AWARENESS OF DEFICITS AFTER BRAIN INJURY: THE ROLE OF EXECUTIVE FUNCTION AND METACOGNITION

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OVERVIEW

Part 1, the Literature Review, introduces the phenomenon of impaired self-awareness after brain injury. Examples of theoretical models influential in the understanding of impaired self-awareness are described. A review of the empirical literature on the role of executive function in impaired self-awareness after brain injury is reported, which includes ten relevant studies. Impaired executive functioning was found to be associated with impaired self-awareness in the majority of these studies. This is despite variations in the way impaired self-awareness and executive functions were assessed, and mixed patient samples.

Part 2, the Empirical Paper, reports a study aiming to assess the relationship of executive function and metacognition to impaired awareness of deficit after brain injury. Impaired self-awareness was measured by the discrepancy between patient and significant other's report on a questionnaire asking about functional deficits. The Brixton Spatial Anticipation Test assessed executive function, and patients were asked to rate their confidence in each guess in order to assess metacognition. No statistical associations were found between the cognitive measures and impaired self-awareness. However, anxiety and depression levels were associated with awareness of deficits. Impaired self-awareness was greater in patients with frontal brain lesions. Level of brain injury severity was not associated with self-awareness.

Part 3, the Critical Appraisal, discusses the process of arriving at this topic of study, the challenges posed by the research setting and ethical considerations. Limitations of the study design are discussed in further depth.

CONTENTS

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If our brains were so simple that we could understand them,

we would be so simple that we could not.

Anonymous

PART 1: LITERATURE REVIEW

A Review of the Empirical Literature examining the Role of Executive Function in Impaired Self-Awareness after Brain Injury

Abstract

This review discusses the phenomenon of impaired self-awareness after brain injury. Examples of theoretical models influential in the understanding of impaired self-awareness are described. On a cognitive level, executive processes are implicated in the construction of self-awareness. A review of the empirical literature on the role of executive function in impaired self-awareness after brain injury is reported, in which ten relevant studies are reviewed. The most prevalent method of assessing impaired self-awareness has been by questionnaire. Impaired executive functioning was found to be associated with impaired self-awareness in the majority of studies. This is despite variations in the way impaired self-awareness and executive functions were assessed, and mixed patient samples with regard to severity and cause of brain injury, lesion location, time since injury, inclusion and exclusion criteria, and whether they had received rehabilitation. Recommendations for future research are made.

1.Introduction

This review will discuss the phenomenon of impaired self-awareness after brain injury. The curious and wide-ranging ways in which it can manifest will be described. Research findings on its association with location of brain injury, severity of brain damage and general intellectual ability will be outlined. Examples of theoretical models influential in the understanding of impaired self-awareness will be covered. A review of the empirical literature on the role of executive function in impaired self-awareness after brain injury will be reported, with implications for future research.

2. Impaired Self-Awareness after Brain Injury

2.1 The Clinical Phenomenon

Disorders of self-awareness are common following neurological injury and illness. Approximately 30% of severe traumatic brain injury (TBI) patients show residual impairment of self awareness months and years after their injury (Prigatano & Altman, 1990). Typical examples include denial of hemiplegia, blind patients who insist they can see, and those with amnesia who claim their memory is intact. Several terms have been used in the literature to refer to this phenomenon, including anosognosia, impaired self-awareness, and denial. In this review the term "impaired self-awareness" (ISA) will be used.

An individual can have impaired awareness for virtually any neurological or functional deficit. The definition given by Prigatano (1996) is "the clinical

phenomena in which a brain dysfunctional patient does not appear to be aware of impaired neurological or neuropsychological function, which is obvious to the clinician and other reasonably attentive individuals. The lack of awareness appears specific to individual deficits and cannot be accounted for by hyperarousal or widespread cognitive impairment" (pp80-81).

Disorders of self-awareness vary with regard to the kind of deficit of which awareness is impaired, whether the impaired awareness is seen across all deficits a patient may present with, and whether the implications of these deficits for functioning are acknowledged by the patient. The range of presentations will be described in detail later.

2.2 The Importance of Understanding Impaired Self-Awareness

It is important to develop an understanding of ISA for several reasons. A greater understanding of ISA would be relevant to a range of disorders. The phenomenon of ISA is seen after brain injury of various causes, as well as in psychiatric conditions such as Alzheimer's Dementia and Schizophrenia. Therefore a better understanding of it could inform the assessment, management and rehabilitation of these conditions.

ISA interferes with the rehabilitation of brain-injured patients in a number of ways. It interferes with collaborative goal setting and patients' motivation. Fleming, Strong & Ashton (1998) found that patients not aware of their rehabilitation needs show poor motivation and set unrealistic goals for themselves. They may comply poorly with treatment (Lam, McMahon, Priddy, & Gehred-Schultz, 1998; Malec, Smigielski, &

DePompolo, 1991) and develop fewer compensatory strategies (Ownsworth, McFarland, & Young, 2000). For such reasons many authors share the view that rehabilitation interventions should focus on enhancing individual self-awareness of deficits (Sherer et al., 1998). A better understanding of ISA would allow better tailoring of interventions to the individual patient.

As well as affecting engagement with rehabilitation, ISA has a detrimental effect on functional outcome after rehabilitation programmes. Ratings of ISA made early on in rehabilitation after TBI were found to relate to measures of functional independence at discharge and were predictive of later employment (Sherer, Hart & Nick, 2003). A similar outcome was seen for patients with brain injury as a result of cerebrovascular accidents (Jehkonen et al., 2000).

2.3 Characteristics of Impaired Self Awareness after Brain Injury

The phenomenon of ISA manifests in a variety of ways. Patients are more likely to acknowledge motor and sensory impairments than cognitive, social or emotional changes in functioning (Fleming & Strong, 1999; Hibbard & Gordon, 1992; Toglia & Kirk, 2000).

ISA can vary with regard to 'extension' of awareness. This is the extent to which the deficit is comprehended. A patient can have knowledge that a deficit exists but not an appreciation of the consequences of the deficit. For example, Rubens & Garrett (1991) described patients who were aware that they had aphasia but who were not aware of errors in speech as they made them. The opposite dissociation has also been

seen (Marcel, Tegner, & Nimmo-Smith, 2004). ISA also varies in 'specificity' of awareness. This is the degree to which impaired awareness is restricted to a particular deficit or whether it is present for all deficits a patient may have. ISA can also vary with 'partiality' of awareness. This is whether unawareness of the deficit is complete (Schacter & Prigatano, 1991). For example, patients' presentations sometimes imply some degree of awareness of their deficit. Bisiach and colleagues (Bisiach & Geminiani, 1991; Bisiach & Berti, 1987) reported that most patients with hemiplegia who verbally deny their disability usually seem to accept it implicitly by staying in bed or using a wheelchair.

In addition to this variety of presentations, ISA can change over time (Prigatano, 1999). Observations suggest that immediately after injury many patients grossly overestimate their abilities across a broad range of functions. Over time awareness of deficits can increase for a proportion of patients (Fleming et al., 1999; Ownsworth, Clare, & Morris, 2006). Godfrey, Bishara, Partridge, & Knight (1993) found that the development of awareness of deficits is most pronounced between approximately 6 and 12 months post-injury. Approximately 30% of severe TBI patients show residual ISA months and years after their injury (Prigatano et al., 1990).

Those patients with ISA persisting months and years after their TBI show bilateral and asymmetric lesions throughout the brain, including the brain stem and cerebellum (Prigatano et al., 1990). This suggests that persistent problems of ISA after TBI may require bilateral diffuse cerebral dysfunction (Prigatano, 1999). Sherer, Hart, Whyte, Todd, & Yablon (2005) found that ISA was significantly associated with the number but not with the location or volume of focal lesions early

after TBI. They took this finding to imply that ISA may reflect disruption in the integrated operation of broadly distributed networks, with lesion burden in any specific region being less relevant than disruption across multiple regions. Neuroimaging studies in normals also help to shed light on the brain areas that may be involved in judgements made about the self. Under fMRI, the anterior medial prefrontal and posterior cingulate areas showed activation. There was also significant activation in the thalamus. These findings indicate that these may be important neural circuits in self-awareness (Johnson et al., 2002). However, ISA has also been seen after focal lesions in only deep brain structures. House & Hodges (1988) report a patient who denied hemiplegia and had an infarct in the right basal ganglia and showed no cortical damage.

Severity of brain injury is often measured by the Glasgow Coma Scale (GCS - Teasdale and Jennett, 1974) or the length of Post-Traumatic Amnesia (PTA). The GCS score is correlated with duration of coma and both of these measures are correlated with the amount of damage to the central brain structures of the corpus callosum, brainstem and cerebellum. There is no correlation between GCS or length of coma with the amount of damage to hemispheric regions (Wilson et al 1994). While measures of injury severity aid communication between medical units and hospital staff, they have been criticised as being difficult measures to administer accurately. Duration of coma is hard to estimate in less severely injured patients who have often recovered consciousness by the time they are admitted to hospital (Gronwall &Wrightson, 1980). There is controversy over the optimal time of administration of the GCS, as consciousness can fluctuate (Richardson, 2000). A patient's clinical state in the first few hours after their brain injury may be

contaminated by complications of other injuries such as respiratory insufficiency or be confounded by sedative medication or the influence of alcohol. The GCS had been criticised for being insensitive to injuries in the mild range (Kraus and Nourjah 1989).

Evidence for a link between level of ISA and severity of brain injury is mixed. Prigatano (1999) has reported a number of studies reporting significant associations between severe brain injury and ISA but a similar number of studies fail to support this link (Allen and Ruff 1990; Anderson and Tranel 1989; Fleming et al 1998; Sbordone et al 1998). The mixed findings may be due to the shortcomings of the measures used to assess injury severity. Alternatively the mixed findings may suggest that ISA can be present without damage to deep brain structures.

There have been mixed findings as to the role of general intellectual impairment in ISA. A number of studies have failed to find a relationship between the degree of ISA and generalised cognitive impairment (Burgess et al., 1998; Fleming Strong and Ashton 1998; McKinlay and Brooks 1984; Prigitano, Altman and O'Brien 1990; McGlynn and Schacter 1989). These results suggest that ISA is due to a specific cognitive loss (eg Babinski 1914). This view is also supported by clinical reports of patients who have more than one deficit and are aware of one but not the other (Bisiach and Germiani, 1991). However other studies have reported evidence for general cognitive disturbance contributing to ISA after brain injury (eg Nathanson, Bergman and Gordon, 1952; Weinstein and Kahn, 1955; Ullman, 1962).

3. Theoretical Models of Impaired Self Awareness

A range of different explanations have been proposed to explain ISA after brain injury. Any comprehensive explanation of ISA would have to be able to account for the characteristics described in the preceding section.

3.1 Neurological model

The Hierarchy of Brain Function model (Stuss & Anderson, 2004) presents a framework differentiating types of consciousness. The core attribute of each type of consciousness is a particular type of awareness. The model states that there are four operational levels. The first level, 'arousal-attention', is of basic arousal processes required for any type of conscious awareness. The brainstem reticular formation, specific brainstem nuclei, and their projections to the thalamus and cortex are the neural basis for arousal and general responsiveness. The second level, involves processes such as attention, language and memory, which have their own inherent organisation and work at an automatic level. Disorders of self-awareness at this level are domain specific and depend on which process or module is damaged. These processes are thought to depend on various cortical and subcortical regions. The third level involves the executive functions (Stuss and Benson, 1986; Stuss, Shallice, Alexander and Picton, 1995). These integrate information from posterior brain regions and organise goal directed responses. These executive functions are thought to depend on frontal regions, in particular the lateral frontal lobes (Stuss and Levine, 2002). They provide the capacity to sequence and integrate information, and provide

drive, allowing action planning, inhibition, facilitation of parietotemporal association cortices and working memory.

The fourth level is related to self-awareness. This is located in the frontal lobe and its limbic connections, with the right frontal lobe being thought crucial. Damage to these connections is thought to lead to the lack of a model of the entire self.

These levels of consciousness are hierarchically organised. Each level feeds forward to the higher levels with an analysis of incoming information and can also feed backward to modulate the operations of lower levels.

The model serves to delineate types of human consciousness and their neurological correlates. It does not detail the individual cognitive processes involved in creating a model of the self and therefore self-awareness. It does not address the variations in extension or partiality of self-awareness that can occur. The model does not attempt to explain why patients tend to be more aware of some deficits than others, or why change can occur over time in ISA. Therefore it is of limited use in informing the assessment and rehabilitation of deficits of self-awareness. It does not consider the self in a social or cultural context or the individual factors that may impact on self-awareness.

3.2 Multidimensional models

A number of theories conceptualise self awareness as multifaceted and specify the cognitive, psychological and social processes it is thought to depend on.

Allen & Ruff (1990) contend that three levels of processing influence patients' report of deficits after brain injury. Firstly "awareness of deficits" requires the ability to attend to, encode and retrieve information regarding the self. The second level of "appraisal" involves comparing current incoming information about the self with a pre-morbid set of beliefs about the self. Impaired cognitive function will interfere with these levels of processing, affecting the patient's ability to recognise functional deficits. The third level, "disclosure", concerns the patients' willingness to report self-perceptions to another person. This is proposed to involve a complex interaction of neuropsychological and socio-psychological factors.

Levine's (Levine 1990; Levine et al., 1991) Discovery Theory proposes that functional deficits have to be 'discovered' by the patient, and focuses on factors that can impede this process. The model was developed to explain unawareness of sensory and motor deficits but can as well be applied to cognitive, emotional or social impairment. As the loss of the function does not produce any immediate experience of the loss, it must be 'discovered' by self-observation or inference. When cognitive deficits interfere with the detection of the deficit, ISA can result. The specific cognitive impairments involved are, however, unspecified in this model. The availability of accurate and meaningful feedback from the environment is thought to promote realistic self-awareness over time, so a lack of such relevant information or opportunities to observe post-injury changes in functioning is held to be a crucial factor in the maintenance of ISA.

The above models hint at a distinction between beliefs about the self, and self-evaluation that may occur during a task. Crosson et al's (1989) Pyramid Model of Self-Awareness explicitly states a distinction between three levels of self-awareness that are arranged in a hierarchy. 'Intellectual awareness' is knowledge that a particular function is impaired. 'Emergent awareness' is the ability to recognise a problem in functioning when it occurs. This in turn is necessary for 'Anticipatory awareness'. This is the ability to recognize that a problem is likely to occur during a particular task. In this model, intellectual awareness is held to be the first basic level required for the other subsequent levels of emergent and anticipatory awareness to be possible.

