Chapter 23

Assessment of anosognosia for motor impairments

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1 Introduction

Patients with anosognosia fail to acknowledge their motor impairments. Anosognosia is usually assessed by means of a structured interview, beginning with questions about general health and moving to specific questions about the patient's motor impairment. A patient whose arm or leg is paralysed or weak following a stroke may deny the weakness in response to questions like 'Is there anything wrong with your arm or leg?' or 'Is your limb weak, paralysed, or numb?' (questions from Cutting, 1978; Nathanson, Bergman and Gordon, 1952; Starkstein, Federoff, Price, Leiguarda and Robinson, 1992), and may continue to deny the impairment even when it has been demonstrated. The examiner may ask the patient to raise both arms and then demonstrate to the patient that one arm is not raised as high as the other. Recognising that a patient has anosognosia may be relatively straightforward, for example, when the patient denies outright that there is anything the matter. In many patients, however, a full assessment will reveal a more complex profile.

In this chapter, we begin (Section 2) with a threefold distinction that organises our investigation of anosognosia — the distinction between *failure to experience* a motor impairment (*concurrent unawareness*), *failure to acknowledge* the impairment itself, and *failure to appreciate the consequences* of the impairment (Aimola Davies, Davies, Ogden, Smithson and White, 2009). Then, we review methods for the assessment of motor impairments and anosognosia for motor impairments (Section 3) including structured anosognosia interviews that have been published (Section 4). This literature review reveals considerable variation in the methods by which patients with anosognosia have been assessed. The development of a comprehensive and widely accepted procedure for assessing anosognosia for motor impairments would contribute to a better understanding of the many factors in anosognosia and might also lead to improvement in the clinical management of patients (Orfei, Caltagirone and Spalletta, 2009). We present a structured interview (Section 5) that offers a theoretically motivated and relatively comprehensive approach to the assessment of anosognosia for motor impairments.

2 A threefold distinction

Two ideas figure in the *Oxford English Dictionary* definition of anosognosia: 'unawareness of or failure to acknowledge one's hemiplegia or other disability'. *Unawareness* suggests a failure of experience (sensation and perception). *Failure to acknowledge* suggests a failure of judgement (belief and assertion). This important distinction is obscured if the term 'unawareness' is used interchangeably with 'anosognosia'. We regard anosognosia as a failure or pathology of belief: a mismatch between the patient's estimate of his or her abilities and the reality of the impairment. The patient believes that he or she does not have the impairment despite the fact that it is clearly present. This incorrect belief will be manifested in the patient's failure to acknowledge the impairment verbally in response to questions.

Consider a hypothetical case of a patient with hemiplegia following right-hemisphere stroke. When the patient intends to raise his left arm, proprioception and vision tell him that the arm is still hanging by his side. When the patient tries to raise his arm, a comparator within the motor control system detects a mismatch between the expected movement of the arm and what actually happens and the patient is alerted to his paralysis. If the patient directs his attention to the left side of his body, this only confirms that his left arm has not moved. This hypothetical patient has immediate experiences — concurrent awareness — of his motoric failure and these experiences may lead him to abandon long-held beliefs about his motor abilities. In contrast, patients with proprioceptive loss (Levine, 1990), or unilateral neglect (Vuilleumier, 2004), or with damage to the comparator in the motor control system (Gold, Adair, Jacobs and Heilman, 1994; Heilman, 1991; Heilman, Barrett and Adair, 1998), may not fully experience their motoric failures. They may even seem to experience motoric success — illusory limb movements (Frith, Blakemore and Wolpert, 2000; Feinberg, Roane and Ali, 2000; Levine, Calvanio and Rinn, 1991). Such patients, with concurrent unawareness of motoric failure, may be more likely to maintain long-held beliefs that are now incorrect — beliefs that overestimate their motor abilities.

It is plausible that concurrent unawareness often plays an important role in the aetiology of anosognosia. But the distinction between concurrent unawareness (a failure to experience motoric failures when they occur) and anosognosia (a failure of belief) is confirmed by thought experiments and empirical findings (Marcel, Tegnér and Nimmo-Smith, 2004). In principle, a patient with impaired proprioception might have no immediate bodily experience of failure to move a paralysed limb yet, on the basis of other evidence, the patient might still reach the correct belief about his or her paralysis (failure of experience without failure of belief). Conversely, a patient with intact proprioception might have vivid bodily experiences of failure to move a paralysed limb but, because the information is not consolidated into more lasting representations, the patient might fail to reach the correct belief about his or her paralysis (failure of belief without failure of experience).

Having an incorrect belief about the severity of an impairment itself is also distinct from having an incorrect belief about the seriousness of the consequences of the impairment for activities of daily living. House and Hodges (1988) present an example that is relevant to this second distinction. They describe an 89-year-old woman who suffered left-side paralysis following a right-hemisphere stroke. When she was examined six months after her stroke, she acknowledged that her left arm was weak, and weaker than her left leg. When it was demonstrated to her that her left arm was completely paralysed and her left leg nearly completely paralysed, she rated the strength of her left elbow and hand/wrist zero out of ten and her left hip, knee and ankle/foot two out of ten. But even while she acknowledged her motor impairments she failed to appreciate their consequences, 'she insisted that she could walk upstairs unaided if she were allowed to' (whereas, in reality, she was restricted to a wheelchair) (House and Hodges, 1988, p. 113). Marcel and colleagues (2004) also report several patients who acknowledged that their left arm was paralysed yet overestimated their ability to carry out bimanual tasks such as tying a knot, clapping hands, or shuffling cards. We might describe such patients as having anosognosia for the consequences of their motor impairment but not anosognosia for the impairment itself. They overestimate their ability to carry out activities of daily living even if they do not, strictly speaking, overestimate their motor abilities.

Thus, we reach the threefold distinction between *concurrent unawareness* of an impairment, *failure to acknowledge* the impairment itself, and *failure to appreciate the consequences* of the impairment for activities of daily living. The first is a failure of experience; the second and third are both failures of belief.

