Spanish patients with TBI (Prigatano et al., 1998), reported similar findings to a study of American patients with TBI (e.g., Prigatano & Altman, 1990; Prigatano, 1996).

A third study using the PCRS with Japanese patients with brain dysfunction revealed an important cultural finding (Prigatano et al., 1997). While the Japanese patients tended to overreport their behavioral competencies compared to therapists' ratings (suggesting ISA), there was a greater tendency for the Japanese relatives of the patients to agree with the patients' ratings. In that culture, individuals "rarely engage in an open discussion of a person's emotional characteristics or social interactions" (pg. 140). Relatives, therefore, might view it as a sign of disrespect or socially inappropriate behavior on their part to say that the person is more impaired than what the person reports. This study highlighted the importance of taking into consideration cultural mores when constructing tests that attempt to indirectly measure ISA or DD.

Cultural differences in ISA of memory impairment in persons with dementia have also been noted in India, Latin America, and China (e.g., Mograbi et al., 2012). In addition to demonstrating that individuals from India appear to have less awareness of their memory impairments, the authors make the point that the educational level of the person is associated with the frequency of unawareness, which was highest in persons with higher education. They argue that unawareness should be considered a common neurobiological disturbance associated with dementia, but one that is influenced by social and cultural factors. Weinstein and Kahn (1955) would most likely add that it is also influenced by the premorbid personality characteristics of the individual.

It is my opinion that in any given patient population who demonstrates probable ISA, measures of DD should be included to adequately characterize the study sample (Prigatano et al., 2024).

The negative effects of ISA on caregivers including rehabilitation therapists

Patients who persistently report that their cognitive abilities are greater than what their therapists observe can eventually irritate rehabilitation therapists, which can negatively impact patient care. This topic is often not adequately discussed in the literature, although the quality of the therapeutic alliance correlates with neuropsychological rehabilitation outcome (e.g., Prigatano et al., 1994). I have previously described a case of a young man with an amnestic disorder who would not use memory compensation techniques because he insisted his memory was better than what the therapists were telling him (Prigatano, 1999, pg. 231–231). To teach the patient a lesson (with the secret hope of convincing him of his misperception of himself), the therapists participated in actions that caused the patient considerable anxiety. This fractured, not helped, the therapeutic alliance with the patient.

Equally importantly, patients with severe ISA often produce considerable emotional distress in family members. We reported that "the correlation between relatives' level of distress and their ratings of the patients' unawareness of their difficulties for persons with TBI was –0.52, $p = .006$" (Prigatano et al., 2005). Collectively these findings argue for the importance of training rehabilitation staff and family members to understand the problem of ISA (and DD). This has been recognized not only in neuropsychological rehabilitation of persons with acquired brain injuries (Prigatano, 1999), but in the care of persons with dementia as well (Clare, 2010).

A clinical classification model for distinguishing anosognosia, impaired self-awareness, and denial

As noted earlier, the work of Weinstein and Kahn (1955) was the only scholarly and extensive study on anosognosia that was available in the 1970's. Their methods included extensive and repeated interviews with patients (often however only in the acute phases of illness), psychometric testing, EEG recordings, and comparison of their findings of patients with anosognosia to patients with similar types of brain lesions without anosognosia. They make a distinction between explicit verbal denial versus implicit denial. They reviewed cases in which patients who denied their paralyzed limbs might ascribe ownership of their paralyzed limb to someone else (pg.4). Such patients may also refer to their affected paralyzed limb in pejorative terms (pg.4). This basic approach and identification of important comorbid features of persons with anosognosia were later studied using somewhat more contemporary terminology and more sophisticated technologies

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(see Prigatano, 2010). Weinstein and Kahn's (1955) work anticipated many important issues involved in studying disturbances in higher order consciousness associated with brain disorders.

Based on their data and Weinstein's training in psychiatry as well as in neurology, they concluded: "Our findings indicate that the various forms of anosognosia are not discrete entities that can be localized in different areas of the brain. Whether a lesion involves the frontal or parietal lobe determines the disability that may be denied, not the mechanism of denial." (pg. 123). Later Weinstein recognized that this conclusion was misleading (personal communication, 1997). Denial is indeed a mechanism that may not be in or mediated by specific frontal or parietal lobe neurocircuits. However, the unawareness of a disability/impairment can be discrete (as many studies have subsequently shown, see Bisiach et al., 1986; Prigatano et al., 2011). He attempted to clarify this point and concurred that both neurologically mediated impaired self-awareness and psychologically mediated denial can exist in the same patient at the same time. Both phenomena are "real" and need to be better understood to advance the field of neuropsychological rehabilitation (Prigatano & Weinstein, 1996).