Toglia and Kirk (2000) expand on the distinction of Crosson et al (1989) between 'intellectual awareness' and the awareness present during performance of tasks, which they term 'online awareness'. The models described so far have considered how some social and environmental factors may impact on self-awareness. Toglia and Kirk (2000) present the most comprehensive framework to explain ISA by incorporating themes from psychology, neuropsychology, social psychology and culture. Further, they propose self-awareness to be constructed from a dynamic interaction between intellectual and online awareness rather than being a relatively static construct. Intellectual awareness, defined as beliefs about the self stored in long-term memory, is relatively stable. Online awareness is the ability to monitor and evaluate performance within the stream of action. This is seen as relatively unstable, being more accurate in some situations than others and varying with the task. Factors influencing online awareness are one's knowledge of the task and its context, beliefs about one's capabilities, and affective state. The results of self-monitoring on a task

are compared to expectations of performance based on prior beliefs about personal ability. A discrepancy between how one performs a task and one's expectations may lead to adjusting one's strategy in performing the task. Self-evaluation of task performance may lead to restructuring of the stored beliefs about one's abilities. Thus there are constant interactions between stored beliefs and online awareness.

Factors proposed to impede these processes with ISA resulting, include cognitive deficits, lack of motivation, fatigue, task demands and context of the testing situation. Cognitive deficits that could interfere with this process are: Impaired perception of errors during task performance (self-monitoring), impaired ability to adjust performance (self-regulation), impaired ability to compare the outcome of performance with expectations about performance (self-evaluation), and impaired adjustment of long-term beliefs about one's abilities resulting from self-evaluation (Toglia and Kirk, 2000).

The model encompasses psychological factors that influence these processes: personality, specific beliefs about one's strengths and limitations, general self-efficacy beliefs, affective state, motivation to perform well on the task, the meaning of the task to the individual, its perceived difficulty, whether the individual has been exposed to similar tasks before. The influence of the social context is also addressed, in terms of what task failure or success would mean to the patient, and who is asking that the task be carried out.

As the model considers the role of psychological and social factors it can incorporate ideas about the role of psychological 'denial' and culture in ISA. Weinstein and

Kahn (1955) suggested that ISA may be a defence reaction in the form of emotionally motivated denial. This would serve to protect self-esteem by not acknowledging a functional impairment which would impact on personal control and independence. Indeed, refusal to acknowledge illness or putting it out of one's mind is seen in many disabling conditions (Caplan & Shecter, 1987) and is seen as a way of coping with stress. Support for this idea comes from studies linking ISA to certain personality traits (Prigitano & Klonoff, 1998). However other studies using systematic questionnaires have failed to find distinctive personality traits associated with ISA (Levine et al 1991; Starkstein et al 1992; Small & Ellis 1996).

Studies carried out in brain injury samples across cultures throw light on how cultural attitudes may influence patients' self report of deficits they experience. A study by Prigitano et al (1997) found that Japanese patients with TBI did not overestimate social or emotional control problems but they did overestimate their self-care abilities. This was in contrast to a United States sample who overestimated social-emotional skills and underestimated self-care skills. This finding was interpreted as being due to the fact that self-care activities and the ability to be independent are highly valued in Japanese culture.

Toglia and Kirk's (2000) model presents a comprehensive account of how self awareness may be constructed. The model has the advantage of proposing testable links between different factors. It has implications for rehabilitation assessment and intervention methods as it specifies the factors that may be contributing to ISA. It has the capacity to explain the range of presentations of ISA with the dynamic influences of different factors.

Vuilleumier (2004) proposes another means by which affect may be involved in the development of ISA. This may be in the form of an abnormal affective drive to respond to uncertainties about current bodily states or current cognitive abilities (Vuilleumier, 2000). Affective signals can exert influences on cognitive processing and may be necessary to activate the appraisal operations that allow the adjustment of behaviour and beliefs in the face of novel situations (Tiedens & Linton, 2001). A reduced emotional impact of perceived failure might contribute in this way to impede discovery of the deficit by the patient, beside any cognitive impairment. This explanation, although not explicitly included in Toglia and Kirk's (2000) model, could be incorporated into it as a way in which affective state may influence ISA.

Summary

The existing theoretical models of ISA vary with regard to the scope of their explanation of the different presentations of ISA, the level of explanation on which their emphasis lies (neurological, neuropsychological, psychological, social), and how useful they are in informing intervention in and management of patients with ISA.

From this brief review of the theories of ISA it is clear that no single deficit on any level of explanation (neuropsychological, psychological, social) is proposed to account for ISA. Further, it is unlikely to be explained by any unique combination of deficits, given the mixed findings with regard to the relationship of ISA to intellectual function, injury severity and lesion location. Variations in ISA with type

of deficit, extension, specificity and partiality, and its changes over time point to complex and dynamic underlying mechanisms.

4. Measuring Impaired Self-Awareness

Markova and Berrios (2006) discuss the methods of measuring ISA and their various drawbacks. The most common way of assessing ISA is to measure the discrepancy between the patient's report of deficits since brain injury and a carer/clinician's report of deficits. These methods assume that an accurate assessment of the patients' abilities is obtained by the carer/clinician. The patient's report of their functioning may be influenced by a number of factors. The patient may respond non-systematically due to an interaction between their cognitive deficits and their approach to the questionnaire, leading to variable and unpredictable responding. The carer/clinician's perspective of the patients functioning may be affected by stress, fatigue, lack of knowledge of the brain injury, and frustration in managing the challenging behaviour. Any discrepancy between the patient's self report and the report of the carer/clinician is assumed to reflect a lack of awareness of deficits on the part of the patient. This discrepancy is often totaled with the assumption that it is reflecting a quantifiable and continuous variable. Questionnaire and interview methods assess patients' explicit 'intellectual' awareness only. The exclusive use of assessment by such verbal means results in neglect of behavioural manifestations of ISA and of patients' 'online' awareness.

Alternatively, the discrepancy between the patient's rating of their performance on a task and a rating of their objective performance can be used as an indication of their

'online' self-awareness. However this means that only their awareness of their ability to carry out that particular task is assessed. It cannot be assumed that this will reflect their general self-awareness.

Alternatively, awareness can be rated by clinicians involved in the care of the patient. This requires that the clinician be sufficiently familiar with the patient, and utilises their experience of dealing with such presentations.

The variety of methods of assessing ISA and their various shortcomings indicate that measuring ISA is not a straightforward exercise. Variations in the methods to assess ISA and their accuracy is likely to have contributed to the mixed findings in studies relating ISA to injury severity, lesion location and general intellectual ability.

5. Executive Function

According to Spreen & Strauss (1998), executive function describes "a multidimensional construct that refers to a variety of loosely related higher-order cognitive processes, that are necessary for effective and contextually appropriate behaviour" (p.171). Godefroy (2003) places the emphasis in his definition of executive functions on those which operate in "non-routine situations such as novel, conflicting or complex tasks". Stuss and Alexander (2000) state that executive functions are distinct processes that can be differentiated but which converge on the general concept of control functions. Thus, definitions of executive function vary in the emphasis they place on facilitating control of appropriate behaviour, behaviour in new or complex situations, and whether they are loosely related or are distinct.

Executive processes include initiation, planning, hypothesis generation, cognitive flexibility, decision making, self-regulation, judgement, feedback utilisation and self-perception (Spreen and Strauss, 1998). Godefroy (2003) adds to this list response suppression, focussed attention, rule deduction, maintenance and shifting of set, problem solving, and information generation. Lezak (2004) summarises executive function with four broad groupings. Volition is the capacity for intentional behaviour, requiring the capacity to formulate an intention and goal. Motivation and awareness of self is a prerequisite for this. Planning is the identification and organisation of steps and elements needed to carry out an intention or achieve a goal. This requires the ability to view oneself in the environment in an objective fashion and to conceive of alternatives and make choices. Good impulse control, intact memory functions and sustained attention are also prerequisites. Purposive action is the translation of an intention or plan into productive self serving activity, requiring initiation, maintenance and switching of set, and stopping sequences of complex behaviour in an orderly and integrated manner. Effective performance involves self-regulation, productivity, flexibility and capacity to shift set.

Support for the notion that executive functions can be distinguishable from each other comes from studies showing dissociations between them. Burgess et al (1998) conducted a factor analysis of 92 brain injury patients' performance of executive tests. Ten measures of executive function were found to load on three cognitive factors – Inhibition, Intentionality and Executive Memory. This supports the notion that different executive tests measure a number of different cognitive processes and that there may be limits to the fractionation of the executive system.

Impairment on executive function tests can be seen without impairment on tests of general intellectual status (Kolb & Whishaw, 1995).

However, constructing tests of executive function comes with challenges. Tests often have an inherent structure, so skills like initiation, planning and judgement are hard to test as the test or the examiner will provide them (Lezak, 2004). As well as this, Godefroy (2003) states that most tests involve several executive and non-executive processes, so determining the underlying cause of impaired performance is difficult, and several factors have to be controlled before such interpretation is possible. Tests often engage multiple and coordinated executive processes, so impairment on the test cannot be attributed to a single deficit. According to Tranel (1992) very few tests of executive function have shown high sensitivity and specificity.

6. Executive Function and Impaired Self Awareness

Initial evidence to support the role of frontal lobes, and the executive functions related to them, in self-awareness was based on case studies of individuals with frontal lobe pathology who showed awareness deficits (McGlynn & Schacter, 1989). The review of theories of ISA highlighted several cognitive processes that were deemed important in the construction of self-awareness. These included self-monitoring, self-regulation, self-evaluation and updating of long-term beliefs (Toglia and Kirk, 2000). These processes appear to overlap with cognitive processes deemed to form the executive functions, such as feedback utilization, self-regulation, appraisal, judgement, and hypothesis generation. During the last 15 years various

researchers have examined the relationship between executive function and ISA (Prigitano, 2005).

7. A Review of Studies of the Relation of Executive Function to Impaired Self-Awareness

7.1 Aims

The aim of this review is to examine the empirical literature on the role of executive function in ISA after brain injury. The review will aim to describe how far this question has been addressed in previous research, the methods used to answer this question, and to summarise the findings. This will help to highlight gaps and guide future research into understanding self-awareness.

7.2 Method

The electronic Medline database was searched covering the years 1984 to January 2007 to locate relevant studies The search terms used were (executive function) and (((stroke) or (brain injury)) and ((self awareness) or (self-awareness) or (awareness) or (insight))). Studies were included in the review if they met the following criteria:

1. The sample under study were people with an acquired brain injury
2. Self-awareness was measured
3. Executive function was measured

4. The association between the executive function measure and self-awareness was explored in the statistical analysis

7.3 Results

Ten studies fulfilling the inclusion criteria were found. These are summarized in Table 1 and numbered from 1 – 10.

It was decided to review the studies according to their method of assessing ISA. Most studies used a measure of "intellectual" self-awareness assessed by questionnaires and interviews.

Table 1. Studies found in literature search.

Study Number	Authors	Sample	Executive Function measure	ISA measure	Result
1	Burgess, Alderman, Evans, Emslie, & Wilson (1998)	92 mixed aetiology general neurology patients	1.Modified Wisconsin Card Sorting Test (MWCST) 2.Cognitive estimates test 3.verbal fluency FAS 4.verbal fluency animals 5.Trails A and B 6.Simplified 6 elements test	DEX[1]	DEX correlated with verbal fluency FAS and animals. MWCST categories and perseverative errors. 6 element test, Trails A and B
2	Ownsworth, McFarland, & Young (2002)	61 with Brain Injury of various causes	1.Health and Safety subtest from Independent Living Scales (ILS) 2.Tinker toy test (TTT) Both classed into Impaired or Normal	SADI[2] SRSI[3]	ILS and all ISA scores correlated. TTT correlated with 2 aspects of SRSI

[1] Dysexecutive Questionnaire (DEX- Burgess et al,1996)
[2] Self Awareness of Deficits Interview (SADI – Fleming et al, 1996)
[3] Self Regulation of Skills Interview (SRSI - Ownsworth et al, 2000)

3	Bogod, Mateer, & Macdonald (2003)	45 with TBI	1.Reversal go – no –go 2.Victoria Stroop 3.Self ordered pointing task (SOPT)	DEX SADI	SADI correlated with all executive scores. In multiple regression. SADI predicted by SOPT, go-no-go. SADI and DEX not associated.
4	Goverover (2004)	33 acute phase of BI with multiple aetiologies.	1.Toglia Category Assessment (TCA) 2. Deductive reasoning test. (DR)	Pre and post task question on how well they think they will/thought they will do. Rated as 0, 1 or 2.	ISA score correlated with TCA, not DR.
5	Ownsworth & McFarland (2004)	28 long term Brain Injury	1.Health and Safety subtest of ILS 2.Tinker Toy Test	SRSI	ISA correlated with Health and Safety subtest of ILS
6	Schmitter-Edgecombe & Woo (2004)	31 Closed Head Injury	1.verbal fluency FAS 2.Stroop 3.Trails A and B 4.Wisconsin Card Sorting Test 5.Initiation/perseveration on Dementia Rating Scale (DRS I/P)	Pre-task and post-task prediction of how much they could remember	Pre-task prediction correlated with trails, stroop, DRS I/P. No correlation between memory post-task prediction and executive tests

7	Hart, Whyte, Kim, & Vaccaro (2005)	36 patients with moderate and severe TBI	Composite score derived from 8 measures: 1.Stroop 2.Trails B 3.Wisconsin Card Sorting Test 4.verbal fluency FAS 5.Regard's 5 point test 6.Digit backwards 7.Peterson Auditory Consonant trigrams 8..Petrides' Self-ordered pointing task	DEX	Correlations between ISA and executive composite score.
8	Noe et al. (2005)	62	1.WCST 2.colour trails 3.verbal fluency	PCRS[4]	High and low ISA groups differed on WCST and verbal fluency, not on Trails a and b. Independent predictors of ISA were WCST categories
9	Ownsworth & Fleming (2005)	67	1.Health and Safety subtest of Independent Living Scales 2. Five Point Test 3.FAS 4.Key Search 5.Tinker Toy Test	SADI SRSI	3 executive function factors found: Idea generation, Plan Execution, Error Self-regulation. ISA correlated with Idea Generation and Error self-regulation
10	Anson & Ponsford (2006)	33	Six Elements Test from BADS	PCRS SADI	No correlations between SADI and executive function score or PCRS and executive function score

[4] Patient Competency Rating Scale (PCRS - Prigatano et al., 1986)

7.3.1 Dysexecutive Questionnaire (DEX- Burgess, Alderman, Wilson, & Emslie, 1996)

The Dysexecutive Questionnaire (DEX- (Burgess et al., 1996) is a questionnaire measure of a patient's intellectual awareness of deficits. It covers twenty of the most commonly reported symptoms of the dysexecutive syndrome. The questions ask about four areas of likely change: emotional or personality, motivation, behavioural, and cognitive, and whether they are being experienced currently. The respondent is required to rate from 0 to 4 how often they experience each symptom. There is one version for the patient and one for a significant other who preferably has daily contact with them. The discrepancy between these scores is used as a measure of self-awareness.
A number of the questions have double clauses, and use language that perhaps not all respondents would be familiar with, for example, the word "lethargic". This may cause problems for respondents in answering the questions. The questionnaire assesses the specific symptoms associated with dysexecutive syndrome. It does not ask about activities of daily living or motor or sensory deficits. Its use therefore has the potential to miss deficits of awareness related to these areas.

