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Efficacy of an intervention programme for rehabilitation of awareness of deficit after acquired brain injury: A pilot study

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ABSTRACT

Background: Impaired Awareness of Deficit (AD) is a frequent symptom after suffering acquired brain injury (ABI) that severely influences patients' daily lives.
Primary Objective: Pilot study to assess the effectiveness of a structured intervention programme which was developed from a biopsychosocial approach, and relied on common therapeutic strategies of proven effectiveness.
Methods: We assessed the effectiveness of our intervention on a sample of 60 patients with ABI, 30 of whom received the specific AD intervention programme, while the other 30 followed an equivalent rehabilitation approach where they received no specific intervention on AD. AD were assessed before and after the specific intervention on AD through an ad-hoc designed questionnaire.
Results: This study reports that patients who received the proposed programme demonstrated significant improvement in their level of AD, as compared to the control group. This improvement was observable on all the proposed dimensions of awareness. Interestingly, results from correlation analysis also showed that patients with lower initial AD were those who exhibited a greater degree of improvement following the intervention.
Conclusions: This research provides evidence in favour of the effectiveness of implementing an intervention programme for AD in the context a global rehabilitation process for patients with ABI.

Introduction

When a person suffers acquired brain injury (ABI), there are often many residual physical symptoms as well as sensory, cognitive, behavioural and emotional deficits. One impairment commonly seen after ABI is in Awareness of Deficit (AD).

Impaired AD is a complex phenomena and is often referred to in the literature using other terms such as self-awareness or anosognosia, the latter usually being used as a synonym for lack of AD (1). George Prigatano defined self-awareness in first instance as the "*capacity to perceive oneself in relatively objective terms while keeping a sense of subjectivity*"; thus self-awareness or awareness of higher mental functions involves an integration of thoughts and feelings (2). Also, this author proposes a definition of impaired AD as "the clinical phenomena in which a brain dysfuctional patient does not appear to be aware of impaired neurological or neuropsychological function, which is obvious to the clinician and other reasonably attentive individuals" (3).

Scientific research has emphasised the importance of considering self-awareness as a multidimensional construct (4). Initial investigations on this topic proposed a hierarchical model, the Pyramid Model of Self-Awareness, with three separate levels: intellectual, emergent and anticipatory awareness (5). Later on, this model has acquired more complexity, leading to the development of the Dynamic Comprehensive Model of Awareness (4), which primarily focuses on the relationship between different aspects of meta-cognition and consciousness. In this model, the term "online awareness" includes components that come to action whilst performing the task as well as after doing it. This encompass the ability to change thoughts and beliefs during the execution of the task (self-monitoring), error detection (error-monitoring) and proper adjustment of the performance (self-regulation). The concept of metacognition refers to the level of awareness prior to the performance of a task, including knowledge and beliefs about oneself and the individual's perception of his own functioning. In our study, we mainly focus on metacognition of patients who have suffered brain injury. This corresponds to the initial concept of intellectual awareness, at the base of the Pyramid Model of Self-Awareness, on which the other dimensions of online-awareness depend (5).

From a clinical point of view, AD has often been defined as the ability to recognise deficits or problems caused by a brain lesion (5). Similarly, keeping in mind the important relationship that arises between this concept and patients functional status, it may be noted that AD stems from objective knowledge, being the ability to relate this knowledge to the person's

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activities of daily living and this person's ability to use them to set realistic goals (6).

Other researches have also focused on the need to establish different dimensions within AD. Beside the AD itself, an individuals' emotional response to their difficulties or deficits as well as the ability to understand the impact or consequence of such deficits in their daily life functioning also need to be taken into consideration (7). Finally a fourth dimension involving the ability to establish realistic objectives and implement alternative adaptive strategies has been proposed (4).

Another line of research has tried to identify possible physiological and neuroanatomical underpinnings of impairments in AD in patients with ABI. Early studies highlighted the importance of the right prefrontal cortex as a relevant area, showing abnormal activity in patients with impaired AD (8). Over the last years, Functional Magnetic Resonance and Tensor Diffusion Imaging studies have identified the brain areas that are involved in AD, as well as the bundles of fibers that connect these regions, emphasising the importance of those connections in maintaining an adequate level of AD in patients suffering ABI (9). Activity within the frontoparietal control network seems to be altered in these patients. Specifically, decreased resting state connectivity has been found between the dorsal anterior cingulate cortex, a key component of the network mainly responsible for monitoring, and the rest of the frontoparietal control network in patients with ABI (9).