Selected studies have subsequently appeared which attempted to investigate the neuroanatomical and functional imaging correlates of anosognosia for hemiplegia (AHP) (e.g., Berti et al., 2005; Karnath et al., 2005; Vocat and Vuilleumier, 2010) as well as denial in patients with "hysterical sensorimotor loss" (Vulleumier et al., 2001). Patients with classical AHP often show damage or disruption to frontal-parietal regions in addition to the insular cortex. In the few patients studied with hysterical sensorimotor loss (in which denial is thought to play an important role in their symptoms), alterations of blood flow in the thalamus and basal ganglia have been reported (Vulleumier et al., 2001).

While the technological advancements in neuroimaging allowed for a more detailed assessment of brain regions associated with AHP, there is no overall neurological model of human consciousness that allowed us to integrate these findings. Zeman (2001), however, provided an innovative model that could be of potential help. Zeman noted that the term "consciousness" can be applied to three different types of human experience. He gave these examples. "After a lucid interval, the injured soldier lapsed into unconsciousness." "I am conscious of a feeling of dread and overpowering smell of burning rubber." "I am conscious that I am straining your patience." In conjunction with Sterling Johnson, we proposed that Zeman's (2001) insights could be restated as "three vectors of consciousness" (Prigatano & Johnson, 2003). These three vectors of consciousness must: "(1) interact; (2) be subserved by overlapping neurocircuits in the brain and brain stem; (3) evolve to meet different needs of the organism that aid the never-ending processes geared towards survival." (pg. 16). By using the term 'vector,' we were proposing that these three components of human consciousness have a "magnitude and a direction." As such they appear to be "energy forces" that influence one another and yet are somehow "united," the result being a preserved "sense of self" even when "islands" of self-unawareness exist. There are many behavioral examples which are compatible with this view that disturbances in human consciousness are associated with changes in the arousal/energy systems of the brain. For example, after a right hemisphere stroke, many patients with AHP appear hypoaroused with their heads bent forward. Many patients with severe TBI with ISA often appear tired (i.e., frequently yawning) and can sleep long hours each day, especially with the first few months of their brain injuries. Patients with depression (and possible denial of that depression) often speak of low interest and energy. While we certainly do not understand how consciousness emerges and reflects different overlapping energy systems of brain functions, Sperry's (1969) observations are insightful. He proposed that conscious awareness is " . . . . A dynamic emergent property of cerebral excitation" (pg. 533) that can have " . . . .causal effects in brain function that control subset events in the flow pattern of neural excitation." (pg. 533). It is an "emergent" (I would add energy) product or consequence of brain function that at same time influences brain function. Perhaps this is why we are so interested in consciously understanding consciousness.

Adapting Zeman's model (2001), we suggested (Prigatano & Johnson, 2003) that "Vector 1" allows for the biological foundation of wakefulness. It involves the upper brainstem, the posterior hypothalamus, and the thalamus (Zeman, 2001). It is the "gatekeeper of the sleep-wakefulness continuum." It allows us to awake from sleep and know "what is real." It forms the foundational basis from which "Vector 2" can emerge. Vector 2 emerges as basic limbic system structures evolve, which includes primitive cortical structures (i.e., the anterior and posterior cingulate gyrus). Luria (1976) made the important evolutionary observation that the frontal lobes are an evolutionary extension (he referred to them as a "tertiary zone") of both limbic and motor cortex. Thus, the frontal lobes are involved in the regulation of movement and the experience and expression of emotion. These two domains are often affected in both ISA and DD but in somewhat different manifestations as I have attempted to partially illustrate in Table 1. Another term for this "tertiary zone" is "heteromodal cortex." In this model, Vector 2 provides the biological basis of the phenomenological state of "self-reflection" in the "here and now." It provides the individual with their subjective experience of specific personal needs and motorically necessary responses to external threats/opportunities. It does not form the "I," "me," or "sense of self." Rather it appears modularly organized, providing self-awareness of whether specific needs are experienced and or acted upon. Depending on which areas of the heteromodal cortex are rendered dysfunctional, different (specific) disorders of self-awareness (i.e., self-reflection) can be observed (see Prigatano, 2010). Vectors 1 and 2 are anatomically connected as recent neuroimaging had demonstrated (Edlow et al., 2024).