In cases of mild motor impairment, where patients have considerable residual movement in their impaired limbs, there is less room for overestimation of motor abilities. It may be difficult to classify such patients as having substantially incorrect beliefs about their motor abilities. Even mild motor impairments can, however, have serious consequences for activities of daily living such as walking, washing, dressing, grooming, and feeding. So patients who do not have complete hemiplegia may still have dramatically incorrect beliefs about their ability to carry out everyday activities. Assessment of anosognosia, considered as a pathology of belief, should investigate both failure to acknowledge the motor impairment itself and failure to appreciate its consequences. Assessment of the causes of anosognosia should extend to investigation of concurrent unawareness of motoric failure.

3 Assessment of motor impairments and anosognosia

Before one can assess whether a patient has anosognosia for motor impairments, it is necessary to establish that the patient does have a motor impairment. In fact, some researchers (e.g., Berti, Spinazzola, Pia and Rabuffetti, 2007) have argued that only patients with complete hemiplegia should be included in studies of anosognosia because, otherwise, the patient's belief that he or she can move the affected limbs is at least partly correct (see also Berti, Làdavas and Della Corte, 1996; Bisiach, Vallar, Perani, Papagno and Berti, 1986; for discussion, see Vallar and Ronchi, 2006, pp. 252–3).

3.1 Simple assessment of motor impairments and anosognosia

We now outline a procedure for establishing that the patient has a motor impairment. If the primary purpose is to identify patients with complete hemiplegia then a simple assessment

of motor performance is sufficient. The examiner might, for example, ask the patient to raise the affected limb, or to maintain a raised position following passive elevation by the examiner. Three ordinal rating scales that can be used to assess patient performance are presented in Table 23.1: Medical Research Council (MRC) Scale (Guarantors of Brain, 2000), National Institute of Health (NIH) Stroke Scale (Brott, Adams, Olinger, Marler, Barsan, Biller *et al.*, 1989; Goldstein, Bertels and Davis, 1989; Lyden, Lu, Levine, Brott and Broderick, 2001), and the Bisiach Motor Impairment Scale (Bisiach *et al.*, 1986). Complete plegia corresponds to a score of 0 on the MRC Scale, 4 on the NIH scale, and 3 on the Bisiach scale. All three scales have been used in previous studies of anosognosia.

Alongside the Bisiach Motor Impairment Scale (see Table 23.1), Bisiach and colleagues (Bisiach *et al.*, 1986) introduced the Bisiach Anosognosia Scale. A four-point scale is used for assessment of anosognosia, ranging from 0 (no anosognosia) to 3 (severe anosognosia):

0 The disorder is spontaneously reported or mentioned by the patient following a general question about his complaints (no anosognosia)

1 The disorder is reported only following a specific question about the strength of the patient's affected limbs (mild anosognosia)

2 The disorder is acknowledged only after its demonstration through routine techniques of neurological examination (moderate anosognosia)

3 No acknowledgement of the disorder can be obtained (severe anosognosia).

The distinction between moderate and severe anosognosia depends on whether or not the patient acknowledges the disorder 'after its demonstration through routine techniques of neurological examination'. This demonstration would be provided by the assessment of motor impairments mentioned in the previous paragraph. In the case of a patient with a score of 3 for motor impairment of the left arm according to the Bisiach Motor Impairment Scale, the demonstration would be provided by the patient's raised arm falling to the bed surface within five seconds (see Table 23.1).

Many studies (including Bisiach *et al.*, 1986; see also Baier and Karnath, 2005; Berti, Bottini, Gandola, Pia, Smania, Stracciari *et al.*, 2005; Karnath, Baier and Nägele, 2005; Spalletta, Serra, Fadda, Ripa, Bria and Caltagirone, 2007) classify patients as having anosognosia only if they receive a score of 2 (moderate anosognosia) or 3 (severe anosognosia). In a recent study of 128 acute left- and right-hemisphere stroke patients, Baier and Karnath (2005) found that twelve patients (9%) had a score of 2 or 3 (moderate or severe anosognosia). They also found that sixteen of the seventeen patients with a score of 1 (mild anosognosia) spontaneously mentioned other neurological deficits or symptoms of stroke when asked a general question and immediately acknowledged their motor impairments when asked specifically about the strength of their limbs. Baier and Karnath proposed that these patients had no problem accepting their motor impairments but simply mentioned 'subjectively more prominent' symptoms (p. 361) in response to a general question. The authors therefore argued that patients with a score of 1 on Bisiach's Anosognosia Scale should not be classified as having anosognosia.

Table 23.1 Assessment of Motor Impairments

Scale	Instruction	Rating scale
Medical Research Council (MRC) Scale*	*Upper limb*: The patient abducts the upper arm against resistance. (Guarantors of Brain, 2000, Fig. 21).	5. Normal power 4. Active movement against gravity and resistance: 4+ strong resistance 4 moderate resistance 4 – slight resistance
	Lower limb: The patient lies on his or her back and flexes the thigh at the hip against resistance with the leg flexed at the knee and hip (Guarantors of Brain, 2000, Fig. 70).	3. Active movement against gravity 2. Active movement with gravity eliminated 1. Flicker or trace of contraction 0. No contraction
National Institute of Health (NIH) Stroke Scale	*Upper limb*: The arms are placed in the appropriate position: arms outstretched (palms down) at 90° if sitting, or at 45° if supine. Full effort is requested for 10 seconds. If consciousness or comprehension are abnormal, cue patient by actively lifting arms into position as request for effort is orally given.	0. No drift; arm holds 90° (or 45°) for full 10 seconds 1. Drift; arm holds 90° (or 45°) but drifts down before full 10 seconds; does not hit bed or other support 2. Some effort against gravity; arm cannot get to or maintain (if cued) 90°(or 45°), drifts down to bed but has some effort against gravity 3. No effort against gravity; arm falls 4. No movement of arm
	Lower limb: The leg is placed in the appropriate position: while supine, the patient is asked to maintain weaker leg at 30° for 5 seconds. If consciousness or comprehension are abnormal, cue patient by actively lifting the leg into position as request for effort is orally given.	0. No drift; leg holds 30° position for full 5 seconds 1. Drift; leg falls by the end of the 5-second period but does not hit bed 2. Some effort against gravity; leg falls to bed by 5 seconds, but has some effort against gravity 3. No effort against gravity; leg falls to bed immediately 4. No movement of leg
Bisiach Motor Impairment Scale	*Upper limb*: The supine patient is asked to hold the following position for 30 seconds: arm flexed at 45°, forearm extended and supinated, fingers abducted.	0. No defects or minimal defects not scorable as 1 1. Appearance of at least one of the following signs: finger adduction, pronation of the fore-arm, lowering of limb without reaching bed surface within 15 seconds 2. Limb lowers and reaches bed surface within 15 seconds 3. Limb reaches bed surface within 5 seconds
	Lower limb: The supine patient is asked to hold the following position for 30 seconds: thigh flexed at 90°, leg flexed at 90°.	0. No defects or minimal defects not scorable as 1 1. Lowering of limb without reaching bed surface within 15 seconds 2. Limb lowers and reaches bed surface within 15 seconds 3. Limb reaches bed surface within 5 seconds