A key aspect of the study of AD has concerned the impact of impairments in this area with a patient's ability to make progress in rehabilitation. Patients with impaired AD show a decreased understanding of the functional impact of the changes related to their brain injury, which may be linked to a tendency for them to set unrealistic goals for the future. Therefore, these patients experience difficulties in engaging in rehabilitation, have low motivation and a poor acceptance of the use of compensatory strategies (10). Conversely, there is also evidence linking greater AD with more favorable rehabilitation outcomes, including improvements in physical or motor function, increased level of the patient safety, greater independence in activities of daily living, better prospects for professional integration of outpatients, greater psychological and emotional adjustment, and better social functioning (11). Thus, the development of specific programmes for the rehabilitation of impaired AD after ABI should be a key element to take into account in rehabilitation programmes.

In recent years, a wide variety of intervention programmes has been developed with the aim of increasing AD and maximising functional improvements in patients with ABI. In a comprehensive review carried out by Fleming and Ownsworth (12), the following methodologies were identified as the most commonly employed to intervene in AD decline: neuropsychological programmes, psychotherapy, approaches based on compensation and facilitation, structured experiences, direct feedback, video feedback, confrontation techniques, cognitive therapy and group therapy programmes in the form of games and behavioral interventions (12). Incorporating feedback as a central component of intervention is a common strategy in AD rehabilitation programmes (13). Some studies have assessed the effectiveness of verbal feedback provided by the

therapist when the patient performs a range of different tasks or activities including both positive and negative aspects of their performance (6). Interventions based on recording of the patient's performance are also commonly used (14,15). Despite the widespread use of this methodology, only one recently published study has precisely described a video feedback intervention protocol in patients with ABI and with impaired AD (16). The effects of these interventions would be classed as moderate in terms of effect size (10), which suggests that these approaches may be effective when integrated within a broader and more complex intervention programme.

Other intervention programmes for AD include psychoeducational approaches which aim to develop the patient's knowledge of the brain basic functioning, as well as about the consequences that brain injury can cause on the cognitive system (17). Also, the use of the patients' own clinical and radiological tests results (e.g. medical and neuroimaging reports) can be an important element in the intervention programme and has been proven to be an effective tool in the management of impaired AD (18). It is also important that each patient should have an individually tailored approach to intervention which takes into account their own unique neuropsychological, physical and social-environmental condition (12).

A recent systematic review on interventions for AD after ABI considered more than 470 peer-reviewed journal articles and found a number of methodological limitations in the literature, including small experimental group sizes, and the absence of a control group (19). Of the total number of studies considered, nine were judged to be of high methodological quality of which only three reported a positive effect for their AD intervention (6,20,21). This highlights the importance of developing and evaluating theory-driven interventions specifically focused on disentangling the components of treatment that are successful in improving awareness.

In this pilot investigation we present an intervention for improving AD in patients who have sustained ABI and try to address the main methodological issues identified in the aforementioned systematic review. Our intervention has been developed using a biopsychosocial approach and adopts techniques such as psychoeducation and structured feedback, administered in a group format, in the context of a comprehensive rehabilitation treatment. In order to assess the effectiveness of this programme, we compare two equivalent groups of patients with ABI. One of them received the intervention programme while the other received an equivalent therapeutic workshop in which AD was not specifically addressed. In addition, we explore the different dimensions of AD and the influence that the intervention programme had on each of them. Finally, we explore potential relationships between AD before treatment and the degree to which the patient benefits from the intervention programme.

Traditionally several different approaches to measuring AD have been utilised in clinical practice. One of the most common strategies consists of comparing the scores on a standardised questionnaire completed by the patient themselves and by a relative, taking discrepancies between the two scores to represent an apparent impairment in AD. A widely used

example of this assessment method and one of the most used tools is "The Patient Competency Rating Scale" (PCRS) (22).

Another common method for assessing AD is the employment of a structured interview administered and scored by the clinician. The Self-Awareness of Deficits Interview (SADI) (23) is a commonly used measure of this kind. The SADI includes items addressing three domains: AD itself, awareness of the functional implication of these deficits and ability to set realistic goals.