Vector 3 is viewed as a further evolutionary development of Vectors 1 & 2 that may be unique to mammals (Humphrey, 2023). It allows the animal to sense what another is experiencing and to act accordingly. In humans, we often refer to this as "theory of mind" or "metacognitive judgments" about our own "mind" and the "mind of others." As such, disturbances in self-awareness are often associated with disturbances of awareness of another's emotional or mental state. This is exemplified in the second clinical state I noted. In that case the young man with bilateral frontal contusions secondary to severe TBI was not aware that he was making another person uncomfortable with his socially awkward statements.

The model proposed by Zeman (2001) and modified by Prigatano and Johnson (2003) has implications for understanding denial (of both disability and ability). Denial of hemiplegia several months or years post stroke is indeed rare (see Prigatano, 2010). Yet House and Hodges (1988) reported such a case in an individual with damage primarily to the basal ganglia. The study by Vuilleumier et al. (2001) cited above noted that alterations of blood flow in thalamus and basal ganglia were observed in patients with hysterical sensorimotor loss. The implication is that psychological defense referred to as denial may reflect a disruption

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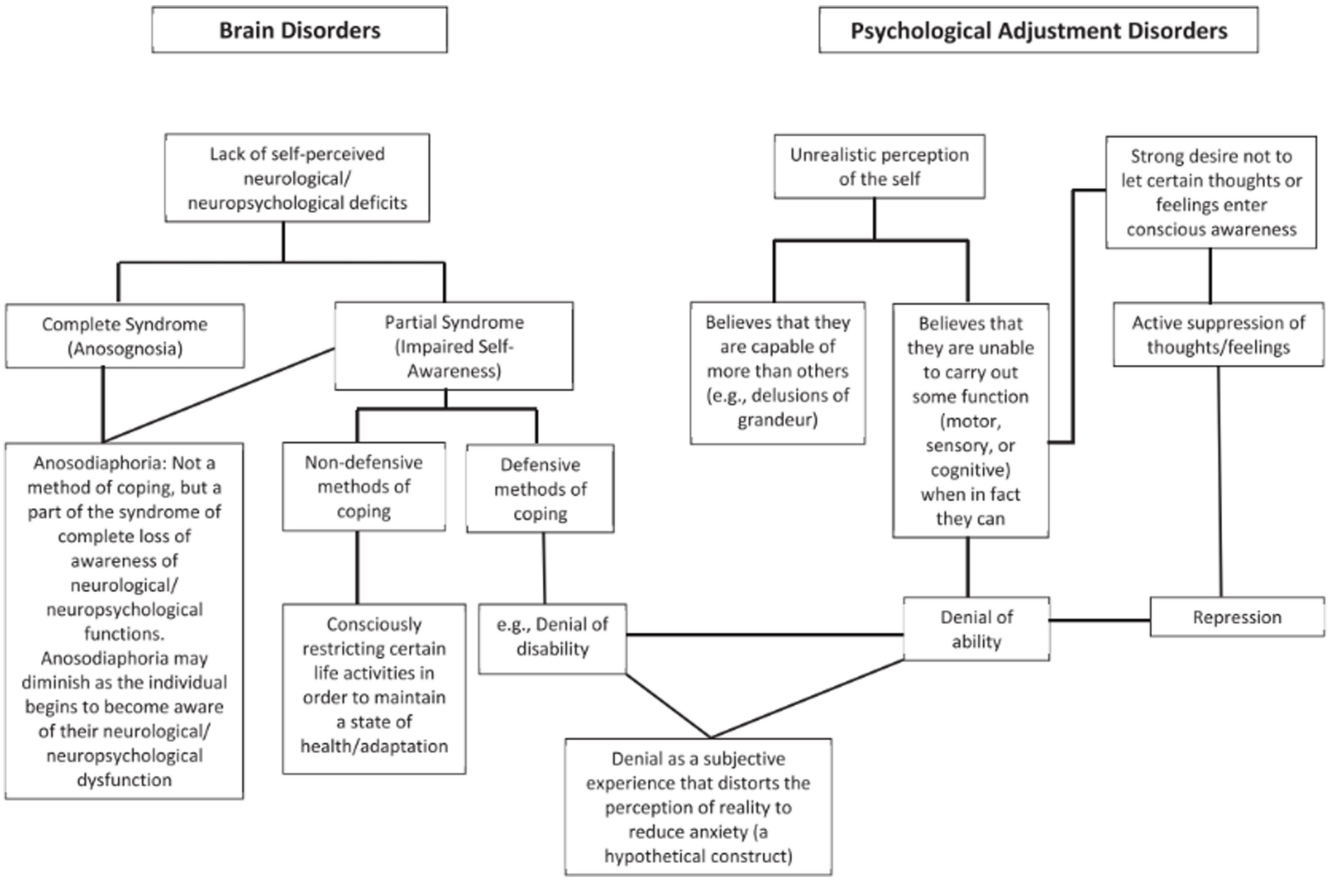