* Medical Research Council Scale is different in two ways from the NIH Stroke Scale and the Bisiach Motor Impairment Scale: the assessment is for raising the limb (as opposed to maintaining a raised limb) and scoring is in the opposite direction, so that higher scores indicate better motor function.

This recent discussion of 'mild anosognosia' recalls an insightful and perhaps insufficiently recognised contribution to the field by Willanger, Danielsen and Ankerhus (1981). In their study, 55 patients admitted to hospital following right-hemisphere stroke were asked general questions about their stay in hospital and were also explicitly asked whether they could move their limbs. Patients who consistently reported their motor impairments 'were grouped as having adequate understanding of these symptoms' (p. 315). What is noteworthy is that patients who acknowledged their motor impairments only when they were specifically asked if they could move their limbs (fulfilling Bisiach's criterion for mild anosognosia) were not classified as having anosognosia.

Patients who did not report their motor impairments in this initial stage of questioning were asked to move their affected limb, and immediately afterwards were asked to reflect on their performance during their attempt to move the limb. Once their impairments had been demonstrated, eleven patients who 'admitted either that they could not move or had certain difficulties in moving the affected limb' (p. 316) were classified as having neglect of their motor impairments. They did not acknowledge their impairments in the initial stage of questioning, they acknowledged their impairments when they were demonstrated, but usually the acknowledgement was not lasting. These patients fulfilled Bisiach's criterion for moderate anosognosia. Fourteen patients who demonstrated 'obstinate denial of paresis even when the defect was concretely shown at least three times' (p. 316) were classified as having denial of their motor impairments. These patients fulfilled Bisiach's criterion for severe anosognosia. Thus, in total, 25 of 55 right-hemisphere stroke patients (45%) were classified as having neglect or denial of motor impairments (that is, moderate or severe anosognosia, a score of 2 or 3 on Bisiach's anosognosia scale).

3.2 Further assessment of motor impairments

The requirement of complete hemiplegia (score of 0 on the MRC Scale; see Table 23.1) will exclude patients who, despite retaining some movement of the affected limb (scores of 1 to 4 on the MRC Scale), overestimate their ability to move the limb (claiming, for example, that the affected limb is just as strong as the corresponding unaffected limb). In more inclusive studies of anosognosia for motor impairments, rather than only anosognosia for complete hemiplegia, a brief yet detailed motor assessment such as the Motricity Index (or the abridged version of the Medical Research Council Scale[1]) can be used to assess the degree of impairment across different body parts and movement types.

[1] The sixteen commonly tested upper and lower limb movements from the abridged version of the Medical Research Council Scale are listed below (Guarantors of Brain, 2000, p. 62). Five of these sixteen movements are included in the Motricity Index for Motor Impairment after Stroke.

a) *Upper Limb Movements* (shoulder abduction; elbow flexion; elbow extension; radial wrist extension; finger extension; finger flexion; finger abduction);

b) *Lower Limb Movements* (hip flexion; hip abduction; hip extension; knee flexion; knee extension; ankle dorsiflexion; ankle eversion; ankle plantar flexion; big toe extension).

The Motricity Index (MI) for Motor Impairment after Stroke (Demeurisse, Demol and Robaye, 1980) takes about five minutes to administer, and consists of six tests providing a rapid overall assessment of motor impairment:

1 Pinch grip using a 2.5 cm cube between the thumb and forefinger
2 Elbow flexion from 90° so that the arm touches the shoulder
3 Shoulder abduction moving the flexed elbow from off the chest
4 Ankle dorsiflexion with the foot in a plantar flexed position
5 Knee extension with the foot unsupported and the knee at 90°
6 Hip flexion with the hip bent at 90° moving the knee towards the chin.

Medical Research Council grades MRC 0 to MRC 5 are used to measure movement at each joint, and these six grades are then converted into weighted scores ranging from 0 (no movement) to 33 (normal power). Full guidelines for administration and scoring the Motricity Index are provided by Collin and Wade (1990, p. 57).[2] Patients receive an overall score from 0 (no motricity) to 100 (normal motricity) for the upper limb (Tests 1–3) and lower limb (Tests 4–6). As with the MRC scoring, these grades 'indicate strength on the basis of a patient's ability to activate a muscle group, to move a limb segment through a range of motion, and to resist the force of an examiner' (Bohannon, 1999, p. 59).

The Motricity Index has been shown to have excellent validity for both the upper and lower limb scales. Upper limb validity is supported by correlations with grip strength (Sunderland, Tinson, Bradley and Hewer, 1989), with dynamometer measures of muscle strength (Bohannon, 1999) and with other measures of arm function (e.g., Action Research Arm Test: Hsieh, Hsueh, Chiang and Lin, 1998; Rivermead Motor Assessment: Collin and Wade, 1990). Lower limb validity is supported by correlations with dynamometer measures of muscle strength (Cameron and Bohannon, 2000) and with other measures of leg function (e.g., Rivermead Motor Assessment: Collin and Wade, 1990).

