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Computer-aided relearning activity patterns for people with acquired brain injury

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ABSTRACT

People with disabilities constitute a collective that requires continuous and customized attention, since their conditions or abilities are affected with respect to specific standards. People with *Acquired Brain Injury* (ABI), or those who have suffered brain injury at some stage after birth, belong to this collective. The treatment these people require is mainly a continuous relearning process, as they must relearn to walk, read or even interact with their environment. This relearning is critical during the first two years after suffering brain damage. Thus, any assistance in the relearning process in the first two years is of paramount importance for their recovery. This paper describes the activities carried out in the course of developing a tool, HABITAT, to assist people with ABI. A description of the activity patterns that are used in the relearning process is provided. This paper also describes the experiment conducted in collaboration with ADACE (Association of Acquired Brain Injury of Castilla-La Mancha) to evaluate if the use of a computer-based treatment is accepted by people with ABI. This experiment was developed by recording several treatment sessions and passing out questionnaires. The analysis of the questionnaires reveals that computer-based treatment is especially accepted by younger people, increases the motivation of the patient, and reduces the activity completion time.

1. Introduction

People with disabilities constitute a collective that requires continuous and customized attention, since their conditions or abilities are damaged with respect to specific standards. The United Nations (2006) formally recognized through the *Convention on the Rights of People with Disabilities* that currently more than 650 million people with disabilities have the right to effectively enjoy all human rights and fundamental freedoms. Such persons can suffer the disability either unexpectedly due to an accident or suffer chronic problems throughout their life because of congenital conditions. No matter when the disability emerges, its treatment from the very beginning is a deciding factor in providing them with a good quality of life.

People with *Acquired Brain Injury* (ABI) belong to this collective. Toronto Acquired Brain Injury Network (2005) states that people with ABI have suffered "damage to the brain that occurs after birth and which is not related to congenital disorders, developmental disabilities, or processes that progressively damage the brain". There are several causes of ABI. The most frequent, present in at least 50% of cases, is cerebral vascular pathology due to degeneration of the blood vessels altering the blood flow and/or producing a brain haemorrhage. Another frequent cause is skull–brain trauma due to motor vehicle accidents, falls or physical aggression. Brain damage can also be due to specific illnesses such as meningitis or brain tumours. It can therefore be said that all of us are exposed to this disability in our daily lives. The impact of ABI is wide-ranging. It can affect a person's social life and their development. The multitude of physical effects might include muscle spasticity, paralysis or weakness, blurred vision or decreased coordination. ABI also affects a person's cognitive abilities, such as memory, thinking skills, concentration, and organisation and planning abilities. Moreover, ABI is called "the hidden disability" because its effects may not be visible, or they may be mistaken for something else, or seen by some people as deliverable behaviours.

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This disability has severe cognitive, emotional and/or behavioural and physical consequences that make everyday life difficult. For instance, cognitive problems may prevent victims from doing simple tasks such as going to their homes, getting dressed by themselves, or recognizing a lion in a cartoon. Their emotional disorders may make it difficult for them to speak with other persons or accept their own deficiencies. The physical consequences can make it impossible for them to walk or hear. They often find it hard to accept because of its consequences and its sudden occurrence, but it is also hard for their family as they see how one of its members is even unable to speak to them. Correct treatment is the only option they have to recover, at least partially, their former activities.

As can be observed, because of both the causes and the consequences, people with ABI require the continuous and customized attention of specialists in order to recover their cognitive, emotional and behavioural abilities, and to provide them with as much autonomy and independence as possible, if they are to improve their quality of life. However, studies published by The Spanish Ombudsman (2005) on the current situation of this collective in Spain have highlighted the fact that this disability is almost unknown to public organisations and society in general. Considering the social context and the inherent characteristics of this disability, it is clear that severe difficulties prevent patients from gaining access to treatment, which is mainly a relearning process, as they must learn again how to walk, read or even interact with their environment. Relearning is critical during the first two years after the onset of damage, as most of the recovery of their previous abilities is achieved during this period. Unfortunately, several difficulties prevent them from gaining access to this process. These are mainly: (1) the difficulty of access to relearning centres due to the mobility problems of the handicapped; (2) the limited time available to perform their relearning tasks due to the small numbers of staff at the centres; (3) long waiting lists due to the increasing number of persons suffering from brain damage (state that 1.7 million Americans experience brain injury each year (Faul, Xu, Wald, & Coronado, 2010)).