The DEX was used in 3 of the studies (1,3,7). Study 1 looked at the ecological validity of ten tests of executive function. It found that the DEX discrepancy score was correlated with six out of the eight measures of executive function used. These were the Modified Wisconsin Card sorting Test (MWCST) Categories and Perseverative Errors score, Verbal Fluency 'FAS' and 'animals' test, Trails A and B, and the Simplified Six Elements Test (SET). It was not correlated with the Cognitive Estimates Test or MWCST Total errors score. The study used a large sample of 92 patients who were of

mixed aetiology of brain injury as they were recruited from a general neurology clinic. An advantage of this study was the use of several executive function tests allowing examination of which executive function may be related to ISA and which not. The particular tests were chosen to represent two verbal tasks, two non-verbal tasks and one (SET) that has shown dissociation from performance on other executive tests at the single case level (eg Shallice and Burgess 1991). There was no correlation between the DEX discrepancy score and measures of memory, general intellectual function or language, indicating that impairment of these abilities was not contributing in a systematic fashion to lack of awareness of deficits.

Study 3 found no correlation between the DEX discrepancy score and three measures of executive function: the Reversal Go-No-Go, Victoria Stroop, and Self Ordered Pointing Task. In this study it was rehabilitation therapists who completed the Significant Other form of the DEX. It could be that these therapists may not be able to rate the items of the DEX as accurately as family members, as done so in other studies using the DEX, due to limited contact with the patients. This may have led to the DEX discrepancy score being an invalid measure of ISA. Another measure of intellectual awareness – the Self Awareness of Deficits Interview (SADI) (which is described in detail below) was found to be correlated with the executive measures in this study. It could be that this is a more sensitive measurement tool. Alternatively the limited scope of the DEX - symptoms of the dysexecutive syndrome – may have meant that deficits present in the sample were not detected. Supporting this notion, the two measures of awareness were only modestly correlated, suggesting they were not tapping exactly the same constructs or information.

Study 7 used a composite score of eight executive tests, treating executive function as an inventory of cognitive operations that may be tapped by different tests. They found the DEX discrepancy score to be modestly correlated with the executive composite score in the sample of 36 patients with post-acute moderate to severe brain injury. The use of a composite score in this study means that the relation of ISA to particular executive functions could not be examined.

7.3.2 Patient Competency Rating Scale (PCRS - (Prigatano et al., 1986)

The Patient Competency Rating Scale (PCRS - (Prigatano et al., 1986) requires the patient and a close other to rate the ease with which the patient can perform 30 functional activities of daily living, memory, interpersonal and social skills, and dealing with emotions, from 1 (can't do) to 5 (can do with ease). The questions ask "How much of a problem do I have in ...?"

The PCRS focuses on a range of functional skills, and seems easier to rate than the DEX as each item has the same structure and asks how much of a problem various tasks are. An advantage of this questionnaire is that scoring can be done in more than one way. A disadvantage of using the totalled score of the discrepancy between self- and other-ratings is that it could be insensitive to differences that may exist for a small number of items. The actual magnitude difference between the subject's and respondent's ratings on specific items may also be used. However all of the studies described below used the totalled discrepancy score to quantify ISA.

The PCRS was used in two studies (study 8 and 10). Study 8 used the PCRS as it had been validated for its sample of Spanish speakers. The aim of the study was to contribute to the understanding of ISA of disability after brain injury by looking at which factors predict 'high' and 'low' ISA. Despite this the study did not present a theoretical framework. The study used the total discrepancy score, the significant other's form was completed by the treating neuropsychologist in the majority of cases and by the family in the rest of them. Following from previous research they classed their patients as having either 'high' or 'low' self awareness by using a cut-off score of 28 on the PCRS. The high and low awareness groups had significantly different scores on the Wisconsin Card Sorting test (WCST) and verbal fluency tasks but not the Trails A and B. A number of other neuropsychological tests, including the WAIS-III FSIQ, were also different for the high and low ISA groups. However, in a multivariate regression the WCST number of categories achieved and Delayed Free Recall of the TAVEC (a Spanish verbal memory test similar to California Verbal Learning Test) were independent predictors of ISA level.

Study 10 also used the total discrepancy score on the PCRS. No correlation was found between this score and the Six Elements Test. It could be that the PCRS discrepancy score was not a valid measure of ISA in this study. The Significant Others (SO) were asked to rate how well acquainted they were with the patient and all reported being at least "fairly well" acquainted with them. However the Self-Awareness of Deficits Interview (SADI) - an interview assessment method of intellectual awareness, described later – which allows a more sensitive assessment of ISA was also not related to this executive measure. It is possible that the sample could have consisted of people with

high self-awareness particularly as the sample was from a rehabilitation programme. On average they had spent 69 days in rehabilitation and 42% were between 1 and 7 years post-injury. Indeed the PCRS score for the patient and SO were significantly correlated. The mean PCRS discrepancy score was 0.9 (18.4) whereas in Study 8 the 'high' self awareness group had a score of 6.7 (9.5) (higher scores indicating lower levels of self-awareness). The Six Elements Test is a relatively demanding test of executive function as it requires planning and organisation by the patient for its successful performance. An alternative explanation for the lack of association between the SET score and ISA may have been that this test was too difficult for these patients. The SET scoring range is from 0 to 4, a relatively small scoring range and this may have been insufficient to capture the variability in executive functioning displayed by patients in this study. The sample was relatively small consisting of 33 TBI patients and so could have lacked statistical power. Of note is the finding that the PCRS and SADI scores were not correlated, indicating that they were not measuring the same construct.

7.3.3.Self Awareness of Deficits Interview (SADI – Fleming, Strong &Ashton, 1996)

This is a semi-structured interview scored by the interviewer. It has the advantage that an experienced clinician is able to discuss experiences reported by the patient in detail. It is likely to ascertain a more accurate report of the patient's experiences in comparison to the patient and relative answering questionnaire items according to their personal interpretations. A score sheet guides the interviewer's scoring. The interviewer asks whether the patient or others have noticed changes in the patient's functioning in physical abilities, memory/confusion, concentration, problem solving, decision making,

organising and planning, controlling behaviour, communication, getting along with people, personality, and any other problems. The interviewer then asks about what they hope to achieve in the future. A checklist is given to relatives to assist with scoring components of the interview. The interview gives three indices of 'intellectual' awareness - self awareness of deficit, self awareness of functional implications of deficit, ability to set realistic goals. These indices allow examination of the "extension" of ISA, ie. how far the patient is aware of the deficit and its consequences. The indices are scored from 0 to 3. This could be criticised as being a crude scale, given that the interview covers a broad range of functioning. Four studies (2,3,9,10) used this interview measure of 'intellectual' awareness. The studies will be evaluated after another interview measure often used alongside the SADI has been described .

7.3.4 Self Regulation of Skills Interview (SRSI - Ownsworth et al 2000)

Another interview measure of ISA is the SRSI. This is a semi-structured interview composed of six questions that assess self-regulation skills. The six questions are applied to an area of difficulty identified by the patient. Commonly, these are memory problems, impaired attention and concentration, depression, poor anger management, speech difficulties, lack of motivation and anxiety (Ownsworth et al 2000). Three indices are obtained on a 10 point scale: awareness, self-rated readiness to change, and strategy behaviour.

Three studies used the Self Regulation of Skills Interview (SRSI) (2,5,9). The studies using this interview make a distinction between intellectual and online awareness and

intend the SRSI to measure online awareness. However as it relies on verbal report by the patient about performance on various tasks while the patient is not engaged in that task, it cannot be seen as a true measure of online awareness.

Study 2 used a sample of 61 severe brain injury patients. It used two measures of executive function. These were the Independent Living Scales' Health and Safety subtest and the Tinker Toy test. The Independent Living Scales' Health and Safety subtest assesses basic cognitive skills for daily living, asking 20 questions requiring common sense judgements about practical problems. Response quality is rated on a 2 point scale. However it seems likely that response quality is likely to depend on skills such as memory, language, verbal ability as well as executive function. The Tinker Toy test is a test of purposive behaviour – a category of executive function involving productivity and self-regulation. The SADI total score was found to be correlated with the Independent Living Scales' Health and Safety subtest. The study used the SADI total score and so did not make use of the sub-scales which measure important distinctions in the concept of intellectual awareness. The Tinker toy test complexity score was associated with Readiness to change and Strategy behaviour but not the Awareness Index on the SRSI. In this study different executive functions were found to be associated with different aspects of awareness, suggesting that the specific aspects of ISA may depend on different cognitive processes.

Study 3 found the SADI to be correlated with all three measures of executive function used – Reversal go-no-go, Victoria Stroop and Self-ordered pointing test. The individual factors of the SADI were not used. The SADI was negatively correlated with IQ,

indicating that impaired intellectual function contributed to ISA for this sample. When IQ was partialled out from a regression analysis, the SADI was significantly predicted by the executive functioning measures, with the SOPT being the strongest predictor, followed by the Reversal Go-no-go and Stroop test.

Study 9 used five measures of executive function and after factor analysis found three factors: Idea Generation, Plan Execution, and Error self regulation. These seem to correspond to Lezak's (2004) volition, purposive action, and performance effectiveness. The SADI was found to correlate with the factors of Idea Generation and Error self regulation. Individual factors of the SADI were not used. The SRSI Awareness index was found to correlate with Idea Generation and Error self regulation. The SRSI Strategy Behaviour Index correlated with the Idea Generation factor. IQ was not controlled for in this study.

Study 10 used the Six Elements Test to measure executive function. There was no correlation between the SADI and this test. It may be that the executive test was an inappropriate one for the sample of patients, or that the patients in this sample had low levels of ISA. These possibilities have been discussed previously when Study 10 was reviewed in Section 7.3.2.

Study 5 found that patients with low scores on a measure of volition (the Health and Safety subtest of the Independent Living Scales) showed lower self awareness on the SRSI. The sample consisted of 28 long-term brain injury patients who had volunteered to take part in a rehabilitation program.

7.3.5 Impaired Self-Awareness assessed by rating of performance on a task

Two of the ten studies (study 4 and 6) attempted to make a measure of online awareness. They asked patients direct questions about their performance on a task, and these responses were compared to an objective measure of performance. Consequently these measures of self-awareness were of a very specific ability. A drawback of this method is that patients may differ on how well they understand the task and what successful performance means, and how familiar they may be with such tasks. There is the possibility that patients may have ISA of abilities that are not being measured by the specific task.

Study 4 asked patients before and after they had performed two tests of executive function (Toglia Category Assessment and Deductive Reasoning Test) how well they thought they would do before they undertook the tests and how well they thought they had done after the tests. Their two answers were compared to their actual performance and they were given a rating of 0 to 2 to indicate their awareness of their performance. This means that they averaged across the important theoretical distinction between intellectual and online awareness and used this measure to represent ISA in general. ISA was found to be correlated with the Category Assessment task but not with the Deductive Reasoning task. The latter task may have been too demanding as it requires the patient to draw new conclusions from question to question within each trial, or it may have been too difficult to assess one's performance on this task. In contrast 'shifting set' is only required from trial to trial on the Category Assessment Task. The sample

was taken from an acute neurosurgery unit consisting of patients soon after their brain injury, which means they are likely to have had diffuse brain dysfunction and so such ratings may have been hard to make. It is also unlikely that they had had opportunities to 'discover' any deficits they may have after their brain injury. This study was the only one of those included in this review to cite a power calculation. The study sample exceeded this number so low power is not likely to be a possible cause of the lack of association found.

Study 6 asked patients to predict how many units of material they thought they would remember in immediate and delayed recall and confidence ratings in their predictions before exposure to the material to be remembered, and after. This was done for the three memory tasks used – Logical Memory I, Visual Reproduction I and II from the Wechsler Memory Scale Revised and list learning in the California Verbal Learning Test (CVLT). The pre-exposure question was designed to assess intellectual awareness, and the second post-exposure question was designed to assess online awareness. Predictions across the tasks were collapsed. As predictions of recall were made in terms of units of material to be remembered, the ISA measure did not reduce itself to a crude measure. An advantage of this study was the use of a control group allowing comparison of task performance and predictions about performance to a normal group. This study found that the measure of intellectual awareness was correlated with three of the five executive tests used – the Stroop task, Trails A and B, and the Initiation/perseveration scale from the Dementia Rating Scale. It was not related to the WCST or the FAS test. This relationship could not be attributed to a more generalised cognitive deficit as no relationship was found between ISA and IQ. There were no correlations between the

online awareness measure and the executive tests. The authors explained this result as a consequence of online awareness being updated following exposure to the task. In other words patients used information from practice to update online memory of self-knowledge.

7.3.6. Issues in Measurement of Impaired Self Awareness

There has been a strong tendency for studies to focus their assessment of ISA on one aspect of it: intellectual awareness. This may be because questionnaire methods are the easiest to administer in terms of time, expertise required on the part of the researchers, and convenience, and these methods are able to assess intellectual awareness only. Measurement of online awareness in the studies was through questions asked while a task was being carried out.

The majority of studies (7) assessed only one aspect of self-awareness. This meant that possible dissociations between different aspects of awareness or between different methods of assessment could not be demonstrated in these studies.

It seems that the SADI has the advantage of taking into account a carer's report, comparing this to patient's report, but allowing exploration of the precise nature of the awareness deficit, with the help of a structured interview and an experienced clinician. However this method requires more time on the researcher's part.

The studies assessed ISA in a quantitative fashion. In doing so they conceptualised ISA as a continuous construct that can be quantified. The use of a total score on questionnaires means that lack of awareness of a very small number of deficits that may be extreme may not be distinguishable from the score of a patient who shows no ISA but may have completed their questionnaire with slightly more optimism about their abilities than their relative.

Such methods do not take into account of the range of ways ISA can manifest. There can be variations in the extension of a patient's knowledge of their deficit, and in its specificity and its partiality. There is a tendency for patients to acknowledge motor and sensory impairments more readily than cognitive social or emotional changes in functioning (Fleming & Strong, 1999). Some studies do not acknowledge the dissociation that can occur between intellectual awareness and online awareness. Quantitative assessment of ISA as a global construct does not take into account these qualitative differences in the phenomenon.

Interestingly, when the questionnaire measures of self-awareness (PCRS and DEX) were used with the SADI in studies, they were found not to be associated with the SADI. This reflects the impact that the method of assessment has on the measurement of ISA. It may reflect that different constructs are being tapped, or that one form of assessment is an inaccurate measure.

The SADI and SRSI do acknowledge the qualitative differences in ISA that can be present. Indeed in the study that used them both, they were found to be associated with

different executive tests, suggesting that they may be tapping different constructs that may be dependent on distinct executive processes.

The SRSI has been used in studies as a measure of online awareness. The means of assessment is through verbal report by the patient about a deficit that they have identified, so this cannot be deemed to be a true measure of online awareness. Online awareness consists of the ability to recognize deficits in task performance as they occur, to anticipate them and to adjust performance accordingly. As such it needs to be assessed during the 'live' performance of a task. So far the studies attempting to do this have assessed ISA of performance of executive and memory tasks. Future studies should assess ISA of activities of daily living to make such assessment more ecologically valid and relevant to rehabilitation.