[2] Scoring for Test 1:
0 No movement
11 Beginnings of prehension (any movement of finger or thumb)
19 Able to grip the cube, but not hold it against gravity (examiner may need to lift wrist)
22 Able to grip and hold the cube against gravity, but not against a weak pull
26 Able to grip and hold the cube against a weak pull, but weaker than the other side
33 Normal pinch grip.

Scoring for Tests 2–6:
0 No movement
9 Palpable contraction in muscle, but no movement
14 Visible movement, but not full range and not against gravity
19 Full range of movement against gravity but not against resistance
25 Full movement against resistance, but weaker than the other side
33 Normal power.

3.3 Assessment of the consequences of motor impairments for activities of daily living

For a more comprehensive profile of a patient's motor impairments, encompassing the impairments themselves and their consequences, the examiner may wish to use a standard assessment of motor function, such as the Motricity Index, together with an assessment of fundamental mobility (e.g., Rivermead Mobility Index; Collen, Wade, Robb and Bradshaw, 1991) and a measure of functional independence (e.g., Barthel Activities of Daily Living Index; Collin, Wade, Davies and Horne, 1988; Mahoney and Barthel, 1965).[3] While the assessment of motor function provides quantitative information about muscle activation, range of movement and motor strength, the functional measures provide information about the impact of motor impairments on mobility and independence when the patient is engaged in activities of daily living. Together, these measures provide the basis for subsequent assessment of whether the patient acknowledges the impairment itself and appreciates the consequences of the impairment for activities of daily living.

The Rivermead Mobility Index (RMI) is a short, simple, clinically relevant and widely used outcome measure, which focuses on aspects of mobility that are fundamental 'activities that most people will undertake if they possibly can' (Wade, 1992, p. 77). The RMI takes about five minutes to administer, and consists of one direct observation (Question 5, below) and fourteen questions about the patient's ability to perform common daily movements:

1 Turning over in bed
2 From lying in bed to sitting on edge of bed
3 Sitting balance (on edge of bed without holding on for 10 seconds)
4 From sitting in chair to standing
5 *Observe* patient standing unsupported for 10 seconds (no aid and no support)
6 Transfer (from bed to chair and back without help)
7 Walking 10 metres inside (with an aid if needed but no standby help)
8 Flight of stairs (without help)
9 Walking outside (even ground, without help)
10 Walking 10 metres inside (with no aid or standby help)
11 Picking items off floor (walking 5 metres to the dropped item and back)
12 Walking outside (uneven ground, without help)
13 Bathing (in and out of bath or shower unsupervised)
14 Climbing up and down four steps (with no rail, but with an aid if needed)
15 Running or fast walking (10 metres in 4 seconds).

[3] Recommended versions of each measure – Motricity Index, Rivermead Mobility Index and Barthel Activities of Daily Living Index – can also be found in *Measurement in neurological rehabilitation* (Wade, 1992).

Patients receive a score from 0 to 15, with higher scores indicating better mobility. The RMI has been shown to be reliable and sensitive to change during hospital rehabilitation and it is a valid measure of functional status, both before and after rehabilitation programmes (Antonucci, Aprile and Paolucci, 2002; Chen, Hsieh, Lo, Liaw, Chen and Lin, 2007; Green, Forster and Young, 2001). Good validity has been demonstrated in correlations with other validated measures (e.g., Motricity Index for the Lower Limb, Trunk Control Test and Functional Independence Measure: Franchignoni, Tesio, Benevolo and Ottonello, 2003).

The Barthel Activities of Daily Living (ADL) Index (Collin *et al.*, 1988; Mahoney and Barthel, 1965) is probably the most widely used instrument for measuring functional independence following stroke, and for most patients the ten questions take only five minutes to complete:

1 Control bowels
2 Control bladder
3 Grooming (personal care with implement provided: face, hair, teeth, shave)
4 Toilet use (reach toilet, handle clothes, clean self)
5 Feeding (food provided within reach but not cut up)
6 Transfer (from bed to chair and back)
7 Mobility (with aid e.g., stick; in wheelchair must negotiate corners/doors unaided)
8 Dressing (selecting clothes and using buttons, zips, laces)
9 Stairs (ascending and descending)
10 Bathing self (bath or shower, unsupervised and unaided).

A scale ranging from 0 to 20 in one-point increments is commonly used, as it has been argued that Mahoney and Barthel's original scoring (with a scale ranging from 0 to 100 in five-point increments) may give an exaggerated impression of accuracy (Collin *et al.*, 1988; Wade and Hewer, 1987). For each item, the patient is rated as either independent (1, 2, or 3 points, depending on the item), able to perform the given task with help (0, 1, or 2 points, depending on the item), or cannot meet the criteria for a higher score (0 points). A maximum score of 20 (or 100 in the original scoring system) means that the patient is functionally independent (but not necessarily that the patient has normal mobility). Full guidelines for administration and scoring of the Barthel ADL Index, using the 20-point scale, are provided by Collin and colleagues (1988). Reliability and validity of the Barthel ADL Index as a measure of disability have been established in a number of studies (Collin *et al.*, 1988; Green *et al.*, 2001; Wade and Collin, 1988; Wade and Hewer, 1987).

3.4 Assessment of anosognosia for the consequences of motor impairments

Collin and colleagues (1988) also investigated four methods of obtaining information for the Barthel ADL Index:

(a) asking for information from:
— (1) the patient (or a relative) or
— (2) a nurse who had worked with the patient for at least one shift,

(b) direct observation of the patient, who was tested either by:
— (3) a trained nurse or
— (4) an occupational therapist.

The findings obtained by the four methods were comparable, and the authors state 'the method of obtaining the information does not appear to be important, but allowance needs to be made for confused patients if self-reporting is used' (p. 62). They found that method (1) was slightly less reliable, in that the patient's (or relative's) report was the most likely not to agree with the other three methods.

These findings lead us to implement a dual scoring system when administering the Barthel ADL Index (and also the Rivermead Mobility Index). Specifically, the system separates a score based on *self*-report (that is, by the patient) from a score based on report by a nurse who had worked with the patient for at least one shift. On this dual scoring system, the nurse's report provides a quick and reliable measure of the patient's mobility and independence, while comparison with the patient's self-report reveals the extent to which the patient fails to appreciate the consequences of his or her motor impairments for activities of daily living.