E-learning provides a powerful tool to complement or replace regular teaching/learning activities. The relearning process for people with ABI is also a learning/teaching process, where those persons struggle to relearn some of their lost motor or cognitive capabilities. E-learning can provide a means of compensating for some of the difficulties previously identified. For instance, by providing a platform available at any time, the queues at the treatment centres can be drastically reduced. Using the platform at home is also a great advantage for people affected by mobility problems. The limited staff resources at treatment centres can be used more efficiently, by focusing on cases that actually require constant help and on reviewing the relearning process of the online users of the platform.

The HABITAT (HCI techniques for ABI TreAtmenT) was developed in this context. This system was designed to exploit both e-learning and HCI approaches, such as that presented by González, Montero, López-Jaquero, Fernández, Montañés, & Sánchez (2001), so as to provide this collective with a virtual space where they can put into practice their relearning process by themselves or supervised by a specialist or a relative. Navarro, López-Jaquero, & Montero (2008) show that HABITAT was designed as a distributed application to provide remote access to both specialists and the handicapped. For the development of HABITAT, the traditional relearning process was studied in order to determine which types of activities are carried out by the handicapped, how the interaction is performed, which kind of devices they can use, etc. One of the main goals of this analysis was to define an authoring tool so that the specialist could design these activities more efficiently. The main results of the analysis are presented in this paper. The paper is structured as follows. ABI is described in Section 2 from a social point of view. In Section 3, some related works are presented. Section 4 describes the research method applied. Sections 5 and 6 describe the main results of this work, i.e. the relearning activity patterns detected along with the acceptability of the present proposal. Finally, some conclusions and future work round off the paper.

2. Situation of ABI victims

As stated in the Introduction, people with ABI have suffered brain damage at some stage after birth. Unfortunately, this phenomenon is becoming more and more frequent. According to the Health Council of JCCM (2006), 4 out of every 1000 persons suffer some kind of ABI at some time in their lives.

There are several causes of ABI, classified as internal or external according to the origin of the injury. Internal causes are found 2–3 out of 1000 of the population, and are more frequent as persons become older. Strokes are the most frequent internal cause and are due to a disorder in the blood supply to the brain. Several factors are decisive in the risk of suffering a stroke, such as high levels of cholesterol or blood pressure, smoking, excessive drinking of alcohol, etc. External causes, generally known as *traumatic brain injury* (TBI), are usually due to traffic accidents, falls, etc. TBI is also widespread; for instance, only in the United Stated approximately 500,000 persons require hospitalization for this reason every year (Jennett, 1996). Although people of all ages can suffer from TBI, it is more frequent among the younger and older members of the population, as they are more prone to accidents.

As the brain is the damaged area, these persons can suffer different long-term deficits that directly affect their daily lives. Patients can be classified into four categories: (1) *physical impairments* related to inability to control part of the body, such as paralysis of one side of the body, motor in coordination, or balance problems; (2) *cognitive impairments* that directly affect intellectual performance, including attention or memory problems; (3) *emotional impairments* such as depression or adjustment problems; and (4) *behavioural impairments* related to interaction with their environment, such as irritability and restlessness.

Although physical deficits are difficult for persons to adapt to (Neumann, 1995), cognitive, emotional, and behavioural deficits can also be highly disabling (Chamberlain, 1995), especially the first type of deficit. As Eslinger, Downey-Lamb, Ward, Robertson, and Glisky (2002) have pointed out, a cognitive deficit 'interferes with rehabilitation efforts, is enduring/chronic and results in a greater negative impact on quality of life than physical disabilities alone'. Therefore, for these patients treatment is a must if they are to have a decent quality of life. However, most of the treatments for these persons focus their efforts on physical, language or visual deficits, but not on cognitive difficulties, as they are not so apparent or "important" (Limond & Leeke, 2005). Three types of impairments are usually related to cognitive deficits:

- *Executive function impairments*. People with this impairment have problems to control and regulate other activities or behaviours (Ardila, 2008) such as *problem solving*, *planning*, *cognitive flexibility* (the ability to adapt cognitive processing to new and unexpected situations), *deductive reasoning*, *categorization* (object recognition and actions) or *abstraction*.
- *Attentional impairments*. These are related to inability to process a sequence of information (Grafman & Salazar, 1987). This impairment can be detected when a person with ABI exhibits problems with abilities (Moore Sohlberg & Mateer, 1989) such as *sustained attention* (to