7.3.7 Issues in the Measurement of Executive Function

It is important to bear in mind some considerations when conducting executive function research. In their role in controlling behaviour, executive processes receive input from some subordinate processes and output through others. Therefore any measure of executive processes will inevitably be contaminated by any impairments of these slave processes. If a study compares patients' performance across a range of tasks, the background demands are likely to differ greatly from task to task. Dissociations may arise because of the differing influences of peripheral contributory factors and impairments of them (Burgess, 1997). Since the study samples had a range of extent and

location of damage, it is likely that impairments in cognitive processes other than executive abilities influenced task performance.

None of the studies reviewed attempted to control for the interference of specific peripheral processes in the performance of the executive tests. When dissociations arose between different executive tests they were interpreted as arising from the differential involvement of executive processes in aspects of self-awareness.

7.3.8 Sample Issues

Sample size in the studies ranged from 28 to 92. One study (study 4) cited the power calculation used to obtain its sample size. A few studies did not find support for their hypothesized associations between executive function and self-awareness. The possibility that these studies lacked statistical power cannot therefore be ruled out.

The majority of studies (7) used samples with mixed causes of brain injury. These included injury resulting from trauma, – road traffic accidents, assaults, falls and other accidents – cerebrovascular events, anoxia, hydrocephalus, neoplasm and encephalitis. One study (Study 4) used patients in the acute phase of non-traumatic brain injury who were awaiting surgery on the hospital ward. Two studies (study 6 and 10) used samples with TBI patients only. The cause of brain injury has implications for the type of brain damage resulting. Penetrating head injuries may give rise to severe focal brain lesions (Russell 1951; Salazar et al 1986) as can cerebrovascular events, whereas closed head injuries are much more likely to lead to diffuse cerebral damage (Richardson 2000).

The studies varied in how severe the patients' brain damage was. Patients' severity of brain injury was classified using either the Glasgow Coma Scale (Teasdale and Jennett, 1974), length of Post-traumatic Amnesia or length of coma. Two studies (2, 6) used patients who were all classified as "severe", 3 used patients who were "moderate" to "severe" (7,8,10) and 3 (3,5,9) used patients whose injurity severity ranged from "mild" to "severe". One study (1) reported excluding patients with "mild" injury, and another used patients in the acute phase of brain injury (4). Severity of brain damage is associated with damage to deep brain structures. With such varying cause and severity of brain damage, it is likely that the samples had widely different range and location of brain damage. This means that the damaged neural networks involved in the aetiology of ISA is likely to have varied widely within and across the samples in the studies reviewed.

The studies varied with regard to whether the reported their exclusion criteria. Three studies did not report any such criteria (2, 5, 10), so it is unclear how inclusive their samples were. Three studies (6, 7, 9) excluded patients who had a history of neurological disease or psychiatric disorder, severe past or current substance abuse. The study samples therefore varied with regard to inclusion of patients with premorbid disorders affecting the brain.

Location of brain injury was not reported in the majority of studies. In those that did report this information, the samples were mixed with regard to lesion location and whether injury was diffuse or focal. Diffuse lesions usually lead to memory, attention

and concentration disabilities, impaired reasoning and general response slowing (Hsiang & Marshall, 1998).

McKinlay and Gray (1992) discuss the limitations of brain scanning methods and variations in scan results according to the time at which they are taken. CT scans are an unreliable guide to the extent of eventual cerebral damage, especially when they are carried out immediately after the injury. Scans carried out some months after injury will very often show damage that was not evident in early scans due to cell death or subsequent complications.

Across the study samples the mean length of time since injury was 0.8 years to 11 years. With single event brain insults, patients tend to make the most rapid gains in the first weeks and months following medical stabilisation (Bode and Heinemann 2002). Cognitive functions such as memory, attention and concentration generally continue to improve during the first 6 months to a year. Spontaneous improvements continuing beyond a year are generally slight (eg Geschwind1985). This means that patients across the samples would vary in their stage of recovery of brain function. Further, patients several years post-injury are likely to have had more opportunities to 'discover' their deficits.

Patients were recruited in the majority of studies from rehabilitation programmes. Their rehabilitation activities may well have impacted on their awareness of their deficits, and this is likely to have varied with the length of time spent in rehabilitation.

7.4 Conclusions

It is not possible to make generalisations from the results of the studies described above to the general brain injury population about the relation of executive processes to ISA. This is because the samples were heterogeneous in terms of severity of injury, cause of brain injury, lesion location, time since injury, inclusion and exclusion criteria, whether they had received rehabilitation and their level of self awareness. However associations with executive function were found in the majority of studies. This was despite the use of different ISA assessment methods, small samples, and different executive function tests. Therefore there appears to be a robust association between intellectual self-awareness and executive abilities.

7.5 Future Research

The use of broader methods of assessing ISA would be desirable. Assessment methods should be informed by an understanding of the various ways in which ISA can manifest. Assessment by a single method does not capture the complex and multidimensional construct of self-awareness and general conclusions about ISA should not be drawn on the basis of a single assessment. The definition of ISA could be refined into a number of dimensions, making use of the already described distinctions between extension, specificity and partiality, and the distinction between online and intellectual awareness. Thus ISA would be conceptualised as a multidimensional construct rather than a single score along a single dimension.

Future research could focus on curious presentations of ISA, such as when ISA is restricted to only one deficit (specificity) or when ISA is expressed verbally but not behaviourally (partiality).

Future studies should bear in mind the difficulties in assessing executive function. The problem of 'task impurity' (Burgess, 1997) should be borne in mind. Cognitive tests which are able to control for the subordinate cognitive processes involved in executive tests should be utilised.

Samples of patients should be better delineated in terms of lesion location, time since injury, and exclude premorbid conditions that would impact on cognitive function.

Studies could move away from a correlational design and study the development of self awareness over time. This could be informative as to which factors are pertinent in its development.

Future research could be informed by the understanding of ISA in other clinical disorders such as psychosis and Alzheimer's Dementia. Cooke (2005) reviews the theories of lack of insight in schizophrenia and the empirical research supporting these theories. Innovative strategies to study lack of insight include the assessment of 'metacognition' alongside traditional executive tests (Koren et al 2004).

8. Conclusions

Characteristics of the intriguing presentations of ISA after brain injury were described. The theoretical models of ISA after brain injury vary in their emphasis and usefulness for the management of the phenomenon. A model by Toglia and Kirk (2000) provides a comprehensive framework within which to conceptualise ISA. This incorporates neuropsychological, psychological, social and cultural factors. On a cognitive level, executive processes are implicated in the construction of self-awareness. A review of the empirical literature on the role of executive function in ISA after brain injury was carried out. Tens relevant studies were found. The most prevalent method of assessing ISA was by questionnaire, and thus most studies obtained a measure of 'intellectual' awareness of deficits. 'Online' awareness as a separate aspect of awareness was assessed in only one study (Schmitter-Edgecombe et al., 2004). Executive functioning was found to be associated with intellectual awareness in the majority of studies. This is despite variations in the way ISA and executive functions were assessed, and mixed samples with regard to severity of brain injury, cause of brain injury, lesion location, time since injury, inclusion and exclusion criteria, and whether they had received rehabilitation. Future research should be careful not to reduce the complex construct of self-awareness to a single score, but should explore the dimensions along which it can vary. Care should be taken to choose appropriate cognitive tests and study samples.

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PART II: EMPIRICAL PAPER

Awareness of Deficit after Brain Injury:

the Role of Executive Function and Metacognition

Abstract

The aim of this study was to assess the relationship of executive function and metacognition to impaired awareness of deficit after brain injury. Impaired self-awareness was measured by the Awareness Questionnaire discrepancy between patient's and significant other's report. The Brixton Test assessed executive function and patients were asked to rate their confidence in each guess in order to assess metacognition. The Hospital Anxiety and Depression Scale (HADS) was also administered. No statistical associations were found between the cognitive measures and impaired self-awareness. However anxiety and depression levels were associated with awareness of deficits. Patients with frontal lesions had greater levels of impaired self-awareness. Level of injury severity was not associated with self-awareness of deficits. In this heterogeneous sample of patients, impaired executive function and metacognition did not contribute to impaired self- awareness.

1. INTRODUCTION

1.1 Impaired Self Awareness after Brain Injury

Disorders of self-awareness are common following neurological injury and illness. Approximately 30% of severe traumatic brain injury (TBI) patients show residual impaired self-awareness months and years after their injury (Prigitano and Altman 1990). Typical examples include denial of hemiplegia, blind patients who insist they can see, amnesics who claim their memory is intact. In this study the term "impaired self-awareness" (ISA) will be used.

An individual can have impaired awareness for virtually any neurological or functional deficit. The definition given by Prigatano (1996) is "the clinical phenomena in which a brain dysfunctional patient does not appear to be aware of impaired neurological or neuropsychological function, which is obvious to the clinician and other reasonably attentive individuals. The lack of awareness appears specific to individual deficits and cannot be accounted for by hyperarousal or widespread cognitive impairment" (pp80-81).

1.2 Characteristics of Impaired Self-Awareness after Brain Injury

The phenomenon can manifest in a variety of ways. Patients tend to be more likely to acknowledge motor and sensory impairments than cognitive social or emotional changes in functioning (Fleming and Strong, 1999; Hibbard and Gordon, 1992;

Toglia and Kirk, 2000). The severity and type of ISA can change over time (Prigitano, 1999).

ISA can vary with regard to 'extension' of awareness. This is the extent to which the deficit is comprehended. A patient can have knowledge that a deficit exists but not an appreciation of the consequences of the deficit. For example, Rubens and Garret (1991) describe patients who are aware that they had aphasia but were not aware of errors in speech as they made them. The opposite pattern has also been seen (Marcel et al 2004). ISA also varies in 'specificity'. This is the degree to which impaired awareness is restricted to a particular deficit or whether it is present for all deficits a patient may have. ISA can also vary with 'partiality' of awareness. This is whether unawareness of the deficit is complete (Schacter and Prigitano, 1991). For example, patients' presentations sometimes imply some degree of awareness of their deficit. Bisiach and colleagues (Bisiach and Germiniani, 1991; Bisiach and Berti, 1995) reported that most patients with hemiplegia who verbally deny their disability usually seem to accept it implicitly by staying in bed or using a wheelchair.

Many writers have emphasized the role of the frontal lobes in self-awareness (e.g. Stuss 1991). Studies of self-reflection in normals indicate that multiple brain areas are involved but they also indicate that the frontal lobes are of particular importance (Gusnard et al., 2001; Johnson et al., 2002). However, Sherer et al (2005) found that ISA was significantly associated with the number but not with the location or volume of focal lesions early after TBI. They took this finding to imply that ISA may reflect disruption in the integrated operation of broadly distributed networks, with lesion

burden in any specific region being less relevant than disruption across multiple regions.

Evidence for a link between level of ISA and injury severity is mixed. Prigatano (1999) presented a number of studies reporting significant associations between severe brain injury and ISA, while a similar number of studies fail to support this link (Allen and Ruff 1990; Anderson and Tranel 1989; Fleming et al 1998; Sbordone et al 1998). Possible reasons for this may be damage to differing underlying mechanisms in the creation of ISA, or differences in the measurement of ISA and severity of injury.

There have been mixed findings as to the role of general intellectual impairment in ISA. Many studies have failed to find a relationship between the degree of ISA and generalised cognitive impairment (Burgess et al 1998; Fleming Strong and Ashton 1996; McKinlay and Brooks 1984; Prigatano, Altman and O'Brien 1990; McGlynn and Schacter 1989) while others have found some empirical support for the role of general cognitive disturbance in ISA after brain injury (eg Nathanson Bergman and Gordon 1952; Weinstein and Kahn 1955; Ullman 1962).

A number of studies have noted an association between self-awareness of deficits and emotional distress. Godfrey et al (1993) noted that better self-awareness was paralleled by greater emotional distress. Ranseen et al (1990) found that patients who rated themselves as less functionally competent showed greater levels of depression. Heilbronner et al (1989) found that a group of patients with better self-awareness

were rated higher on measures of depression than a group who had less self-awareness.

1.3 Theoretical Model of Impaired Self Awareness after Brain Injury

It is unlikely that a single deficit can for account for ISA. Further it is unlikely to be explained by any unique combination of deficits, given the mixed findings with regard to the relationship of ISA to intellectual function, injury severity and lesion location. Variations in ISA with type of disability, extension, specificity and partiality, and its changes over time point to complex and dynamic underlying mechanisms.

Toglia and Kirk (2000) propose self awareness to be constructed from a dynamic interaction between "intellectual" and "online" awareness rather than being a static construct. Intellectual awareness, defined as beliefs about the self stored in long term memory, is relatively stable. Online awareness is the ability to monitor and evaluate performance within the stream of action. This is seen as relatively unstable, being more accurate in some situations than others. The results of self monitoring are compared to expectations of performance based on prior beliefs about personal ability. A discrepancy between how one performs a task and one's expectations, may lead to selecting a different strategy in performance of the task. One's self-evaluation of task performance can restructure the stored beliefs about one's abilities. Thus there are constant interactions between intellectual awareness and online awareness.

Factors proposed to impede these processes with ISA resulting include cognitive deficits, lack of motivation, fatigue, task demands and the context and meaning of the testing situation. The model presents a comprehensive framework to explain ISA incorporating themes from psychology, neuropsychology, social psychology and culture.

Cognitive deficits that could interfere with the construction of self awareness are: impaired perception of errors during task performance (self monitoring), impaired ability to adjust performance (self regulation), impaired ability to compare the outcome of performance with expectations about performance (self evaluation), and impaired adjustment of long term beliefs about one's abilities resulting from self evaluation (Toglia and Kirk, 2000)

1.4 Executive Function

Executive function has been defined as "a multidimensional construct that refers to a variety of loosely related higher-order cognitive processes, that are necessary for effective and contextually appropriate behaviour" (Spreen & Strauss, 1998). Executive processes include initiation, planning, hypothesis generation, cognitive flexibility, decision making, self-regulation, judgement, feedback utilisation and self perception (Spreen et al., 1998). Godefroy (1993) adds to this list: response suppression and focussed attention, rule deduction, maintenance and shifting of set, problem solving, and information generation.

Following from Toglia and Kirk's (2000) model, executive processes implicated in the creation of self-awareness are feedback utilization, self-regulation, appraisal, judgement, and hypothesis generation. Initial evidence to support the role of frontal lobes, and the executive functions related to them, in self-awareness was based on case studies of individuals with frontal lobe pathology who showed awareness deficits (McGlynn and Schacter, 1989).

1.5 Studies of Executive Function and Impaired Self-Awareness after Brain Injury

Several studies have explored the relationship between executive function and ISA. The samples of patients in these studies have varied in terms of severity of injury, cause of brain injury, lesion location, time since injury, inclusion and exclusion criteria, whether they had received rehabilitation and their level of self-awareness. This makes it difficult to generalise from the results of these studies to the general brain injury population about the relation of executive processes to ISA. However associations with executive function were found in the majority of studies. This was despite the use of different ISA assessment methods, small samples, and different executive function tests.

The most common way of assessing ISA in these studies has been to measure the discrepancy between the patient's report of deficits since brain injury and a carer/clinician's report of deficits. This is the quickest and most convenient method to assess ISA.