Figure 2. Disturbances of self-awareness in "awake" neurological and psychiatric patients: an integrated clinical model.

of the energy system emerging from Vector 1 which influences Vector 2. This, of course, is a conjecture, but conjectures are necessary when testing any model, especially a model that helps capture key aspects of human consciousness. Figure 2 illustrates my attempt to portray the relationships between anosognosia, from impaired self-awareness from denial (Prigatano, 2014).

The model assumes that disturbances in self-awareness are different in their phenomenology if they are associated with a neurological disturbance versus a psychological adjustment problem. In the former, a lack of self-awareness is a direct result of underlying brain pathology. Analogous to aphasic syndromes, in which one can have "global aphasia" versus "fluent" versus "nonfluent" aphasia, one can have a complete loss of awareness *of a specific function* or partial loss of awareness *of a specific function*. In the former case, we have a "complete syndrome" or anosognosia, whereas in the latter case, we have an "incomplete syndrome" or ISA. When there is partial awareness of an impaired function, a person may use defensive or non-defensive methods of coping with their partial perceived functional change. This was a position that Weinstein eventually agreed with (personal communication, 1997). Note that in defensive methods of coping, denial may occur, but other psychological defenses might also come to play.

In one extreme scenario, the person believes they are substantially more capable than others, which can reach psychotic proportions in the form of delusions of grandeur. The opposite can also occur, in which the individual perceives themselves as unable to perform some functional skill that neurologically and neuropsychologically of which they appear capable. In this case, one might refer to "denial of ability," which is seen in the traditional conversion disorders. If this diagnostic model is useful, it should help guide treatment strategies.

Treatment considerations in neuropsychological rehabilitation, psychological care, and psychotherapy

Treatment of disorders of higher levels of consciousness (i.e., those emanating from a disruption of Vectors 2 and 3) is a difficult task that requires hours of effort on the part of both the patient and therapist(s). When Vectors 2 and 3 are altered because of underlying brain dysfunction, the approach is different than when they are altered due to psychological conflicts or crises. Table 2 lists suggested approaches when dealing with ISA and DD after moderate to severe TBI (from Prigatano & Sherer, 2020). In the case of ISA, engaging the patient in meaningful rehabilitation activities that allow them to observe their behavior helps them to experience potential "strengths" or "weakness." In some instances, this helps improve self-awareness, which may increase the likelihood of using compensatory strategies. As they benefit from such activity, there is often improvement in the therapeutic alliance, and the patient is more easily guided into activities that he or she can successfully perform. When DD is strongly suspected, a traditional psychotherapy approach is often more helpful. Understanding the patient's life history and methods of dealing with anxiety or conflict can give clues as to how to talk to the patient in a manner that allows them to explore the source of the anxiety that stimulates denial.

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Table 2. Different approaches to treating/managing clinically significant ISA verse clinically significant dd after moderate to severe TBI

Treating/managing ISA	Treating/managing DD
Avoid arguing with the patient regarding impaired awareness	Avoid directly confronting the patient with their denial of disability
Engage the patient in tasks the patient finds meaningful and that require skills that the patient overestimates	Avoid presenting tasks that will expose deficits the patient is currently denying
Encourage the patient to track performance on tasks and compare these performances to their self-expectations	Have the patient describe self-perceived strengths and weaknesses without associating them with TBI
Provide feedback when the patient's performances failed to reach self-expectations or functional requirements	Engage the patient in discussions regarding their sense of self extending back before the injury and identify issues that could challenge a positive self-image
Look for opportunities to suggest compensatory strategies that will enhance the patient's performance and praise the improved results	Discuss recent experiences the patient has found to be positive/encouraging as well as negative/threatening
Select compensatory strategies based on an understanding of organizational strategies that were used by the patient prior to injury	Engage the patient in discussions of experiences such as dreams, art, etc. that have symbolic significance, positive or negative, for the patient
A strong therapeutic alliance will enhance patient willingness to use compensatory strategies	A strong therapeutic alliance will enhance patient willingness to confront negative emotions such as anxiety and anger
Self-perceived improvements along with positive feedback from others will promote a sense of resiliency and establishment of a positive sense of self	Reduction of negative emotions and the perceived ability to manage negative emotions when they arise will promote a sense of hope and resiliency
Facilitate the patient's continued movement towards a level of compensation and function that will result in return to a productive life with positive social engagement	Encourage the patient to leverage improved emotional control by moving forward with other activities that will increase productivity and social engagement

TBI = traumatic brain injury, ISA = impaired self-awareness, DD = denial of disability.