For the current pilot study, we developed an *ad-hoc* scale administered in a semi-structured interview format to assess AD. Our *ad-hoc* scale has been purposely designed with the aim to suit the characteristics of patients who are at early stages of rehabilitation (participants in our study started the treatment an average of 145 days after they suffered ABI). Scores are based on the clinician's assessment guided by the patient's responses. Thus, it overcomes the drawbacks associated to the first assessment method previously discussed here, thereby reducing the potential bias of emotional burden on the part of the patient's relative (23). In comparison with the second scale described, our *ad-hoc* scale contains a first section on awareness of lesion itself (see Materials section for a detailed description of the scale).

In order to confirm whether the *ad-hoc* scale used in the sixty participants involved in the intervention programme was measuring the level of AD in a similar way than a validated scale does, an additional sample of thirty one patients with ABI were assessed using both, our *ad-hoc* scale and the SADI (23), an established and validated measure of AD.

Method

Participants

Sixty patients (40 men and 20 women) over 16 years (mean age 38.35 years range; from 18 to 57 years), all from the National Centre for Brain Injury Treatment of Madrid (Spain), on a residential basis took part in the study. All of them had sustained a non-progressive ABI with an average evolution of 145 days from the moment they suffered the injury to their admission to the center. All participants were medically stable, did not suffer any communicable diseases in active phase and they were able to actively participate in a rehabilitation process. The etiology of patients with ABI

included: traumatic brain injury (*n* = 20), stroke (*n* = 29), brain tumor (*n* = 4), encephalitis (*n* = 5) and other causes (*n* = 2; epilepsy surgery and HIV).

The experimental group consisted of thirty patients who received an intervention programme to increase AD. The programme was administered by a trained neuropsychologist and structured in eight sessions over the period of a month, complementary to their rehabilitation treatment. Intervention was carried out in groups of six to eight patients. The other 30 patients formed the control group. They received eight equivalent sessions during which they attended rehabilitation workshops according to their therapeutic goals and in which AD was not specifically addressed. Participants were randomly assigned to both groups, which were equivalent in age, years of education, time outside treatment before entering the center and two functional assessments scales (see Materials section for a detailed description of the functional assessment scales), as well as pre-treatment scores of AD (see Table 1).

Thirty one additional patients (twenty one men and ten women) over 16 years (mean age 42.74 years; range from 18 to 55), were recruited from the same centre and assessed using both the SADI (23) and our *ad-hoc* scale, in order to test whether the latter was able to provide a valid measure of the level of AD in a sample of patients with ABI. As the main sample of this pilot study, they all had suffered non-progressive ABI with an average evolution of 149 days from the moment they suffered the injury to their admission to the center. They were also medically stabilised and did not suffer any communicable diseases in active phase. Their ABI etiology included: stroke (*n* = 20), traumatic brain injury (*n* = 6), brain tumor (*n* = 4), autoimmune encephalitis (*n* = 1).

Materials

Functional assessment scales

Two functional assessment scales, widely used in clinical research with patients with ABI (see e.g. 6,24–26) were applied in the pre-treatment evaluation of all participants. In the first one, The Barthel Index (27), rates the patient's ability to perform basic activities of daily living independently. The Lawton Index (28), rates a patients' ability to perform instrumental activities necessary to independently live in the community.

Table 1. Mean, standard deviations and T-statistic for independent samples for demographic data and scores on the pre-treatment *ad hoc* AD scale.

		Mean	Standard Deviation	T	*p* value	Cohen´s D
Age	Experimental	40.37	9.65	1.47	0.15	0.38
	Control	36.33	11.48			
Education in year	Experimental	11.7	2.37	1.43	0.11	0.42
	Control	10.6	2.85			
Time in days pre-rehabilitation	Experimental	139.73	89.9	−0.5	0.62	0.13
	Control	150.07	69.9			
Barthel	Experimental	66.17	31.83	0.97	0.33	0.25
	Control	57.83	34.36			
Lawton	Experimental	2.07	2.21	0.83	0.41	0.21
	Control	1.06	2.16			
Pre score in AD	Experimental	15.73	6.03	0.83	0.45	0.2
	Control	16.8	4.77			

Awareness of deficit measurement

An *ad-hoc* scale was developed, in a semi-structured interview format, consisting of three main areas: Awareness of Injury, AD and Awareness of Disability. This structure is based on previous studies that differentiate between the awareness of the deficits themselves and the awareness of the functional implications of such deficits (7,23). The Awareness of Injury dimension is a novelty with respect to previous divisions established by other authors. This dimension was included in order to take account of the degree to which the patient with brain injury is aware of having suffered brain damage, a factor that could be considered a prerequisite for the development of a global AD.