The Dysexecutive Questionnaire (DEX- Burgess, Alderman, Wilson, & Emslie, 1996) has been used to assess ISA in studies by Burgess et al (1998), Bogod et al (2003) and Hart et al (2005). This questionnaire assesses awareness of dysexecutive symptoms and so has the potential to miss ISA of other deficits. Burgess et al (1998) found the DEX discrepancy score to be associated with a number of executive tests (FAS, Modified Wisconsin Card Sorting Test, Six Elements Test, and Trails A and B) and Hart et al (2005) found the DEX discrepancy score to be associated with a composite score of eight executive tests. Bogod et al (2003) did not find an association between the DEX discrepancy score and three tests of executive function (reversal go-no-go, Victoria Stroop, and Self Ordered Pointing Test). Another questionnaire, the Patient Competency Rating Scale (PCRS – (Prigatano et al., 1986) was used to measure ISA in studies by Noe et al (2005) and Anson and Ponsford (2006). Associations were found with WCST and verbal fluency but not Trails A and B (Noe et al 2005). No association was found with the Six Elements Test (Anson and Ponsford, 2006).

Interview methods have also been used to measure ISA. These enable a richer and more sensitive measure of ISA. The Self Awareness of Deficits Interview (SADI - (Fleming, Strong, & Ashton, 1996) score was associated with the Health and Safety subtest from the Independent Living Scales (a test of volition) but not the Tinker Toy Test (Ownsworth et al, 2002). It was also associated with the reversal go-no-go, victoria stroop, and Self Ordered Pointing test (Bogod et al, 2003). Ownsworth and Fleming (2005) found it to be associated with executive function factors Idea Generation and Error Self regulation. Anson and Ponsford (2006) did not find the SADI to be associated with the Six Elements Test. The Self Regulation of Skills

Interview (SRSI - Ownsworth, McFarland, & Young, 2000) has been used in several studies. Ownsworth et al (2002) found two indices of this interview to be associated with the Tinker Toy Test. Ownsworth and McFarland (2004) found it to be associated with volition. Ownsworth and Fleming (2005) found indices of this interview to be associated with executive factors of Idea Generation and Error Self regulation.

The above questionnaires and interview methods of assessing ISA assess patients' explicit "intellectual" awareness of their deficits only. However, according to Toglia and Kirk (2000), and other theorists (for e.g. Crosson et al, 1989), this is only one aspect of awareness of deficits. Intellectual awareness interacts with "online" awareness to create an individual's self awareness (Toglia and Kirk, 2000). Online awareness is the awareness of functional deficits as they occur and the ability to anticipate them.

A measure of online awareness may be obtained if the patient is assessed carrying out a task 'live'. The discrepancy between the patient's rating of their performance on the task and a rating of their objective performance can be used as a measure of online awareness. Two studies attempted to measure both intellectual and online awareness (Goverover, 2004; Schmitter-Edgecombe and Woo, 2004). Unfortunately Goverover (2004) averaged across their assessments of patients' intellectual and online awareness so findings regarding the relationship of executive function to these separate aspects of awareness were not made.

Schmitter-Edgecombe and Woo (2004) asked patients to predict how many units of material they thought they would remember in immediate and delayed recall, and confidence ratings in their predictions, before exposure to the material to be remembered, and after. This was done for the three memory tasks used – Logical Memory I, Visual Reproduction I and II from the Wechsler Memory Scale Revised and list learning in the California Verbal Learning Test (CVLT). The pre-exposure question was designed to assess intellectual awareness, and the second question was designed to assess online awareness. Predictions across the tasks were collapsed. This study found that the measure of intellectual awareness was correlated with three of the five executive tests used – the Stroop task, Trails A and B, and the Initiation/perseveration scale from the Dementia Rating Scale. It was not related to the WCST or the FAS test. This relationship could not be attributed to a more generalised cognitive deficit as no relationship was found between ISA and IQ. There were no correlations between the online awareness measure and the executive tests. The authors explained this result as a consequence of online awareness being updated following exposure to the task. In other words patients used information from practice to update online memory self-knowledge.

Studies of the role of executive function in ISA after brain injury have been informative in that they have used different indices of awareness and finding different patterns of associations with executive tests.

1.6 Studies of executive function and ISA in Psychosis

Studies in patients with psychosis also point to a link between lack of insight and impaired executive function, often measured by the Wisconsin Card Sorting Test (WCST) (Cooke et al, 2005).

A pilot study with first-episode schizophrenia patients by Koren et al (2004) was driven by a view that the hypothesized relationship between executive function and insight tested in previous studies was simplistic. The major limitation was felt to be a failure to address deficits at the "metacognitive" level. The authors define metacognition as a person's awareness or knowledge of their cognitive abilities. Borrowing concepts from Koriat and Goldsmith's (1994) paradigm developed to study monitoring and control processes in memory test performance, Koren et al (2004) distinguished between tasks using a 'forced choice' response format and those using a "free response" format. Tasks using a 'forced choice' response format do not allow patients the choice of volunteering or withholding their answers. "Free response" format tasks give patients a choice in volunteering answers. Removing control over responding from the patient in forced response format reduces the ecological validity of tests, as in daily life patients may withhold actions if they feel uncertain of their appropriateness. Koren et al (2004) argue that monitoring (subjective appraisal of the correctness of potential responses) and control (determining whether or not to volunteer the response) are important aspects of metacognition. Their study aimed to explore the links between insight in schizophrenia and cognitive versus metacognitive skills.

The WCST was adapted to incorporate a measure of metacognitive skills. While carrying out the WCST, participants were asked to rate their confidence in the correctness of their sort from 0 to 100, and to choose whether the sort should count towards their overall score. Thus in addition to the 'forced response' performance that reflected the patient's ability to perform the sorting task, this additional procedure yielded measures of 'free response' performance dependent on the patient's metacognition. Several metacognitive variables were calculated. Insight was assessed using the Scale to Assess Unawareness of Mental Disorder (SUMD - Amador and Strauss 1990), a semi-structured interview, assessing several aspects of awareness of schizophrenia.

None of the correlations between the conventional WCST scores and the insight measures reached significance. In contrast, several correlations between the metacognitive measures and the insight measures reached significance. These relationships remained when the potential confounding effect of IQ was controlled for. In regression analyses, the metacognitive variables accounted for moderate to high variance in general insight and awareness of current symptoms whereas the conventional WCST scores accounted for a rather small proportion of variance. Koren et al (2004) concluded that poor insight is more strongly related to deficits at the metacognitive level than to cognitive deficits per se.

1.7 Current Study

The aim of this study was to examine whether impaired metacognitive skills contribute to ISA after brain injury more than broader executive functions. The

executive function test used in this study was the Brixton Spatial Anticipation Test (Burgess & Shallice, 1997). Following from Koren et al's (2004) study, the 'metacognitive' adaptation applied to this test would be to ask patients to give their confidence rating in the correctness of each guess. Self-awareness of deficits was assessed by the Awareness Questionnaire discrepancy score between Patient and Significant Other's report. A measure of depression and anxiety, the Hospital Anxiety and Depression Scale, was also taken to assess levels of emotional distress in the sample and to allow examination of its relation to ISA.

1.8 Hypotheses

The following hypotheses were proposed:

1. Greater impairment of executive functioning will be associated with greater impairment in self awareness of deficits.
2. Greater impairment of metacognitive skills will be associated with greater impairment in self awareness of deficits.
3. There will be a greater association between impaired metacognitive skills and ISA than between impaired executive functioning and ISA.
4. Greater impairment of metacognitive skills will be associated with greater impairment of executive functioning.
5. Greater levels of self awareness of deficits will be associated with greater levels of anxiety and depression.
6. Patients with lesions in the frontal lobes will have greater ISA than those with lesions in other areas of the brain.
7. There will be no difference in ISA according to brain injury severity.

2. METHOD

2.1 Sample

Participants were recruited from a Brain Injury Rehabilitation Unit at a Community Hospital which specialises in complex cases of brain injury. Patients attending the unit for assessment of their suitability for rehabilitation were asked to take part in the study. Patients were included if they had a main current diagnosis of brain injury of various aetiologies and were able to communicate adequately for the oral and written assessments. No exclusion criteria were set for participants. In Koren et al's (2004) study, the median significant correlation between measures of awareness and metacognition was 0.44. For this study to detect a similar effect size with 80% power and alpha set at 0.05, a sample size of 38 would be needed.

2.2 Procedure

Patients were approached and asked to take part in the study at the end of their assessment appointment. Testing for the study took on average thirty minutes. After information was given about the study and written consent taken, the National Adult Reading Test (NART) was administered, followed by the Brixton Test, which was followed by completion of the Awareness Questionnaire and Hospital Anxiety and Depression Scale (HADS). The tests were administered in the same order for all participants.

2.3. Measures

The following tests and measures were administered.

2.3.1 Awareness Questionnaire (Sherer et al 1998)

The patient and a 'significant other' completed this questionnaire, which consists of 17 items assessing awareness of changes in cognitive, behavioural, affective, motor and sensory functioning after brain injury.

In this study, patients' awareness was measured by the discrepancy between the patient's questionnaire and a significant other's. The questionnaire requires raters to indicate how well the patient can perform in various areas at the time the questionnaire is completed, compared to how well the patient could perform prior to injury. Questions on the patient version are phrased "How good is/How well can you [perform a function] compared to before your injury?" and patients are asked to rate their functioning on a 5 point scale from "Much worse" "Worse" "the Same" "Better" or "Much Better". The significant other's questions are the same except they ask the respondent to rate the patient's functioning. Higher scores indicate worse functioning.

The questionnaire has the advantage of prompting the respondent to report changes in functioning since brain injury, rather than asking general questions about functioning, as other questionnaires such as the PCRS and DEX do. The factor structure has been described. A factor analysis led to a three factor solution: Cognitive (seven items), Behavioural/Affective (six items), and Motor/Sensory (four

items). These accounted for 48.5% of the variance (Sherer et al 1995). Such a factor structure would allow exploration of whether ISA varies as a function of type of deficit in exploratory analyses.

Consistent findings between studies using the Awareness Questionnaire with those using other indicators of awareness point to the validity of its as a measure of ISA. The study by Sherer et al (1995) replicated previous findings that brain injury patients were more aware of physical impairments than cognitive or behavioural ones (Hendryx 1989; Anderson and Tranel 1989; Prigitano and Altman 1990). Also consistent with previous results (Gasquoine 1992), Sherer et al (1995) found that patients were more accurate at rating functioning in specific situations compared to general ones. Consistent with empirical studies that show a dissociation between awareness for physical as opposed to non-physical sequelae of brain injury (Hendryx 1989, Anderson and Tranel 1989) a factor analysis of the questionnaire found multiple factors underlying self awareness. The factor structure found was similar to that found in a previous study using the Head Injury Family Interview (Kay et al 1995). Also Sherer et al (1996) found that family members and clinicians agreed more closely with each other than either did with patients' self ratings of physical functioning. Sherer et al (1997) found that impaired awareness measured by the patient – family member discrepancy score was predictive of long term employment outcome.

Cronbach's alpha was 0.88 for the total scale and ranged between 0.68 and 0.80 for the factors on the patient form. For the 'significant other' form it was 0.88 for the

total scale and ranged from 0.57 and 0.80 for the three factors, indicating generally quite strong internal reliability (Sherer et al 1995).

This questionnaire method of assessing ISA was felt to be preferable as due to time constraints a relatively quick and simple method of assessment was required. The questionnaire format would maximise collection of data as it would allow completion outside the research time in the hospital setting. Although the use of other methods of assessing ISA, such as interview and assessment while 'on task' would also be desirable, this was not possible given time constraints on testing.

2.3.2 Hospital Anxiety and Depression Scale (HADS; Zigmond and Snaith, 1983)

The HADS is a questionnaire which provides a brief state measure of anxiety and depression. Fourteen items are rated on a 4-point scale to reflect how an individual has been feeling in the past week on a range of symptoms related to depression and anxiety.

Each item is scored from 0 to 3 and so total scores range from 0 to 21 for each of the anxiety and depression subscales. Higher scores indicate greater anxiety or depression. Scores from 8 to 10 on each scale have been taken to indicate possible clinical disorder and from 11 to 21 to indicate probable clinical disorder. The four score ranges can be classified into 'normal' (0-7), 'mild' (8-10), 'moderate' (11-14), and 'severe ' (15-21).

An advantage of the HADS is that it was designed for use in medical out-patient clinics to detect clinical cases of anxiety and depression and to assess the severity of anxiety and depression, without contamination of scores by reports of physical symptomatology.

Good psychometric properties have been reported, based on specific populations of medical outpatients and people with cancer. Internal consistency assessed by Cronbach's alpha was 0.93 for anxiety and 0.90 for depression (Moorey et al 1991). Concurrent validity (r=0.54 for anxiety, r=0.79 for depression) was found with 5-point psychiatric rating scales of anxiety and depression for 100 medical out patients (Zigmond and Snaith 1983). Construct validity as a measure of two factors was confirmed by factor analysis in a study of cancer patients by Moorey et al (1991).

2.3.3 Brixton Spatial Anticipation Test (Burgess and Shallice 1997)

The Brixton Test consists of a 56 page stimulus book, each page of which shows the same array of ten circles set in two rows of five, with each circle numbered from one to ten. On each page, one of the circles is filled in blue. The position of this filled circle differs on most presentations from page to page. The subject is shown one page at a time and is asked to consider where the next filled position will be, by trying to see a pattern or 'rule' based on what they have seen on previous pages. The number of errors made by the subject is converted to a scaled score. There is no one reason for failure on the Brixton test. There are three broad classes of error: perseverations (repeating one's response); misapplication of a strategy; 'guessing' or 'bizarre responses' (Burgess and Shallice, 1996a).

The test is a concept or 'rule' attainment and rule following task. Burgess and Shallice (1997) contend that impairments on such tasks are possibly the most commonly demonstrated in people with dysexecutive problems. The WCST is the most well known test in this class and is known to present problems for patients with frontal lobe lesions. The Brixton Test is designed to be a more straightforward, pleasant, and quicker test for subjects than other tests.

The test was standardised on patients aged between 18 and 75 years. Patients with unilateral anterior lesions were significantly poorer than the posteriors or the control group, with the posterior lesion group not being significantly different from the control group.

Test-retest reliability was 0.71 ($p<0.001$), comparing well to that obtained for Raven's Advanced Progressive Matrices Set 1 (Raven 1943), from the same group.

The Brixton score was found to be significantly negatively correlated ($r = -0.343$) with age, and significantly correlated with the NART predicted IQ ($r = 0.278$).

The test was anticipated to be less frustrating for brain injury patients than the WCST as some rules are relatively easy to pick up. Importantly, it was possible to apply the metacognitive measure to this test as the patient is required to make 54 guesses as to the location of the blue circle and their confidence from 0-100 in each guess could be ascertained. Calculating the metacognitive measure across this large potential

number of guesses would allow for a more refined measure than if a global rating of performance was asked for.