Understanding disturbances in higher order consciousness can guide the psychological care of persons with various brain disorders. In Parkinson's disease, for example, patients' neuropsychological difficulties can include limited awareness of their motor impairments (Maier & Prigatano, 2017). The patient may therefore repeatedly attempt to walk without a walker and have several falls. This can infuriate family members and produce considerable emotional conflict within the home. Explaining to a spouse that the person is not fully aware of these limitations and has underlying problems with working memory can ease the tension between a family member and patient (Prigatano, 2019, pg.266; also, Prigatano & Salins, 2022).

Understanding the difference between denial and ISA can also be useful in psychotherapy. A young man suffered a TBI after "falling" from a building. Medical recorders raised the question of whether this was an accidental fall or an attempt at suicide. In the context of working with him in psychodynamic psychotherapy (as described in Prigatano & Salas, 2017), it eventually came to light that he was experiencing considerable shame in his life prior to his injury. He began to recognize (i.e., experience) this after many hours of psychotherapy. That shame, while under the influence of various unprescribed drugs, led to a suicide attempt, to which he could now admit. He became able to talk about his feelings in more detail, and his use of drugs substantially reduced.

Theoretical implications for understanding human consciousness

There has been a resurgence of interest in the neuroscience community to understand the brain mechanisms that allow consciousness to emerge and change over time. The latter question has been referred to as the "hard problem" of consciousness (Chalmers, 1995).

Using multimodal MRI of the brain, Edlow et al., 2024) have recently described a default ascending arousal network (dAAN) that supports the functioning of the DMN. That network includes the brainstem, hypothalamus, thalamus, and basal forebrain. Further they highlight the potentially important role of the dopaminergic ventral tegmental area of the midbrain in the arousal component of awareness.

Solms (2021) has suggested that brainstem networks are the foundation for the sense of "I" or "self" and are not to be found in the cortex. This is an interesting proposition. The sense that "I am I" does not change in cases of anosognosia, ISA, or denial. The subjective experience is so robust that even when an arm is seen as not belonging to the person with AHP (i.e., the phenomenon of somatoparaphrenia), the person feels/believes that they are who they are. Their self-hood, if you wish, is preserved. But their awareness of specific functioning limitations is impaired. The dopaminergic ventral tegmental area in the midbrain is known to be an important brain region involved in early "reward processing, aversion, stress modulations . . . " (Cai & Tong, 2022). As such it appears to be a primitive response system to reward and aversive stimuli. It might in fact play a key role in the development of the "sense of self" in which humans have an emerging subjective experience that "this is good for me" or "this is bad for me." This may be the earliest experiences of "me."

The recent work of Humphrey's on the evolution of consciousness (Humphrey, 2023) adds further intriguing insights into this proposition. While he does not indicate that "sense of self" evolves purely from a specific brain region, he does suggest that "sensations" are the rudimentary building blocks of consciousness awareness. He states: "sensations are ideas that represent what's happening to your sense organs and how you feel about it. They do this by tracking motor responses that the stimuli evoke in your brain: covert-unrealized-forms of bodily expression. They have acquired phenomenal properties as a secondary overlay. These properties are not illusory. They are veridical properties of the feeling of 'what it's like.'" (pg. 105). Humphrey's (2023) work is especially interesting since it attempts to provide an evolutionary explanation of consciousness and directly relates the emergence of human consciousness with sensations associated with feelings and movements.

Concluding comments

A major emphasis of my clinical work and research has been to highlight the importance of the patient's subjective experience for neuropsychological rehabilitation, neuropsychological assessment, and in the psychological care of patients. A second major emphasis has been on the importance of integrating knowledge of neuropsychology (and other branches of the neurosciences) with nonbiological explanations of human behavior when attempting to understand disturbances of higher order consciousness. If clinical

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neuropsychologists do this, they often enrich their professional work; both they and the patients they serve benefit from this integrative approach. The ultimate "cost-benefit" analysis of clinical neuropsychology in the health care environment (Prigatano & Pliskin, 2003) and in the scientific and academic communities is determined by how our integrated understanding of human beings aids patient care.

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