Summary: A simple assessment of motor impairments using the MRC Scale, the NIH Stroke Scale, or the Bisiach Motor Impairment Scale can be combined with a simple assessment of anosognosia for motor impairments using Bisiach's Anosognosia Scale. A diagnosis of anosognosia would be based on a score of 2 (moderate anosognosia) or 3 (severe anosognosia) on Bisiach's Anosognosia Scale. A more comprehensive assessment of motor impairments and their consequences (using, for example, the Motricity Index, the Rivermead Mobility Index, and the Barthel ADL Index) invites a more nuanced assessment of anosognosia for motor impairments and, with a dual scoring system for the functional measures, allows an initial assessment of anosognosia for the consequences of motor impairments. A diagnosis of anosognosia would be based on a substantial difference between the patient's self-report and the report by a nurse who had worked with the patient for at least one shift.

4 Assessment of anosognosia: structured interviews

A structured interview can provide important information concerning the patient's beliefs—whether the patient acknowledges his or her motor impairments and whether the patient appreciates the consequences of those impairments for activities of daily living. Table 23.2 lists the questions used in nine structured interviews for which the assessment protocol has been published. The table reveals the overlap amongst these interviews, and the manner in which later protocols have built on earlier ones. For example, the interviews presented by Nathanson and colleagues (1952), Cutting (1978) and Starkstein and colleagues (1992) include five questions in common, two general questions about the reasons for the patient's hospitalisation and three questions about the patient's motor impairments (see columns 1, 2, and 4 of Table 23.2A and 23.2B).

Table 23.2 Questions from Nine Structured Interviews for the Assessment of Anosognosia

	Nathanson *et al.* (1952)	Cutting (1978)	Anderson and Tranel (1989)	Starkstein *et al.* (1992)	Berti *et al.* (1996)	Maeshima *et al.* (1997)	Feinberg *et al.* (2000)	Marcel *et al.* (2004)	Spinazzola *et al.* (2008)
A. General Questions:									
Where are we?					√				√
Do you have any trouble?						√			
Why are you here? or Why are you in the hospital? or Why are you now in the hospital?	√	√	√	√	√	√		√	√
What is the matter with you? or What is wrong with you?	√	√	√	√				√	
Is there anything wrong with you?									√
If primary reason for hospitalisation is not explicitly described, Examiner asks: Did you have a stroke?			√						
B. Acknowledgement of Motor Impairments:									
Are you paralysed?						√			
How do your arms (legs) work? Can you move them normally? Both of them?			√						
Can you move your arms or legs?						√			
Examiner indicates paralysed limb: Can you move this hand or foot?						√			
Is there anything wrong with it [limb]? or Is there anything wrong with your arm or leg?	√	√		√					
Examiner either points to or raises the affected limb: Is there anything wrong with it?	√								
Can you move it [limb]? Raise it?	√								
Is your limb weak, paralysed, or numb? How does your limb feel?	√	√		√					
Examiner holds up affected limb: What is this?	√	√		√					
Can you lift it [arm]? You clearly have some problem with this?		√		√					
Examiner asks patient to raise both arms: Can't you see that the two arms are not at the same level?		√		√					
How well do your arms and legs work?								√	
Can you move your arms (legs) normally? Both of them?								√	
Is either of your arms (legs) weak? This one, that one?								√	
Do you have weakness anywhere?							√		
Is your arm causing you any problems?							√		
Does it [arm] feel normal?							√		
Can you use it [arm] as well as you used to?							√		
Are you fearful about losing your ability to use your arm?							√		
The doctors tell me that there is some paralysis of your arm. Do you agree?							√		
Examiner lifts and drops patient's affected arm, first in contralateral hemispace, then in ipsilateral hemispace: It seems there is some weakness. Do you agree?							√		
Take your right arm, and use it to lift your left arm. Is there any weakness of your left arm?							√		
How is your left arm (leg)? Can you move it?					√				√
If patient says he/she cannot move arm, Examiner asks: Why can you not move your left arm?					√				

√ Researchers who used the question(s) indicated.

(continued)

Table 23.2 *(continued)* Questions from Nine Structured Interviews for the Assessment of Anosognosia

	Nathanson *et al.* (1952)	Cutting (1978)	Anderson and Tranel (1989)	Starkstein *et al.* (1992)	Berti *et al.* (1996)	Maeshima *et al.* (1997)	Feinberg *et al.* (2000)	Marcel *et al.* (2004)	Spinazzola *et al.* (2008)
If patient verbally denies left upper limb motor impairment, Examiner asks: Please, touch my hand with your left hand. Have you done it? Why have you not done it? Are you sure? It is very strange because I have not seen your hand touching my hand.					√				
C. Appreciation of the Consequences of Motor Impairments:									
How do you think you did on these tests today?			√						
Based on how you are doing now, do you think you will be able to return to your normal activities in the next several weeks?			√						
In your current state, do you have any problems with daily activities (e.g., eating, dressing, washing, getting about)?								√	
Patient asked whether he or she can perform a range of 'analytic' movements (e.g., put left hand on left shoulder, straighten knee).									√
Patient asked to estimate his or her capacity to perform unimanual, bimanual and bipedal tasks.					√			√	√
Third-person estimate: Patient asked to estimate examiner's capacity to perform unimanual, bimanual and bipedal tasks if the examiner were in the patient's present state.					√			√	
Can you walk without any problem?					√				
Post-performance estimate: Patient asked to re-estimate capacity to perform unimanual, bimanual and bipedal tasks (after attempt has been made to perform these tasks).								√	
D. Anosognosic Phenomena:									
Is it a nuisance? How much trouble does it cause you? What caused it?		√							
Do you ever feel that it doesn't belong? Do you feel that it belongs to someone else?		√							
Do you feel the arm is strange or odd?		√							
Has your arm or leg felt strange in any way?								√	
Have you had any other strange sensations?								√	
Do you dislike the arm? Do you hate it?		√							
Do you have strong feelings about it?		√							
Do you ever call it names?		√							
Do you ever feel it moves without your moving it yourself?		√							
How is the other arm?		√							
Do you ever feel a strange arm lying beside you separate from the real arm?		√							

√ Researchers who used the question(s) indicated.