In the Awareness of Injury dimension, the clinician gives a score depending on whether the patient is able to acknowledge having suffered a brain injury or not, either spontaneously or in response to the clinician's questions. In the AD dimension, scores depends on whether the patient spontaneously refers to suffering from different physical, sensory and cognitive deficits, requires help or examples to recognise them or by contrast, actually ignore their deficits. Finally, Awareness of Disability dimension asks the patient about their ability to currently perform a series of activities (driving, cooking dinner or lunch, doing house chores, looking after a young child, working or studying and living alone) and is scored based on whether their answers are in line with reality or not. The Awareness of Injury dimension ranges from 0 to 6, and both the AD dimension and the Awareness of Disability dimension from 0 to 12. Therefore, the maximum score that a patient can obtain in the scale is 30 indicating full awareness of having sustained a brain injury, its consequences and the disability it causes.

Besides, the SADI (23) was used in an additional sample of thirty one patients to explore whether our *ad-hoc* scale was a valid measure of AD in patients with ABI (see Participants section).

Procedure

The sixty participants in the main study received a pre-treatment AD assessment. Then they were randomly assigned to the experimental and control groups. The experimental group received a treatment programme in AD in 8 sessions over one month. In parallel, during those 8 sessions, patients in the control group attended a rehabilitation workshop according their therapeutic goals, where they received no specific intervention on AD. After the intervention period, patients from both groups underwent a post-treatment assessment. (Figure 1).

The awareness of deficits intervention programme

Awareness of Deficits Intervention Programme in AD was designed to include the methodologies that have been proven effective in improving AD in the context of brain injury (19). Thus, aspects of psychoeducation were included (18) and work sessions on the patients' own clinical tests data were incorporated (e.g. neuropsychological report, neuroimaging tests, etc.) as well as sessions based on verbal feedback as a therapeutic tool, both provided by the therapist and the peer group (10). The same neuropsychologist conducted al treatment sessions to ensure a consistency of approach. Each patient was given a notebook where the different activities to be develop were listed and which was filled in during the sessions. It was intended to facilitate memory and transdisciplinary work. The intervention programme was designed in a group format and it was structured in eight sessions distributed over a month, at a rate of two sessions per week (see Box 1 for a detailed description of the eight sessions in the programme, with their specific goals and activities).

Comparing the AD-hoc scale with a validated measure of AD

As the main outcome measure of AD was an *ad-hoc* scale, and no secondary validated measure was available for the sixty participants involved in the intervention programme, thirty one additional patients with ABI were assessed using both, our *ad-hoc* scale and the SADI (23), so that a validated and an *ad-hoc* scale scores of AD were available for each participant in this additional sample. A correlation analysis was computed in order to confirm whether our *ad-hoc* scale was measuring the level of AD in a similar way than a validated scale did.
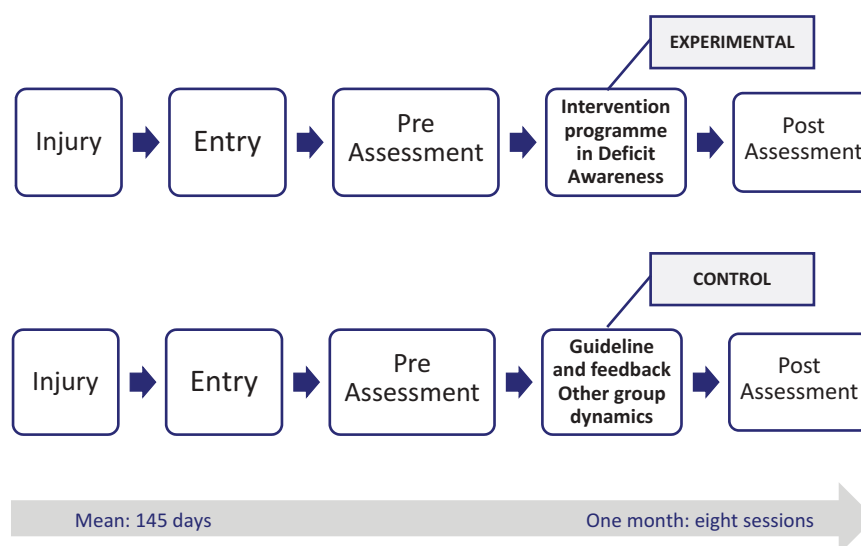

Figure 1. Research process outline.

Box 1. Content of the 8-session intervention program in Deficit Awareness.