2.3.4 Metacognitive measure

In the study by Koren et al (2004) the metacognitive measure, which they termed 'monitoring resolution', was the Kruskal-Goodman gamma correlation between the level of confidence in the correctness of each Wisconsin Card Sorting Test sort and its actual correctness. Other indices of metacognition used by Koren et al (2004) were felt to be potentially too burdensome for patients and could interfere with Brixton Test performance, so only this measure of metacognition was used. However in this study it was the Kruskal-Goodman gamma correlation between level of confidence in the correctness of their guess and whether the guess was correct or not across all trials on the Brixton test.

2.3.5 National Adult Reading Test (NART) (Nelson and Willison 1991)

This was administered in order to estimate the patients' premorbid IQ so that any contribution of level of intellectual function to levels of self-awareness could be detected.

The NART was designed to provide a means of estimating the premorbid intelligence of adult patients suspected of suffering from intellectual deterioration. It consists of a list of 50 words, all 'irregular', such that application of common grapheme-phoneme and stress rules would result in incorrect pronunciation. Thus

they can only be read correctly if the subject knows and recognises them in their written form. The subject is required to read aloud the words and the number of errors of pronounciation are recorded. Wechsler Adult Intelligence Scale – revised (WAIS–R) Full-Scale IQ can be predicted from this error score by inserting it into the appropriate formula.

The validity of the test is based on the finding that vocabulary and general intelligence are highly correlated and that word reading ability tends to be preserved in general intellectual deterioration. Nelson and McKenna (1975) demonstrated in a group of 98 adults that WAIS Full-Scale IQ and Schonell Graded Word Reading Test score was correlated, $r = 0.75$. Nelson and O'Connell (1978) administered the NART and Schonell to 40 patients with bilateral cortical atrophy. This group had a significantly lower IQ as measured by the WAIS compared to a control group, but their NART error scores were not significantly different to the control group, indicating the test's validity in estimating premorbid intellectual function.

The advantages of using the NART are that it is a short, simple task that is less stressful than most other cognitive tests, requires relatively little effort and is relatively unaffected by poor concentration or motivation.

The NART may not be appropriate for a subject whose first language is not English or for a subject who may not have been exposed to English language to an extent expected to be congruent with intellectual ability. Use of the NART to predict premorbid IQ in such cases would lead to an underestimation of premorbid IQ and such cases would be treated with caution.

2.4. Statistical Analyses

It was planned to run correlations between the Awareness Questionnaire discrepancy score, the Brixton Test score, and the metacognitive score, and between the Awareness Questionnaire discrepancy score and the Anxiety and Depression subscale scores from the HADS. It was planned to enter the Brixton test score, the metacognitive score, the HADS scores and NART into a regression analysis in order to determine which of these variables contributed to the Awareness Questionnaire discrepancy score. Patients would be categorised according to the site of their brain damage, and according to level of injury severity. T-tests would be carried out to determine whether levels of ISA differed between these groups.

3. RESULTS

3.1 Recruitment of Sample

Recruitment took place over 7 months from September 2006 to March 2007. Thirty patients were recruited. Twenty-three patients attended assessment appointments during the recruitment period but were not recruited for the following reasons. Seven could not participate in the assessment appointment adequately because of the extent of their cognitive impairment or for medical reasons. Three were difficult to engage in the assessment, because of an uncooperative attitude. Five declined to take part in the current study. Three patients began the testing for the study but could not complete either the Brixton test or the metacognitive aspect adequately. Two were

inappropriate referrals to the service and did not have a clear diagnosis of brain injury. Three needed an interpreter and it was felt that testing would take too long with interpreting and could become tiring for the patients.

3.2 Sample characteristics

A summary of the sample's characteristics is given in the table below.

Table 1. Sample Characteristics

Sex	Male	24 (80%)
	Female	6 (20%)
Age (years)	Mean	47.3
	Range	19-75
Cause of brain injury	TBI as a result of a fall, road traffic accident or assault	15 (50%)
	Cerebrovascular cause	12 (40%)
	Viral encephalitis	3 (10%)
Severity of brain injury	Mild	9 (30%)
	Moderate	5 (17%)
	Severe	9 (30%)
	Not available	7 (23%)
Location of brain injury	Anterior	13 (43%)
	Posterior	12 (40%)
	Not available	5 (17%)
Time since injury (months)	Mean	32.20
	s.d.	48.34
	range	1.25- 192
History of alcohol/drug misuse		8 (27%)

Information on the severity of brain damage was obtained from the patients' notes. This was in the form of Glasgow Coma Scale score, length of post-traumatic amnesia (PTA), or length of coma. This information was classified into indicating 'mild', 'moderate' or 'severe' injury according to Sohlberg and Mateer (2001)'s criteria. When more than one index of brain injury severity was available in the medical notes, the most severe index was used. Information on the location of the patients' lesions was obtained from their medical notes. The lesion location was classified

according to Burgess and Shallice's (1997) method. They were classified as 'anterior' if the frontal lobes were involved and 'posterior' if the lesion was elsewhere in the cortex but not in the frontal lobes.

3.3. Summary of Scores on Measures

Table 2. Summary of Scores on Measures

Measure	Mean (s.d.)	Range
AQ Discrepancy Score		
Total	5.2 (8.9)	-14 to 26
Cognitive factor	2.2 (0.8)	-8 to 11
Behavioural/affective	2.1 (0.8)	-5 to 7
Motor/sensory	0.15 (0.4)	-3 to 4
Brixton Test	4.76 (0.5)	1 to 10
Metacognitive Score	-0.44 (0.45)	-1.0 to 0.69
HADS Anxiety	8 (4.5)	1 to 18
HADS Depression	6.45 (5.2)	0 to 18
NART predicted WAIS-R FSIQ	97.8 (12.0)	77 to 124

Awareness Questionnaire (AQ)

The 'significant other's AQ was completed by the spouse or partner in 18 cases, by a parent in 7 cases, and by a sibling or other relative in 5 cases. The discrepancy

between the Patients' AQ total and their significant other's AQ total was calculated. There was a large range in patients' perceptions of their functioning, varying from being worse than their significant others' ratings to being far better. The factors of cognitive, behavioural/affective, and motor/sensory functioning were calculated according to Sherer et al (1998) for each patient. The cognitive and behavioural/affective factor means indicate less accurate self awareness in these domains than in the motor/sensory domain.

Brixton Spatial Anticipation test

The Brixton scaled score indicates that performance on this test was lower than the average scaled score of 7.

Metacognitive Score

The mean of the Kruskal-Goodman gamma correlation between the level of confidence in the correctness of each Brixton Test trial guess (0-100) and its actual correctness (0- incorrect, 1- correct) was negative. This indicates that on average across the sample, there was not an association between the correctness of each guess and the patients' confidence in the correctness of their guess.

HADS

The mean HADS anxiety score indicates a 'mild' level of anxiety across the sample. The mean HADS depression score remains in the 'normal' range.

NART

The mean NART predicted WAIS-R FSIQ was close to the average IQ of 100 (s.d.=15).

3.4. Hypothesis Testing

Hypothesis 1:

The first hypothesis was that the Brixton error score will be correlated with the AQ discrepancy score - the greater the impairment on the Brixton test, the greater the discrepancy score will be. The Pearson's r was calculated as both these sets of data fulfilled assumptions underlying this test. This was nonsignificant – $r = .032$, $p = .87$. Therefore the first hypothesis was not supported.

Hypothesis 2:

The second hypothesis was that the metacognitive score will be negatively correlated with the AQ discrepancy score - the larger the metacognitive measure, the smaller the discrepancy score will be. Both these sets of data fulfilled assumptions underlying the Pearson's r. This was nonsignificant, $r = -.359$, $p= .061$. Therefore the second hypothesis was not supported.

Hypothesis 3:

The third hypothesis, that the metacognitive score will explain greater variance in the AQ discrepancy score than the Brixton error score, became redundant as a significant association between either of these two variables and the AQ discrepancy score was not found.

Hypothesis 4:

The fourth hypothesis was that the metacognitive score will be correlated with the Brixton error score – the larger the metacognitive measure, the smaller the Brixton error score will be. The Pearson's r was nonsignificant, $r = .231$, $p=.229$.

Hypothesis 5:

The fifth hypothesis was that the AQ discrepancy score would be correlated with the HADS Anxiety and Depression scores - greater self awareness of deficits will be associated with greater levels of anxiety and depression.

Table 2. Pearson's r correlations between Awareness Questionnaire score and HADS

	AQ discrepancy total	**AQ cognitive factor**	**AQ behavioural/ affective factor**	**AQ sensory/ motor factor**
HADS Anxiety	-.632 (p<.001)	-.676 (p<.001)	-.341 (p=.120)	-.429 (p=.029)
HADS Depression	-.558 (p=.002)	-.658 (p=.001)	-.387 (p=.075)	-.149 (p=.469)

The Anxiety score was significantly associated with the total discrepancy score and the two factors, cognitive and sensory/motor functioning. This suggests that with greater self-awareness, patients had greater levels of anxiety. The Depression score was significantly associated with the total AQ discrepancy score and the AQ cognitive factor. With greater self-awareness, patients had greater levels of depression.

Hypothesis 6:

The sixth hypothesis was that patients with lesions in the frontal lobes will have greater ISA than those with lesions in other areas of the brain.

An independent samples t test was carried out to determine whether AQ scores differed according to lesion site. The mean total AQ discrepancy score was 8.54

(8.06) for the frontal lesion group, and 0.13 (10.06) for the posterior group. t (19) = 2.116, p = .048. It appears that patients with lesions involving the frontal lobes have poorer self-awareness than those with lesions in the posterior parts of the brain.

Hypothesis 7:

The seventh hypothesis was that there will be no difference in ISA according to brain injury severity. An independent-samples t-test found that there was no significant difference in AQ scores according to level of severity of brain damage.

3.5. Exploratory Analyses

Exploratory analyses were carried out to see whether other variables were associated with the AQ discrepancy score.

Pearson correlations were run between AQ discrepancy score, the three AQ factors, and age, NART predicted WAIS-R FSIQ, as these fulfilled assumptions underlying Pearson's correlations. These are shown in the table below.

Table 3. Exploratory correlations

	AQ discrepancy total	**AQ cognitive factor**	**AQ behavioural/ affective factor**	**AQ sensory/ motor factor**
Age	.209 (p=.296)	.431 (p=.028)	.285 (p=.210)	.141 (p=.50)
NART predicted WAIS-R FSIQ	.132 (p=.521)	.01 (p=.964)	-.107 (p=.655)	.388 (p=.061)

The cognitive factor discrepancy score was found to be associated with age, indicating that with increasing age patients are less aware of their cognitive deficits. The NART predicted FSIQ was not associated with levels of self-awareness.

4. DISCUSSION

4.1 Summary of results

The first hypothesis, that greater impairment of executive functioning will be associated with greater impairment in self-awareness of deficits, was not supported. There was no association between the Awareness Questionnaire discrepancy score and the Brixton Test score. The second hypothesis, that greater impairment of metacognitive skills will be associated with greater impairment in self-awareness of

deficits was not supported. The association between the metacognitive measure and the Awareness Questionnaire discrepancy score was in the expected direction but did not reach significance ($r = -.359$, $p = .061$). The third hypothesis, that there will be a greater association between impaired metacognitive skills and ISA compared to impaired executive functioning and ISA, became redundant as a significant association between either of these two variables and SA discrepancy score was not found. The fourth hypothesis, that greater impairment of metacognitive skills will be associated with greater impairment of executive functioning, was not supported.

The fifth hypothesis, that greater self-awareness of deficits will be associated with greater levels of anxiety and depression was supported. The HADS Anxiety score was found to be associated with the total Awareness Questionnaire discrepancy score and its two factors, cognitive and sensory/motor functioning. The HADS Depression score was associated with the AQ discrepancy score and the cognitive factor. This suggests that with greater self awareness levels, patients had greater levels of anxiety and depression.

The sixth hypothesis, that patients with lesions in the frontal lobes will have greater ISA than those with lesions in other areas of the brain was supported. Patients with lesions involving the frontal lobes were found to have poorer self awareness than those with lesions in the posterior parts of the brain.

The seventh hypothesis that there will be no difference in ISA according to brain injury severity was supported. There was no significant difference in AQ scores according to level of severity of brain damage.

Exploratory analyses found the AQ cognitive factor discrepancy score was found to be associated with age indicating that with age, patients become less aware of their cognitive deficits.

4.2 Theoretical Implications

The finding that executive function, as measured by the Brixton Test, was not associated with the ISA measure was surprising but not unprecedented. It indicates that in this sample ISA was not related to impairments in executive abilities pertaining to rule attainment and rule shifting. No previous studies were identified that used the Brixton Test to study the relationship of executive function to ISA . Other studies have found a lack of association between other executive function measures and ISA (Anson and Ponsford, 2006; Noe et al 2005; Goverover, 2004; Burgess et al 1998). This study adds to the mixed findings with regard to this relationship. The finding runs counter to predictions made by models of ISA such as those by Toglia and Kirk (2000) that propose executive abilities to play a role in the construction of ISA.

The finding that the metacognitive measure was not significantly associated with the Awareness Questionnaire Discrepancy score ran contrary to the hypothesis. However the association was in the expected direction. This means that for this sample of brain injury patients a measure of their awareness of their performance on the Brixton Test was not significantly associated with the measure of their general intellectual awareness of their deficits in functioning. This runs counter to the relationship found

by Koren et al (2004) where measures of metacognition were found to be associated with patients' awareness of their condition of schizophrenia. Toglia and Kirk's (2000) model would also predict an association between the measure of metacognition used in this study, which could be conceived of as a measure of "online" awareness in their terminology, and "intellectual" ISA, as measured by the Awareness Questionnaire. This is because online and intellectual awareness are posited to interact in the creation of self awareness.

The metacognitive score was not associated with the Brixton score. As the metacognitive measure asked patients to indicate their confidence in whether their guess was correct or not, it could be considered to be a measure of 'self-monitoring'. Self monitoring has been classed as an aspect of executive function (Spreen & Strauss, 1998) this result could be taken to indicate that these two executive processes are dissociated. The result is consistent with a study by Shmitter-Edgecombe and Woo (2004) which also found that the measure of online monitoring, a rating how well patients thought they were doing on memory tasks, was not associated with tests of executive function .

The finding that greater levels of anxiety and depression were associated with better self-awareness is consistent with previous findings of a relationship between emotional distress and greater self-awareness of deficits (Godfrey et al 1993; Ranseen et al 1990; Heilbronner et al, 1989). Such findings have been taken as evidence for a "denial" model of ISA (eg Weinstein and Kahn, 1955) in which the denial of impairments serves to protect the individual from confronting the

implications of the impairments for their functioning and self-esteem. Such models suggest a causal relationship between ISA and levels of emotional distress.

Vuilleumier (2004) presents an alternative picture. The presence of an abnormal affective drive to respond to uncertainties about current bodily states or current cognitive abilities (Vuilleumier, 2000) may impede the normal cognitive processes involved in constructing an up to date awareness of self. Affective signals can exert influences on cognitive processing and may be necessary to activate appraisal operations that allow the adjustment of behaviour and beliefs in the face of novel situations (Tiedens and Linton 2001). A reduced emotional impact of perceived failure might contribute in this way to impede discovery of the deficit by the patient. The finding of this study may lend support to Vuilleumier's (2004) proposal that a decreased capacity for affect goes alongside an outdated construction of the self.