It is important to notice that, although most researchers ask patients whether they are able to move or raise their limbs, the researcher may or may not ask the patient actually to attempt the movement. Questions that do involve a request for the patient to move an affected limb, and consequently provide a demonstration of the patient's impairment, allow the examiner to distinguish moderate from severe anosognosia (Bisiach *et al.*, 1986) or, equivalently, mere neglect of motor impairments from full denial of motor impairments (Willanger *et al.*, 1981).

Some structured interviews investigate the patient's appreciation of the consequences of motor impairments for activities of daily living (see Table 23.2C). Patients who correctly acknowledge their motor impairments may still fail to appreciate the consequences of those motor impairments and so they may overestimate their ability to carry out everyday activities. In the structured interview of Marcel and colleagues (2004), patients are specifically asked whether they have problems with everyday activities of eating, dressing, washing, and getting about. Since patients with motor impairments may develop strategies for accomplishing these tasks, denial of problems with these everyday activities does not, by itself, amount to unequivocal evidence of anosognosia.

A more sensitive method of detecting anosognosia for the consequences of motor impairments is to ask patients about their capacity to perform bimanual and bipedal tasks (Nimmo-Smith, Marcel and Tegnér, 2005), that is, tasks that involve both sides of the body. This approach has been used by Berti and colleagues (1996), Marcel and colleagues (2004) and Spinazzola and colleagues (Spinazzola, Pia, Folegatti, Marchetti and Berti, 2008).

However, the patient's answers to questions about tasks that are assumed to be bimanual or bipedal may still not provide an accurate assessment of whether the patient appreciates his or her limitations. It is strongly recommended that the examiner should ask patients to demonstrate, or at least describe how they would execute, any bimanual or bipedal tasks that they claim to be able to perform. Recently, we assessed a gentleman with complete right-side hemiplegia. When asked whether he could attach a handkerchief to a ring by tying a knot, he responded 'yes' and promptly carried out the task — antecedently classified as bimanual — using his left hand only. The patient's affirmative answer to our initial question whether he could perform the task might have led us to assume that he was overestimating his abilities and had anosognosia for the consequences of his motor impairments. (The 'tie a knot' question is a good predictor of consistent overestimation of bimanual abilities; Nimmo-Smith *et al.*, 2005.) Only by asking the patient actually to perform the action did we discover that, having acknowledged his impairments and appreciated their consequences, he had developed impressive skills for managing so-called bimanual tasks with his unaffected left hand.

Patients who, in response to questions, overestimate their abilities may nevertheless display some partial or implicit knowledge of their limitations. For example, patients may make an accurate estimate of the abilities of another impaired person, even while acknowledging that the other person's condition is similar to their own (House and Hodges, 1988).

Marcel and colleagues (2004) investigated this phenomenon by asking questions about bimanual and bipedal tasks in two forms. For example: 'In your present state, how well can you tie a knot?' (first-person form) versus 'If I were in your present state, how well would I be able to tie a knot?' (third-person form).[4] Marcel and colleagues (2004) found that some patients following right-hemisphere stroke gave higher estimates in response to the first-person form of questions than in response to the third-person form (for discussion, see Vallar and Ronchi, 2006, p. 249). Using a similar protocol, Berti and colleagues (1996) did not find differences in patients' responses to the two forms of the questions.

The final section of the table (see Table 23.2D) lists questions on *anosognosic phenomena*, defined as unusual beliefs or experiences relating to the affected limbs. These questions are for the most part taken from Cutting (1978), who assessed a wide range of phenomena involving the contralesional arm, such as beliefs about non-belonging of the arm, including attribution of the arm to another person (somatoparaphrenia) and experiences of a third arm protruding from the patient's own body (supernumerary phantom limb). The structured interview of Marcel and colleagues (2004) also includes questions along these lines.

4.1 Occurrence rates for anosognosia

There are substantial differences in reported occurrence rates for anosognosia (number of patients with anosognosia divided by study population). Table 23.3 presents the occurrence rates for those studies that did not use presence (or absence) of anosognosia, or related pathologies such as unilateral neglect, as a selection criterion. As can be seen from the table, the method of assessment of anosognosia varies widely across the studies (column 1). This variation may contribute to the differences in reported occurrence rates. Some studies include both left- and right-hemisphere stroke patients while other studies include only left-hemisphere or only right-hemisphere patients (column 3). These differences in study population may impact on occurrence rates, as may time since stroke (column 4) and the level of motor impairment that is required for entry to the study (column 5). In addition, as discussed in Section 3.1, reported occurrence rates may depend heavily on the decision whether to classify patients with a score of 1 on Bisiach's Anosognosia Scale as having anosognosia (Baier and Karnath, 2005).

[4] The questions actually used by Marcel and colleagues (2004, p. 24) were rather more complicated than this. First-person form: 'In your present state how well, compared with your normal ability, can you tie a knot? If you can do it as well as usual, say "ten". If you cannot do it at all, say "nought".' Third-person form: 'If I were in your present state, how well would I be able to tie a knot, compared with my usual ability? If I could do it as well as usual, say "ten". If I could not do it at all, say "nought".'