SESSION 1: WORKSHOP PRESENTATION
Introduction to the program and group peers. A presentation is conducted about the brain and its different motor, emotional and specifically cognitive functions. An exercise is carried out in which the importance of a conscious being is highlighted.

SESSION 2: PERCEIVING OUR DIFFICULTIES
The goal of this session is to pause for thought about all cognitive functions and to reckon if they have difficulties in each of them. It is based on self-reflection.

SESSION 3: UNDERSTANDING OUT LESION
The goal is to delve into the injury and into the discrepancies between our perception and the professionals'. Neuroimages are employed, with drawings of the lesion and data from the radiological report. The own lesion is contrasted with what has been learnt in the previous session.

SESSION 4: WORKING WITH THE NEUROPSYCHOLOGICAL REPORT
The goal is to delve into cognitive difficulties in order to achieve greater Awareness of Deficits with the aid of the neuropsychological report.

SESISION 5: ACTIVITIES TO REFLECT ON I
The goal of this session is to reckon about our own physical, sensory and cognitive skills and discuss with the group peers about our own point of view. Appraise what you can no longer do as you used to.

SESISION 6: ACTIVITIES TO REFLECT ON II
The goal of this session is to reflect on the required abilities to perform several basic and instrumental activities of daily living. The required abilities are contrasted with the difficulties assessed in the neuropsychological report.

SESISION 7: ACTIVITIES TO REFLECT ON III
The goal of this session is to reflect on advanced skills (living alone, working, driving). For each user it is required to focus on the domains of which he/she is less aware and contrast his/her opinions with the reports and his/her peers feedback.

SESSION 8: WHAT HAVE YOU LEARNT IN THIS WORKSHOP?
The goal of this session is to provide the patient with a conceptualisation of the injury and his/her personal limitations through a summery or an overview of the most important aspects considered.

Figure 2. Average level of AD in the pre and post-treatment measures, for the experimental and control groups.

Figure 3. Pre and post-treatment differences in the different dimensions of AD. Error bars represent standard error of the mean.

Results

Group equivalence

Sixty patients were randomly assigned to the experimental (30 patients) or the control group (30 patients). Independent samples T-test showed no differences in age, years of education, time without treatment and functional status (see Table 1).

Effectiveness of the awareness of deficit intervention programme

Effectiveness of our intervention programme to improve AD was assessed using a two-way Analysis of Variance (ANOVA) with group (control and experimental) as between-subject factor and moment of assessment (pre-treatment and post-treatment) as within-subject factor.

The results showed a significant main effect of moment of assessment [$F(1,60) = 68.245$, $p < 0.0001$, $\eta^2 = 0,541$], with AD higher at post-treatment time. No significant main effect of group was observed [$F(1,60) = 2.576$, $p = 0.114$, $\eta^2 = 0,043$]. However, and critically, results also showed a significant effect of the interaction between group and moment of assessment [$F(1,60) = 30.219$, $p < 0.0001$, $\eta^2 = 0,343$], so that the experimental group exhibited higher AD scores only at the post-treatment assessment (Figure 2).

Programme effectiveness and awareness of deficit dimensions

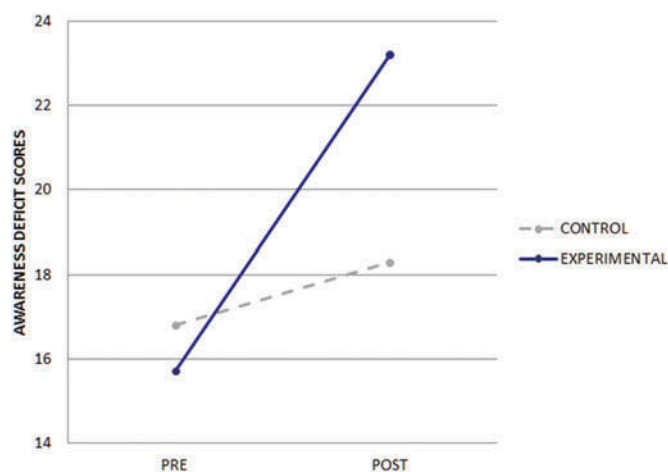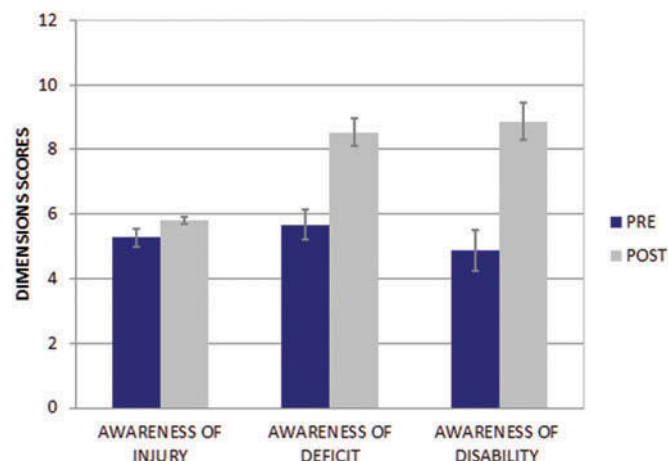The second objective of our study was to explore whether our intervention programme differently influenced each of the three dimensions of AD, Awareness of Injury, AD and Awareness of Disability. Results from paired samples T-test showed that AD improved significantly in all three dimensions: Awareness of Injury ($t(29) = 2.112$, $p < 0.05$, Cohen's $d = 0.455$), AD ($t(29) = 5,787$, $p < 0.001$, Cohen's $d = 1.16$) and Awareness of Disability ($t(29) = 7.374$, $p < 0.001$, Cohen's $d = 1.2$) (Figure 3).