A study by Andersson et al (1999) lends support to this hypothesis. TBI patients rated as apathetic, showed less psychophysiological reactivity from a neutral speech condition to a therapeutic interaction condition compared to patients rated as non-apathetic. The apathetic patients also reported less emotional discomfort in the therapeutic condition. ISA was associated with low autonomic reactivity. The results were interpreted to suggest that reduced psychophysiological reactivity in apathetic patients may be a correlate to their lack of emotional responsivity, disengagement, lack of insight, and concern about their situation.

Patients with lesions involving the frontal lobes had poorer self awareness than those with lesions in the posterior parts of the brain. This finding is consistent with other

studies (Gusnard et al 2001; Johnson et al 2002) and theory (Stuss 1991) that link ISA to the frontal lobes, particularly that it is circuits involving the frontal lobes that are involved in self awareness.

There was no significant difference in ISA scores according to level of severity of brain damage. Previous findings as to the relationship between severity of damage and ISA have been mixed (Prigatano, 1999; Allen and Ruff 1990; Anderson and Tranel 1989; Fleming et al 1998; Sbordone et al 1998). A possible reason for this may be damage to differing underlying mechanisms in the creation of self awareness.

The finding that the cognitive factor discrepancy score was associated with age indicates that over time, with increasing age, patients become less aware of their cognitive deficits. This may reflect ISA of general cognitive decline over and above that caused by the brain injury. Levine's (1990; 1991) Discovery Theory may explain why awareness of cognitive abilities in particular is compromised. According to this theory, an impairment has to be 'discovered' before it can be incorporated into beliefs about the self. Cognitive impairments, and other subtle alterations in functioning, may be difficult to detect, and individuals close to the person with brain injury may be more reluctant to identify changes in personality or intellectual function to the individual than physical changes. This would mean that such changes in functioning are less likely to be acknowledged by the individual. Such an explanation could also explain why the means of the cognitive and behavioural/affective factors of the Awareness Questionnaire indicated less accurate self awareness in these domains than in the motor/sensory domain.

4.3. Limitations of Study Design

The limitations in the design of this study should be borne in mind when considering its findings.

4.3.1 ISA measure

It may be that the measure of ISA used is not an accurate reflection of ISA in the patients. The method used assumes that the patient and significant other are able to provide an accurate report of the patient's abilities. Factors interfering with this for the patient's report are cognitive deficits other than ISA that may influence patients' report such as memory or language problems. It may be that the patient has not had adequate opportunity to experience difficulties in particular areas of functioning and so remains ignorant of them. This may apply to items of the Awareness Questionnaire that ask about the patient's ability to live independently, plan things, and manage money.

The significant other's report of the patients functioning may be affected by stress, fatigue, lack of knowledge, and frustration in managing the patients' challenging behaviour. DeBettignies et al (1990) found that the distress level of relatives of patients with Alzheimers' Dementia correlated with how they perceived the patients' ISA. Prigatano et al (2005) found a similar result in relatives of patients with TBI.

The failure to find a significant association between the metacognitive measure and the measure of ISA, as Koren et al (2004) did, may be due to differences in the way

ISA was assessed in this study. Koren et al (2004) assessed ISA by interview with a clinician who asked about patients' awareness of symptoms that had been identified as ones they did experience. Such an assessment may have been more accurate than the questionnaire assessment of awareness of a standard set of deficits used in this study.

4.3.2 Executive function measure

The Brixton Test is a measure of specific executive abilities. It was designed to be a test of concept or 'rule' attainment and rule following. Burgess and Shallice (1997) contend that impairments on such tasks are possibly the most commonly demonstrated in people with dysexecutive problems. The WCST is the most well known test in this class and the Brixton Test is designed to be a more straightforward, pleasant, and quicker test for subjects than other tests. The WCST has been found to be associated with ISA in studies by Burgess et al (1998) and Noe et al (2005).

The performance of patients on the Brixton Test may not actually be tapping their executive processing ability, but reflecting impairments in other cognitive processes that the Brixton Test relies on. These include short term memory, visuo-spatial memory and language comprehension. A way around this problem would be to assess these other cognitive processes that the Brixton depends on and to assess whether Brixton Test performance is significantly associated with performance on these. If this were the case, Brixton performance could be said to be influenced by impairments of these other cognitive processes and not be a valid measure of

executive deficits. However the ethical and practical constraints on testing did not allow such additional testing to be possible.

4.3.3. Metacognitive measure

The measure of metacognition may not have accurately tapped the patients' level of confidence in their guesses. It is possible that across the sample, patients rated their confidence inconsistently with different 'anchor' points. For example, some patients were observed to reason that since there were only ten potential answers, any of their guesses had at least a 10% chance of being correct and they therefore kept this as their lowest possible guess. Other patients gave a "50 – 50" guess when they felt their answer could be equally correct or incorrect.

Providing a visual analogue scale as an alternative means of indicating their confidence in their guess would have helped those patients who may have had difficulty translating their judgement of confidence into a percentage. Future studies could ask patients to think aloud while reasoning how confident they are. This would shed light on the process by which, and the knowledge they use, to arrive at their ratings of confidence. It is possible that various cognitive impairments other than those specifically involved in self-monitoring interfered with patients making their ratings.

4.3.4. Sample

The sample in this study was mixed with regard to a number of factors. Twenty-three out of 53 patients attending the clinic were not able to participate in the study for reasons described in the results section. This is 43% of the potential participants. This means that the sample recruited from this rehabilitation unit is not representative of the population of patients presenting to the unit.

The sample varied with regard to cause of injury, severity, lesion location, time since injury, and history of excessive alcohol and/or illicit drug use.

The cause of injury and injury severity will have implications for where the brain injury is likely to be. The characteristic neurological picture after closed head injury is of diffuse rather than focal insult to the brain. There is a reduced efficiency over a wide range of functions. In contrast, in penetrating head injury there may be complete destruction of a particular area of the brain resulting in the loss of a capacity such as language, or movement of a limb (McKinlay and Gray, 1992). In the case of stroke, since the blood supply to any area of the brain can be compromised, an extremely wide range of cognitive deficits of varying severity can be seen (Skilbeck, 1992).

The Glasgow Coma Scale Score (GCS) score and duration of coma are correlated with the amount of damage to the central brain structures of the corpus callosum, brainstem and cerebellum. (Wilson et al 1994). This would mean that that the damaged neural circuitry underlying the patients' ISA is likely to have differed

across patients because injury severity varied across the sample. This would mean that specific executive function deficits in ISA may only be relevant for a proportion of the sample.

The variation in time since injury is likely to have impacted on the patients' level of ISA. With time, patients are more likely to 'discover' their impairments (Levine, 1990; 1991) and so be aware of them. It is possible that during physiotherapeutic rehabilitation patients may have become aware of certain deficits. The sample is likely to have varied as to whether they received such intervention before their assessment at the Unit. This data was not collected. With awareness, patients may have learnt compensatory strategies to cope with their impairments and so may not see them as much of a problem.

A significant proportion of the sample had a history of excessive alcohol and/or illicit drug use. This is known to affect brain function and the impact of this may well have interfered with patients' levels of ISA, the mechanisms underlying this, and patients' performance on the Brixton Test. According to Wilson and Wiedman (1992) many alcoholics are left with cognitive deficits varying from impairment of an isolated cognitive function to global impairment of intellect and memory. A study by Hovarth (1975) suggested that 10% of alcoholics have severe and persisting impairment. Polydrug use is associated with neuropsychological impairment and prolonged drug use has been associated with profound neuropsychological impairment (Wilson and Wiedman, 1992). However, such patients formed a significant part of the population of patients presenting to the Unit. Had these patients been excluded to rule out the impact of drug use, the results would have been less representative.

A further possible reason for the lack of replication of Koren et al's (2004) findings is that the mechanisms underlying ISA in schizophrenic patients is likely to differ from the mechanism underlying ISA in patients with brain injury of various aetiologies.

A power calculation was carried out but the recruitment target was not achieved. It could be the case that statistical associations did not reach significance as the study was underpowered.

4.4. Clinical Implications

The study replicates previous findings that anxiety and depression is raised with increased self-awareness of deficits. This means that rehabilitation and clinical staff should be prepared to assess this, and have resources to address and manage it. They should be alert to the possibility of patients' using alcohol or drugs to self medicate. Carers could also be educated about the likelihood of their relative to experience anxiety and depression. They could supported to cope with this and informed of strategies to manage it.

The study suggests that older patients are likely to be less aware of cognitive deficits. Care and rehabilitation staff could be alerted to this tendency and be prepared in management strategies. This would be particularly relevant to Brain Injury Units that receive patients with brain injury after stroke, which occurs in older persons (Skilbeck, 1992).

The results suggest that in a complex brain injury sample ISA is not significantly related to deficits of executive function. Rehabilitation addressing self-awareness of deficits would therefore need to address deficits wider than those of executive functions.

Patients presenting with lesions in the frontal lobes according to scan data should be anticipated to be more likely to have problems with ISA than those with lesions in posterior parts of the brain. Not only patients with severe levels of brain injury should be anticipated to have ISA. Patients with mild injury severity could also present with ISA of deficits.

4.5. Future Research

The use of broader methods of assessing ISA would be desirable. Assessment methods should be informed by an understanding of the various ways in which ISA can manifest. This study attempted to measure intellectual awareness of deficits and online awareness of performance of the Brixton Test. It did not assess awareness of consequences of deficits.

Future research could focus on the other curious presentations of ISA such as when ISA is restricted to only one deficit (specificity) or when ISA is expressed verbally but not behaviourally (partiality).

Future studies should bear in mind the difficulties in assessing executive function. The problem of 'task impurity' (Burgess, 1997) should be borne in mind. Cognitive tests which are able to control for the subordinate cognitive processes involved in executive tests should be utilised.

Samples of patients should be better delineated in terms of lesion location, time since injury, and exclude premorbid conditions that would impact on cognitive function.

Studies could move away from a correlational design and study the development of self awareness over time. This could be informative as to which factors are pertinent in its development.

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PART III: CRITICAL APPRAISAL

Study Development and Methodological Issues

1.Introduction

This purpose of this section is to discuss the process of arriving at the topic of study, the challenges posed by the research setting and to expand on the limitations of the study design.

2. Choice of topic

My interest in this area stems from an interest in the field of neuropsychoanalysis. This field attempts to test, extend and integrate Freudian ideas with modern neuroscience. My initial interest was in studying the phenomenon of confabulation. Confabulation is a neuropsychological disorder in which the patient suggests, and defends against reasonable evidence, an account of reality which is patently false. For example, that their hospital ward is actually a hotel, or that their husband is an imposter. Recent studies have looked at a possible role for emotion in confabulatory states - that confabulations might be accepted as versions of reality because of their affective consequences. For example, Fotopoulou et al (2007) found evidence that motivational factors contribute to confabulation, along with defective reality and temporality monitoring.

I expressed my interest in carrying out a study in the area of confabulation. The setting available to conduct the study was a Brain Injury Rehabilitation Unit at a Community Hospital. However my field supervisor could not guarantee access to patients who were confabulating for the duration of the testing period of the study.

An alternative topic of study was the more general phenomenon of lack of insight in brain injury patients. This was a more amenable alternative as a substantial proportion of brain injury patients present with lack of insight (Prigitano & Altman, 1990). Researchers have studied the role of emotion in producing this condition. Ownsworth et al (2002) found that neuropsychological factors including executive function, and psychological factors of denial and personality, contributed to ISA. I considered conducting a study that would contribute to this area.

3. Ethical and Practical Considerations

A number of practical and ethical considerations posed constraints on the methodology I could use for the study. Existing patients at the Unit were being tested extensively as part of another research project. It was anticipated that this group would be considered already 'overstudied' by the Ethics Committee. It was therefore decided to recruit study participants from the new patients presenting to the Unit. They would be less likely to have been subject to neuropsychological testing for research. Assessment appointments for new patients last two hours. These determine whether patients will be taken on for rehabilitation. It was important to complete all data collection and neuropsychological testing on the day of this assessment appointment as the patients not accepted by the Unit may well have felt unwilling to participate in the research study on a later date. It was decided patients would be tested after their appointment times as it was unlikely that they would agree to arriving earlier than their appointment time. The total data collection and testing time for this study was restricted to 30 minutes as patients were likely to be tired and

hungry by this point. Within this time information about the study would be given, consent taken, testing conducted, and payment given. The challenge was to create a study for which it would be possible to collect data in this time limit and make a contribution to the field of ISA after brain injury.

4. Choice of Study Design

Having looked at the literature on ISA after brain injury, it became apparent that several studies had addressed the role of executive function in ISA. The studies had used differing methodologies and conceptualisations of ISA. My interest in the theoretical models on ISA led me to look at how the phenomenon had been understood in psychosis. A review by Cooke (2004) described theories of lack of insight in psychosis. These were categorised as clinical models, neuropsychological models and denial models. It seemed that the approaches to the understanding of lack of insight in psychosis considered similar factors to those in the brain injury literature. The review described an interesting study by Koren et al (2004) which had approached the phenomenon from a new angle. The study discussed new methods of assessing cognitive processes involved in ISA in schizophrenic patients. Their study used a conventional executive function test (Wisconsin Card Sorting Test) with an adaptation to introduce the new measure. Such an approach could be applied in the circumstances available for the current study with brain injury patients. The relationships examined would be new and contribute to the literature on ISA after brain injury.

5. Extended Discussion of Limitations of Study Design

5.1 Sample

The sample of patients in the study was heterogeneous with regard to several important variables: lesion location, cause of injury, severity of injury, time since injury, alcohol and drug misuse and age. Exclusion criteria were not imposed on the sample with regard to these variables for the study. This decision was taken as the constitution of the patients presenting to the Unit within the study period could not be predicted. It was planned to recruit as wide a sample of patients as possible and address the variations in patient characteristics in the statistical analyses. As the Unit deals with complex brain injury it was likely that a substantial proportion of patients would have a history of alcohol and drug use. Indeed a common cause of traumatic brain injury is falls and these are often as a result of alcohol intoxication. Another common cause of brain injury is stroke. This is usually a disease of later life with the average age of people who suffer stroke being approximately 70 years (Skilbeck, 1992). Imposition of selection criteria on age would exclude such patients. The decisions to include such patients were made to obtain a larger sample at the expense of a purer sample in terms of brain dysfunction. Despite these attempts to make the sample inclusive, 43% of potential participants were not able to be recruited to the study for various reasons described in the Results section of the Empirical Paper.

The variation of lesion location in the sample has implications for the interpretation of the findings. Studies of executive function commonly use patients with relatively isolated frontal lobe lesions. This is because the performance of such patients on

executive tasks is less likely to be contaminated by impairment in peripheral cognitive systems. Any impairment in functioning can then be more confidently attributed to impairments in executive processes (Burgess 1997). The implications of the mixed sample for the current study are that impairment on the Brixton Test cannot be assumed to be due to impairment of executive processes. It may be due to deficits in other cognitive systems supporting the execution of the task. This would also be the case for the metacognitive measure.