Table 23.3 Occurrence Rates for Anosognosia in Patients with Left- or Right-Hemisphere Lesions

Method of assessment	Published report	Study population	Time since stroke	Level of motor impairment	Occurrence rates for anosognosia: % (number assessed)		
					Left hemisphere	Right hemisphere	Left and right hemisphere
Nathanson *et al.* (1952)	Nathanson *et al.* (1952)	100 (95 stroke) consecutive patients with hemiplegia; 76 assessed for anosognosia.	1 day to several years.	Complete hemiplegia.	23.08% (39)	51.35% (37)	36.84% (76)
Cutting (1978)	Cutting (1978)	100 (96 stroke) patients with hemiplegia over 2-year period in a General Hospital; 70 assessed for anosognosia.	Within 8 days.	4-point scale: slight, moderate, severe, total.	13.64% (22)	58.33% (48)	44.29% (70)
	Stone *et al.* (1993)	171 consecutive stroke patients; 116 assessed for anosognosia.	2–3 days.	Not selected by motor impairment.	5.36% (56)	28.33% (60)	17.24% (116)
Willanger *et al.* (1981)	Willanger *et al.* (1981)	55 consecutive RH-stroke patients over a 3-year period.	Not specified.	Paresis graded as: slight-moderate or marked-severe.		45.45% (55)*	
Hier *et al.* (1983)	Hier *et al.* (1983)	41 RH-stroke patients assessed consecutively by Stroke Service.	Within 7 days.	6-point scale: 0 (no movement) to 5 (normal strength).		36.59% (41)	
Bisiach *et al.* (1986)	Bisiach *et al.* (1986)	97 RH patients; 36 with complete hemiplegia assessed for anosognosia.	Within 37 days.	Severe motor impairment.		33.33% (36)*	
	Pederson *et al.* (1996)	566 consecutive unselected stroke patients.	Within first week.	Not selected by motor impairment.	9%	36%	20.85% (566)
	Azouvi et *al.* (2002)	206 consecutive RH patients with first-ever stroke.	Average 11.1 weeks.	4-point scale: 0 (no deficit) to 3 (severe hemiplegia).		17% (206)	
	Beis et *al.* (2004)	89 consecutive LH-stroke patients from 19 Centres; 78 assessed for anosognosia.	Average 10.8 weeks.	3-point scale: 0 (no deficit) to 2 (severe hemiplegia).	6.41% (78)		
	Baier and Karnath (2005)	128 consecutive stroke patients with hemiparesis or hemiplegia.	Up to 15 days.	6-point scale: 0 (no movement) to 5 (normal movement).			Total: 22.66% (128) Moderate or severe: 9.38% (128)*
	Spalletta *et al.* (2007)	50 consecutive RH-stroke inpatients.	Within 3 months.	Not selected by motor impairment.		26% (50)*	
	Baier and Karnath (2008)	79 RH-stroke patients with left hemiparesis or hemiplegia.	Within 10 days.	6-point scale: 0 (no movement) to 5 (normal movement).		15.19% (79)*	

(continued)

Table 23.3 *(continued)* Occurrence Rates for Anosognosia in Patients with Left- or Right-Hemisphere Lesions

Method of assessment	Published report	Study population	Time since stroke	Level of motor impairment	Occurrence rates for anosognosia: % (number assessed)		
					Left hemisphere	Right hemisphere	Left and right hemisphere
Anderson and Tranel (1989)	Anderson and Tranel (1989)	32 stroke patients referred for neuropsychological assessment; 18 with dense hemiparesis assessed for anosognosia.	3–25 days.	Dense hemiparesis.			27.77% (18)
	Wagner and Cushman (1994)	108 consecutive stroke patients from two acute Neurorehabilitation Centres.	Average 4.9 weeks.	Not selected by motor impairment.			18.1% (108)
	Hartman-Maeir *et al.* (2001)	60 patients with first-ever stroke; 46 with severe motor deficit of arm assessed for anosognosia.	4–8 weeks.	Severe.	23.53% (17)	27.59% (29)	26.09% (46)
Starkstein *et al.* (1992)	Starkstein *et al.* (1992)	80 stroke patients selected from 96 consecutive admissions.	Approximately 1 week.	Not selected by motor impairment.			Total: 33.75% (80) Moderate or severe: 23.75% (80)*
	Appelros *et al.* (2002)	377 stroke patients recruited from Örebro, Sweden over 12 months; 276 assessed for anosognosia.	1–4 days.	Not selected by motor impairment.			Total: 17.39% (276) Moderate or severe: 11.96% (276)*
Berti *et al.* (1996)	Berti *et al.* (1996)	34 chronic stoke patients from Geriatrics, selected by RH damage and complete hemiplegia.	Average 60 days.	Complete hemiplegia.		26.47% (34)	
Maeshima *et al.* (1997)	Maeshima *et al.* (1997)	50 patients with RH cerebral haemorrhage.	Within 30 days.	Severe or moderate-mild.		24% (50)	
Marcel *et al.* (2004)	Marcel *et al.* (2004)	64 stroke patients recruited from seven hospitals, selected by hemiplegia.	Average 79.1 days (LH) 55.7 days (RH).	Severe motor deficit in at least one limb.	Arm: 0% (22) Leg: 9.09% (22) ADL: 13.64% (22)	Arm: 28.57% (42) Leg: 29.27% (41) ADL: 52.38% (42)	Arm: 18.75% (64) Leg: 22.22% (63) ADL: 39.06% (64)
Cocchini *et al.* (2009)	Cocchini *et al.* (2009)	33 LH-stroke patients with motor impairments; 30 patients selected as per reliable responses on the Visual Analogue Test.	Average 73.8 days.	4-point scale: 0 (normal motor performance) to 3 (complete hemiplegia).	40% (30)		

LH = Left Hemisphere; RH = Right Hemisphere; ADL = Activities of Daily Living.

* Moderate or severe anosognosia: The patient did not acknowledge his or her deficits until these were demonstrated (moderate) or never acknowledged the deficits (severe).

5 A comprehensive assessment of anosognosia for motor impairments

A new structured interview for the assessment of anosognosia for motor impairments is presented at the end of this chapter. The approach is theoretically motivated and relatively comprehensive. The assessment incorporates items from the interviews presented in Table 23.2 as well as items that build on earlier protocols. Any assessment of anosognosia depends on a prior assessment of the patient's motor impairments and their consequences and so the structured interview is to be used alongside assessments of motor impairments and their functional consequences, such as the Motricity Index, the Rivermead Mobility Index, and the Barthel Activities of Daily Living Index (Section 3). A full investigation of anosognosia must also include assessments of factors that may play a role in its aetiology such as unilateral neglect, 'a notable suspect in anosognosia' (Vuilleumier, 2004, p. 10), and other factors that may impact on recovery and rehabilitation.