Influence of initial level of awareness of deficit on the programme effectiveness

Finally, the third objective of the study was to explore the effect of baseline AD on the effectiveness of the intervention programme. To do this we correlated the degree of AD improvement (difference between pre and post treatment scores in the AD scale) with the pre-treatment score on the same scale, in patients who belonged to the experimental group. Pearson's test showed a negative correlation ($r = -0.643$, $p < 0.001$), so that those patients with lower pre-treatment scores also exhibited greater improvement after AD intervention (see Figure 4).
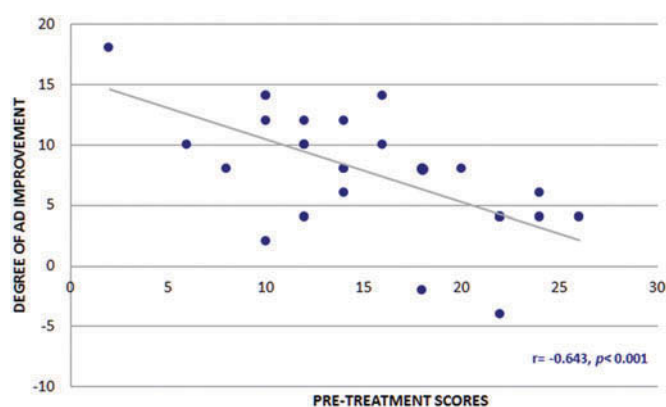
Figure 4. Scatter plot showing the correlation between pre-treatment scores and degree of improvement in the experimental group.
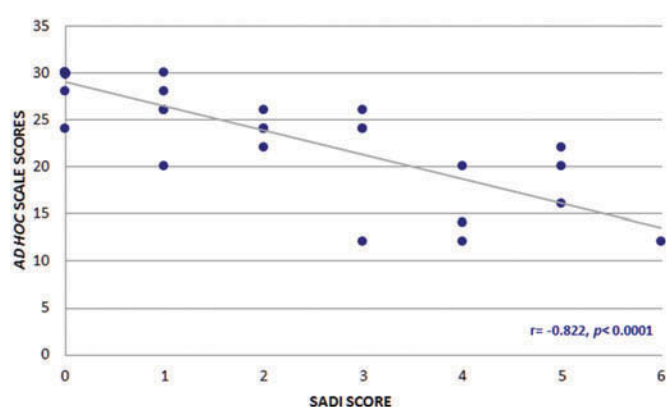

Figure 5. Scatter plot showing the correlation between the awareness of deficit *ad-hoc* scale scores and the SADI scores; important to notice, greater scores on the SADI reflects greater AD impairments, while lower scores on our *ad-hoc* scale points lower AD level.

Correlation between the ad-hoc and a validated measure of awareness of deficit

A limitation of the present pilot study is in regard with the absence of a validated scale of AD in the main sample of patients. In order to take into account this limitation, we assessed an additional sample of thirty one patients with ABI using both, our *ad-hoc* scale and the SADI (23), and computed a correlation analysis between both measures. Results from Pearson's test showed a negative correlation ($R = -0.822$, $p < 0.0001$), so that patients with greater scores on the validated SADI (23) showed lower AD scores on our *ad-hoc* scale (see Figure 5; important to notice, greater scores on the SADI reflects greater AD impairments, while lower scores on our *ad-hoc* scale points lower AD level).