5.2 ISA measure

The Awareness Questionnaire was chosen to assess ISA for a number of reasons which have been described in previous sections, including that it is relatively quick to complete and asks about different areas of functioning specifically after brain injury. Reasons for this measure of self-awareness possibly not being an accurate reflection of patients' ISA have been described in the Discussion to the Empirical Paper and will now be expanded.

Studies suggest that obtaining report of a patient's functioning is complicated by several factors. Sherer et al (1998) identified that patients' responses to specific questions about their injury-related impairments were more consistent with relatives' reports than patients' responses to global questions. This suggests that a discrepancy between patients' and others' report may be due to an artefact of the questionnaire items rather than reflecting a difference in opinion regarding the patient's capabilities. Global questions are likely to be interpreted in a more wide ranging way than specific questions. It could be argued that some items of the Awareness

Questionnaire are rather vague and global in nature, for example, "How well organised are you?", "How well can you get along with people?". These items do not specify what activities the patient can organise, or who they are able to get along with. It is likely that the patient may differ in their ability to organise activities that are more or less demanding, and differ in their ability to get along with people they know well compared to those they have recently met. It is possible that patient and relative may interpret these vague items differently and so actually be reporting the patient's ability to do different things.

Another study highlights that BI patients may be aware of their current deficits but not what these may mean for their functioning in the future. This has been described as the "extension" of awareness of deficit (Marcel et al 2004). Tyerman and Humphrey (1984) found that TBI patients could provide accurate information on personal changes although they clung to unrealistic hopes for the future. All of the items on the Awareness Questionnaire ask about patient's abilities "now, as compared to before your injury". A criticism of using the Awareness Questionnaire therefore is that it is not able to assess patients' expectations for the future. It does not cover the possible range of extension of awareness of deficit.

A possible reason for patients' ISA of cognitive deficits may be that it is harder to become aware of these deficits. A further reason may be that the consequences of executive problems are hard to comprehend and predict. For example, it is easier to comprehend that having a paralysed limb would result in difficulty walking than to comprehend that poor impulse control would lead to difficulty dealing with novel situations and interpersonal relationships (Port et al 2002).

The significant other's report of the patients functioning may be affected by stress, fatigue, lack of knowledge, and frustration in managing the patients' challenging behaviour. The following studies highlight how relatives' distress, relationship to the patient, and their personality may affect their report of the patients' deficits. Prigatano et al (2005) investigated the relationship between relatives' judgement of their own distress level in helping the patient and their subsequent ratings of that person's level of awareness of disturbances in their functioning. The family member's level of distress in trying to help the person was significantly correlated with their view of the patient's unawareness. McKinlay and Brooks (1984) found that parents of a patient with TBI tended to cope better than did spouses and that neurotic personality types over-reported sequelae in their family member.

A study by McWilliams (1991) found that patients with TBI and their family members were largely optimistic about the future and felt that the patient would return to their pre-morbid self within a year. Relatives' may therefore also have unrealistic attitudes towards their relatives' deficits.

Port et al (2002) discuss reasons why a relative's undertanding of a patient's deficits may not be realistic. It is possible that at an early stage post injury specific impairments may not have been manifest in a functional context. Family and friends may not have had the opportunity to observe the changes in everyday activities. This is particularly likely to be the case for patients who have been inpatients at the time of questionnaire completion. Their family may not notice changes until the person is discharged and attempts to resume their pre-injury life roles in work or at home. In

these cases therapist report may be a more accurate measure of deficits. The sample of patients in this study did consist of some patients soon after their brain injury who had been inpatients in other settings before their assessment at the Unit. It is possible that relatives would not be aware of the functional deficits the patients may have.

The context of this study may have influenced the report of patients' difficulties in functioning. Given that patients and relatives took part in the study after their assessment appointment, which would determine whether the patient was suitable for rehabilitation, they may have felt a need to stress the patient's difficulties. They may not have understood that the research study was not part of the clinic procedures, although they were informed of this verbally and in the Patient Information Sheet. Krefting (1990) explored the relationship between patients' families and service providers and reported that patients and families may experience a double-bind in their communications with health professionals. Family members can face a dilemma in determining how much information it is safe to reveal to staff, especially if there are potential implications for rehabilitation.

5.3 Executive function measure

Burgess (1997) discusses the unique demands made by the nature of executive function system on methodology in neuropsychology. Traditional methodology used in neuropsychology of finding dissociations may be less useful in the study of executive function than in studying other aspects of cognitive function. One reason for this is the problem of 'task impurity' – that differential performance across executive tasks cannot be compared as the background demands differ across them.

For example a dissociation between Trail-making and Cognitive Estimates may be a function of motor slowing with age, combined with an improvement in performance on Cognitive Estimates with age due to greater life experience and semantic knowledge. Thus such a patient's performance may say little about the nature of their executive function per se. Studies by Wilson et al (1996) and Reitan (1971) support the view that many executive tasks tap a range of processes incidental to their main purpose.

The Hayling Sentence Completion Test (Burgess and Shallice, 1997) was designed to overcome this problem of task impurity. Burgess and Shallice (1997) designed this task in which the background demands of the two parts of the task are similar. In the first part of the Hayling Test, the initiation condition, the patient is presented with a series of sentences which have the last word omitted and asked to provide the word which completes the sentence. In the second part of the test, the inhibition condition, the patient is required to produce a word which does not fit at the end of the sentence. The extremely low correlations between the two sections suggest double dissociation between the processes supporting these skills. As discussed previously in the Discussion section of the Empirical Paper, the Brixton Test performance cannot be assumed to be reflecting only executive abilities, as there were no tests controlling for the background demands of the Brixton Test.

Rabbitt (1997) discusses a broader problem in the conceptualisation of executive functions and their operationalisation in studies. Executive functions tend to be described in terms of tests that dysexecutive patients fail on, rather than descriptions

of hypothesised functional aetiology. Performance indices in tests are often treated as directly equivalent to the hypothetical system characteristics specified in models. For example, terms such as 'planning', 'inhibition' and 'concept shifting' are not treated merely as descriptions of task demands, but are also used as labels marking qualitative distinctions between the functional processes. Rabbitt (1997) challenges this tendency present in the literature to classify executive tasks according to the abilities they purport to measure. This is because a correspondence between behaviour on a task and putative cognitive processes cannot be assumed. Dissociations between outcomes on executive tests may not reflect actual fractionation of underlying processes. Behavioural components such as 'inhibition', 'planning', 'monitoring' and 'control' may appear logically different but it is possible that they are met by the same cognitive systems (Anderson 1993). This has implications for studies which attempt to find which executive tests are more associated with ISA than others, and suggests that such approaches may not be helpful in understanding the cognitive architecture supporting ISA. The present study could also be criticised for assumptions that the executive test and the metacognitive measure were assessing distinct putative cognitive processes.

A further difficulty arises when studies attempt to assess the relationship of cognitive processes to complex sequences of behaviour. Such behaviour sequences are inevitably carried out according to temporal and physical constraints. These constraints interfere further in relating behavioural outcome to the functional organisation of the executive system (Rabbitt 1997). For example, the processes underlying planning and those that enable a person to execute a self-generated plan

are theoretically separable, but they will not be empirically – one cannot fail or succeed in carrying out a plan one has not made (Burgess 1997).

When executive function is being assessed by performance of complex behavioural sequences with limited structural constraint, individual response style is likely to affect the incidence of certain types of behaviour (Rabbitt 1997). This will increase variation in outcome on the task.

Individuals will also vary in how novel the demands of executive tasks are to them. Since executive function is held to coordinate the effective performance of new or complex tasks, this variation in novelty to the individuals makes it difficult to know how much a task is tapping the executive process of interest. According to Rabbitt (1997), this is likely to weaken correlations between scores on executive tests and to contribute to failure to find patterns of associations between performance on tests with logically similar demands. The above considerations would need to be borne in mind by studies attempting to assess executive function.

6. Development of my understanding of research into cognitive processes

The process of researching, designing, carrying out and interpreting the findings of this study has increased my understanding and appreciation of several issues in research into cognitive function.

I have become aware of the difficulties in studying cognitive processes. In particular I learnt that the subtle and elusive processes of executive function are difficult to define, let alone operationalise. I realised that the finding of dissociations between

tasks is not straightforward to interpret. Assembling ideal samples to study executive function is difficult in practice. I have become aware of the many quandaries involved in research into the relation of the brain to putative psychological constructs.

My understanding of the concept of self-awareness has developed from thinking of it as a relatively simple, unitary and stable construct to conceiving of it as a multifaceted and dynamic construct with several dimensions. I have been intrigued to learn about the role emotion may play in arriving at self-awareness judgements. I am more aware of the possibility of bi-directional relationships between affect and cognitive processes. This development in my understanding of its nature has made me aware of the challenges involved in attempting to measure and quantify a construct such as self-awareness. This increased understanding will help me to consider the validity and accuracy of the measurement and quantification of other psychological constructs when I encounter such research in the future and when conducting future research.

7. References

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APPENDICES

ETHICS COMMITTEE APPROVAL LETTER

Barnet, Enfield & Haringey Local Research Ethics Committee
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Telephone:

01 August 2006

Miss Kaneez Husain
Trainee Clinical Psychologist
Sub-dept of Clinical Health Psychology, UCL
Gower Street
London
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Dear Miss Husain

Full title of study: **Awareness of Deficit after Brain Injury: relation to executive function and access to rehabilitation**

REC reference number: 0

The Research Ethics Committee reviewed the above application at the meeting held on 25 July 2006. Thank you for attending the meeting.

Ethical opinion

issues covered during the review:

- *Discussion took place regarding the Awareness Questionnaire to be sent to the patient and significant other and the importance that the client and carer should not discuss it before completing.*

The members of the Committee present gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation.

Ethical review of research sites

The Committee agreed that all sites in this study should be exempt from site-specific assessment (SSA). There is no need to complete Part C of the application form or to inform Local Research Ethics Committees (LRECs) about the research. The favourable opinion for the study applies to all sites involved in the research.

Conditions of approval

The favourable opinion is given provided that you comply with the conditions set out in the attached document. You are advised to study the conditions carefully.

Approved documents

The documents reviewed and approved at the meeting were:

Document	*Version*	*Date*
Application	1	07 July 2006
Investigator CV		07 July 2006
Protocol	1	07 July 2006
Covering Letter		07 July 2006
Peer Review		07 April 2005
Questionnaire: (validated)	1	
Letter of invitation to participant	1	
GP/Consultant Information Sheets	1	
Participant Information Sheet	1	04 July 2006
Participant Consent Form	1	
CV Supervisor		
Hospital Anxiety and Depression Scale		

Research governance approval

You should arrange for the R&D Department at all relevant NHS care organisations to be notified that the research will be taking place, and provide a copy of the REC application, the protocol and this letter.

All researchers and research collaborators who will be participating in the research at a NHS site must obtain final research governance approval before commencing any research procedures. Where a substantive contract is not held with the care organisation, it may be necessary for an honorary contract to be issued before approval for the research can be given.

Membership of the Committee

The members of the Ethics Committee who were present at the meeting are listed on the attached sheet.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

Yours sincerely

Dr. Peter Savege
Chair

Email: alison.okane@rnoh.nhs.uk

Enclosures: *List of names and professions of members who were present at the meeting and those who submitted written comments*
Standard approval

Copy to: *University College London*
Gower Street
London
[R&D Department for NHS care organisation at lead site]

PATIENT INFORMATION SHEET AND CONSENT FORM

PATIENT INFORMATION SHEET

Date: 04.07.06, Version: 1

Study Title: "Awareness of Difficulties after Brain Injury"

You are being invited to take part in a research study. This Information Sheet will help you understand why the research is being done and what it will involve. Please take time to read the following information carefully. Talk to others about the study if you wish.

- **Part 1 tells you the purpose of this study and what will happen to you if you take part.**
- **Part 2 gives you more detailed information about the conduct of the study.**

Part 1

What is the purpose of the study?

The purpose of the study is to look at what sort of mental skills help people to be aware of any difficulties they may have, after they have had a brain injury.

Why am I being asked to take part?

You have been asked to take part because you are a new patient at the Brain Injury Rehabilitation Unit (BIRU). We will also be asking all other new patients at BIRU during the study period to take part. The study will consist of about 40 patients.

It is up to you to decide whether or not to take part. If you do, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason, and any information collected from you will be destroyed. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive.

What will I have to do if I take part?

If you decide to take part, you are requested to complete some questionnaires. These questionnaires ask you and a member of your family or close friend, about any difficulties you may be experiencing after your brain injury, and any difficulties you may be having with your mood. You are also asked to stay behind for up to 30 minutes after your appointment at BIRU, in order to take part in two tasks: one is a quick reading task, and the other a picture game. These will take up to 15 minutes in all. These questionnaires and tasks are not given to patients as part of the standard assessment. You will be given £6 as a "thank you" for taking part in the study.

What is the benefit of taking part?

Taking part in the study is not expected to help you directly, but the information we get might help improve the treatment of people with brain injury.

This completes Part 1 of the Information Sheet. If the information in Part 1 has interested you and you are considering participation, please continue to read the additional information in Part 2 before making any decision.

Part 2

Complaints and Concerns

If you have a concern about any aspect of this study, you should ask to speak with the researcher, Ms Kaneez Husain, who will do their best to answer your questions (Contact number: 020 8732 6700). Any complaint about the way you have been dealt with during the study will be addressed. If you remain unhappy and wish to complain formally, you can do this through the NHS Complaints Procedure. Details can be obtained from the hospital.

Confidential Information

All information which is collected about you during the course of the research will be kept strictly confidential. Any information about you which leaves the hospital/surgery will have your name and address removed so that you cannot be recognised from it. It will be stored securely in an anonymous form, and only the researcher will be able to view identifiable data. It will be retained until September 2007, after which it will be disposed of securely.

Your GP will be notified of your participation in this trial, with your consent, and relevant clinicians will be contacted for relevant medical details, with your consent.

What will happen to the results of the study?

We intend to publish the results in a peer-reviewed journal. Participants will not be identified in any publication. A summary of the findings in lay language will be available from the Unit for patients who have taken part.

Who is organising and funding the research?

This study is a student research project. University College London (UCL) is sponsoring the research. The doctors involved in your care and the researcher are not being paid for including you in the study.

Who has reviewed the study?

This study was given a favourable ethical opinion for conduct in the NHS by the Barnet, Enfield and Haringey Research Ethics Committee.

Thank you for taking the time to read this Information Sheet.

Patient ID No.:

CONSENT FORM

Title of Study: "Awareness of Difficulties after Brain Injury"

Name of Researcher: Kaneez Husain

Please initial box

1. I confirm that I have read and understand the information sheet (dated 04.07.06, version 1) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected. ☐

3. I understand that relevant clinicians may be contacted in order to access relevant sections of any of my medical notes. I give permission for the researcher to have access to my records. ☐

4. I agree to my GP being informed of my participation in the study. ☐

5. I agree to take part in the above study. ☐

Name of Patient	Signature	Date:
Name of Researcher	Signature	Date:

When completed, 1 for patient; 1 for researcher site file; 1 (original) to be kept in medical notes.