The new structured interview is made up of four modules. The first module does not involve any request for the patient actually to perform tasks using the affected limbs. It includes questions about the primary reason for hospitalisation (Q1), about the patient's acknowledgement of motor impairments (Q2), and about the patient's appreciation of the consequences of his or her motor impairments for activities of daily living (Q3). It also investigates anosognosic phenomena (Q4). Although questions about these phenomena have not been incorporated into most structured interviews, we believe that they may prove useful for assessment and rehabilitation, since patients are unlikely to mention these unusual beliefs and experiences spontaneously.

Thereafter, the structure of the assessment is dictated by the threefold distinction (explained in Section 2 of this chapter) between concurrent unawareness of an impairment, failure to acknowledge the impairment itself, and failure to appreciate the consequences of the impairment for activities of daily living. Thus, the second module investigates whether the patient is concurrently aware of motoric failures of the affected arm or leg. With vision precluded, the patient is requested, for the first time, to move his or her limbs (Q5). If the patient is seated, he or she is requested to raise each arm, and then both arms, to shoulder level and to raise each leg by extending it at the knee. If the patient is supine, he or she is requested to raise each arm, and then both arms, and each leg from the bed surface, to a position indicated by the examiner.

It is not the primary purpose of this second module to investigate the patient's beliefs as to whether he or she is really able to move the affected limbs. Still less is it intended to challenge the patient's beliefs by providing evidence of failure. Instead, the purpose of the module is to provide information about the patient's proprioceptive experience as he or she tries to move the affected limbs; that is, information about the patient's bodily awareness or unawareness of motoric failures when they occur.[5] This is theoretically important because concurrent unawareness of motor impairments may be a factor in failure to acknowledge those impairments. It is only at the end of the module, and only if the patient has reported feeling as if he or she succeeded in moving the affected limbs (illusory limb movements), that the examiner asks whether the patient believes that the limbs really moved. The patient's beliefs about whether he or she can move the affected limbs are the focus of the next module.

As we have seen, one of the key aspects of the assessments of anosognosia by Willanger and colleagues (1981) and Bisiach and colleagues (1986) is that the patient's impairment is demonstrated and the patient is given the opportunity to reflect on this evidence of failure and to acknowledge his or her motor impairments. This allows us to distinguish between moderate and severe anosognosia. The third module investigates whether the patient acknowledges his or her motor impairments, both before (prior belief) and after (posterior belief) an impairment is demonstrated (Q6, raise the limb, and Q7, maintain the limb in a raised position). In order that the evidence of failure should be maximally available to the patient, vision is permitted. All questions are first asked concerning the unaffected limb. This allows the examiner to check that the patient understands the task and also provides a control condition against which responses to questions about the affected limb can be compared.

The fourth module investigates whether the patient appreciates the consequences of motor impairments for activities of daily living. One of the key points in Section 4 of this chapter is that an investigation of anosognosia for the consequences of motor impairments should include asking the patient to perform, or at least describe how they would perform, various tasks. In this module, first-person and third-person forms of questions about unimanual, bimanual, and bipedal tasks are used (Q8) and the patient is asked to rate his or her abilities both before (prior belief) and after (posterior belief) actually trying to perform an action (Q9). Some of the actions involve interaction with objects and so the subsequent position of the objects provides clear evidence of success or failure of the attempt.

By testing the patient's belief revision, the third and fourth modules assess whether the patient makes appropriate use of available evidence of his or her limitations. Thus, the second, third, and fourth modules together could, in principle, go beyond detecting anosognosia for motor impairments and provide the beginnings of an explanation of some cases of anosognosia. The explanation would be of a familiar two-factor kind in which impairment of immediate bodily experience of motoric failure, and cognitive impairments that obstruct the appropriate use of available evidence to update beliefs, would

[5] The second module builds on a protocol used by Marcel and colleagues (2004). In their study, as part of an assessment of motor function and separately from the main anosognosia interview, patients were asked to raise each limb with vision precluded and their performance was rated objectively using the MRC scale (Table 23.1). As soon as the assessment of motor function was complete, 'patients were asked how much they had been able to move each arm and each leg' (p. 23). In making this post-performance evaluation, patients had to rely on 'immediate episodic experience' provided by proprioception, since they were blindfolded and no other feedback was given (p. 32). To the extent that patients gave an unrealistically high evaluation of their performance in trying to move their affected limbs, they were judged to be concurrently unaware of their motoric failure.

both play a role (Aimola Davies and Davies, 2009; Aimola Davies *et al.*, 2009; Davies, Aimola Davies and Coltheart, 2005; Levine, 1990; Levine *et al.*, 1991). As Vuilleumier says (2004, p. 11): 'any neurological dysfunction susceptible to alter the phenomenal experience of a defect might provide the ground out of which anosognosia can develop when permissive cognitive factors are also present'.

6 Conclusion

A theoretical framework for this chapter is provided by the threefold distinction between concurrent unawareness of an impairment, failure to acknowledge the impairment itself, and failure to appreciate the consequences of the impairment for activities of daily living (Section 2). A simple assessment of anosognosia for motor impairments can be carried out at the same time as a routine assessment of motor impairments. An initial assessment of anosognosia for the consequences of motor impairments can be obtained by using a dual scoring system with functional measures of mobility and independence. A more comprehensive assessment of motor impairments and their consequences invites a correspondingly more nuanced assessment of anosognosia (Section 3).

We began this chapter with the proposal that a comprehensive and widely accepted procedure for assessing anosognosia for motor impairments would contribute to a better understanding of the many factors in anosognosia and might also lead to improvement in the clinical management of patients. Building on published structured interviews (Section 4) and other protocols, we have presented a theoretically motivated and relatively comprehensive instrument for assessing anosognosia (Section 5). We hope that this new structured interview will contribute to our understanding of the occurrence, aetiology, time course, and treatment of anosognosia and that this will lead, in turn, to improved recovery and rehabilitation for patients.

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