Discussion

The main objective of this pilot study was to assess the effectiveness of a structured intervention programme for patients who present with impaired ability to recognise that they have had a brain injury or to appreciate the deficits and disability caused by their injury. This is particularly important because about 70% of patients who suffer brain injury experience

decreased AD upon admission. More importantly, this alteration persists in 42% of patients when they are discharged (29). Any rehabilitation programme should therefore target to improve AD in these patients as it affects their involvement in rehabilitation and significantly correlates with subsequent functional performance (30).

In the present pilot study we propose a simple but specific and structured intervention programme, suitable for being part of an integrative cognitive rehabilitation programme. Our programme design drawn on techniques with proven effectiveness in AD, including psychoeducation, clinician peer/feedback and fostering reflection on the skills needed to perform activities of daily living through specific exercises. This integrative approach helps the patient to better understand the problems associated with their brain injury, how their injury affects their functional ability, how they may be required to adopt internal and external aids and strategies to manage their deficits and how their goals may require adaptation due to their residual impairment.

The results of our study show are promising in terms of demonstrating the efficacy of such a programme for AD, in the context of a broader rehabilitation programme. In particular, the group of patients who completed the programme experienced a significant overall improvement in their level of AD, measured through an *ad-hoc* designed questionnaire in order to explore the main dimensions of AD. We found that the improvement experienced by the experimental group takes place in each dimension, with the Awareness of Disability dimension showing the greatest improvement. The structure and format of the intervention programme have been purposely designed to gradually work on the three above-mentioned dimensions, based on the idea that the increase in awareness is progressively acquired, starting from awareness of injury, going through AD and reaching awareness of disability. Hence the proposed intervention programme begins by addressing awareness of injury. This dimension is in some patients already normalised at the beginning of the programme, which could explain the lower improvement observed in this dimension after completing the whole programme. Subsequently the various difficulties that patients experience in the motor, cognitive, behavioral and emotional domains are addressed. The intervention on awareness of disability begins when the patient themself recognises these difficulties, since recognising those deficits is a prerequisite to be aware of having suffered a brain injury that causes changes in our functioning. This progressive conception of AD development might account for the lower scores on the Awareness of Disability dimension at the pre-treatment time, and might also explain why this dimension showed greater improvement than the two others following the intervention.

Previous intervention proposals have identified the use of feedback as a useful tool in AD development (10). Our programme included both feedback from clinician and from peers with a brain injury. This facilitates the identification of their deficits and disabilities resulting from ABI. The inclusion of exercises and reflections in the context of a peer group has been proven effective in other intervention programmes for populations different from ABI which also require the

development of a certain degree of AD with respect to their own pathology, including major depression (31), social anxiety (32), schizophrenia (33), intellectual disability (34) or substance abuse (35).

Our programme also employs the use of self-reports which patients completed for each treatment session, including writing down their activities completed, and their level of personal achievement. Self-reports are a widely used tool in psychotherapeutic intervention in different kinds of populations. These techniques are particularly appropriate to foster self-management and self-control in patients, as they are an effective way to actively involve patients in therapy and gradually modify their attributions regarding their possibilities to change the environment and their own behavior (36). Clinicians have used techniques such as self-observation and self-registration due to their potential therapeutic value, not only as motivational instigators of change, but also as active treatment components, sometimes useful by themselves (37).

A common limitation in the studies on the effectiveness of intervention programmes in AD has to do with the spontaneous improvement that patients experience over time. Recent studies have shown that metacognitive awareness spontaneously increases with the passage of time, without intervention (38,39) so it is difficult to isolate the improvement resulting from the effectiveness of the proposed programmes from the spontaneous improvement due to the time elapsed since brain injury (40,41). In order to control the effect of spontaneous improvement, our study included a control group equivalent to the experimental group, consisting of patients suffering from ABI who received the same overall rehabilitation treatment, with the exception of the intervention programme in AD sessions. Instead, patients in the control group participated in workshops equivalent in format to those in the proposed programme, during which AD was not specifically addressed. In line with previous studies, our results show that both groups improved in AD after the four-week intervention programme, regardless of whether they received the AD intervention or not. However it was of particular relevance that the experimental group obtained a significantly higher degree of improvement than the control group. Thus, our results show that intervention in AD through a specific programme with the above described characteristics induces a significantly higher improvement than the mere passage of time.

Another important issue when considering the integration of an intervention programme in AD in the context of a comprehensive cognitive rehabilitation programme has to do with the degree to which the patient with ABI can benefit from this intervention. In particular, we wondered whether the pre-treatment level of AD might influence the degree of improvement after the intervention. The results of our study show that patients with lower pre-treatment AD scores are those who benefit most from this intervention programme. This result is of particular interest, since it could allow clinicians to establish a reasoned criterion for the inclusion of patients in the intervention programme in clinical settings, in a potential context of scarce health care resources.

Despite the promising results of this pilot study, caution must be taken with some aspects. Most of the studies in this field have not tested the long-term stability of their intervention programme's effects. Whilst some studies suggest that the benefits of AD intervention can last for up to 6 months post conclusion of treatment [42] many studies in the field do not adequately asses long-term maintenance of treatment benefits. Our study did not include a follow-up assessment and therefore future research should consider inclusion of this factor in order to draw conclusions with regards to the stability and sustainability of treatments benefits.

Another potential area of concern relates to the question of validity in relation to our *ad-hoc* measure of AD. This scale was developed for allow the exploration of the different dimensions of AD and, although it has not been subject to formal validation, it has been applied in a consistent form to both groups of patients and both at pre and post treatment. Therefore the improvement showed by the experimental group is not likely to be explained by the instrument used for measuring AD, as it was the same for both groups and moments of assessment. Also, a potential test retest gain can be discarded, as the control group did not show such improvement. Notwithstanding, the absence of concurrent scores from a validated scale of AD is still a serious limitation that deserved consideration. In order to try to limit such limitation in the context of a pilot study, we recruited an additional sample of thirty one patients with ABI who were assessed on AD by using our *ad-hoc* scale and the SADI, a standardised and recognised instrument for the assessment of AD. Then, we performed a correlation analysis to get a sense on whether our *ad-hoc* scale was measuring the level of AD in a similar way than a validated scale did. The results of this correlation analysis show that patients with lower AD scores on our *ad-hoc* scale also showed lower AD scores on the SADI (23), suggesting that our *ad-hoc* scale is able to provide a valid measure of AD in a sample of patients with ABI. Even though this data contributes to reduce the uncertainty regarding the reliability of the *ad-hoc* scale, a future comprehensive study should address these limitations tackling the formal validation process of the *ad-hoc* scale.

In spite of the aforementioned limitations, this pilot study presents a potential intervention for AD which, when integrated into a broader brain injury rehabilitation programme, shows the potential to result in beneficial effects beyond the spontaneous gains which may be expected due to the mere passage of time.

Funding

Declaration of interest

The authors report no declaration of interest.

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Appendix

Annex 1. Awareness of Deficit *ad hoc* Scale

AWARENESS OF DEFICIT SCALE	
Awareness Injury	
The patient does not acknowledge having suffered a brain injury, accident, or needing any kind of rehabilitation	0
Does not acknowledge having suffered a brain injury but admits having suffered an accident or being diseased	2
Only acknowledges having suffered a brain injury under questioning	4
Spontaneously explains what has happened to him/her	6
TOTAL AWARENESS OF INJURY (1–6)	
Awareness of Deficit	
The patients is not aware of having any difficulty that needs to be rehabilitated	0
Only under questioning does the patient acknowledges having difficulties in an affected domain (physical, sensory or cognitive) but not in others also affected	2
Spontaneously acknowledges having difficulties in an affected domain (physical, sensory or cognitive) but not in others also affected	4
Is able to describe difficulties in several affected domains (physical sensory or cognitive) only under questioning or with the aid of examples, but is not aware of other important deficits	6
Is spontaneously able to describe difficulties in several affected domains (physical sensory or cognitive) but is not aware of other important deficits	8
Knows and is able to describe his/her main difficulties with help or with the aid of some examples	10
Knows and is able to spontaneously describe his/her main difficulties	12
TOTAL AWARENESS OF DEFICIT (1–12)	
Awareness of Disability	
(Score 2 if the patient's view is realistic and 0 if it is not)	
Driving (if the patient does not drive, ask about riding a bike)	0–2
Cooking dinner or preparing a snack	0–2
Doing the house chores	0–2
Looking after a young child	0–2
Working or studying	0–2
Living alone	0–2
TOTAL AWARENESS OF DISABILITY (0–12)	
TOTAL SCALE (0–30)	