Accessible Button Interfaces: Improving Accessibility for Brain-Injured and Other Disabled Users

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ABSTRACT

The number of people with brain injuries is increasing, as more people who suffer injuries survive. Some of these patients are aware of their surroundings but almost entirely unable to move or communicate. Brain-Computer Interfaces (BCIs) can enable this group of people to use computers to communicate and carry out simple tasks in a limited manner. BCIs tend to be hard to navigate in a controlled manner, and so the use of “one button” user interfaces is explored. This one button concept can not only be used brain injured personnel with BCIs but by other categories of disabled individuals too with alternative point and click devices. A number of accessible button interfaces are described, some of which have already been implemented by the authors.

Keywords: Accessibility, Brain Computer Interface, Brain Injury, Communication, Disability, One Button Interface

INTRODUCTION

People who have suffered a brain injury or some other form of motor impairment may have difficulties communicating. In the most extreme case, the patient may be non-verbal and quadriplegic. Some patients are “locked in”: cognitively intact but unable to communicate at all. The authors are particularly interested in improving accessibility for this neglected group of people, in areas such as communication, recreation, controlling the environment, controlling games, and accessing web and applications using a simplified button interface. This paper describes work which aims to provide access to off-the-shelf software, using a “one button” interface.

“One button games” are games in which the only control is a single button, which may be pressed or not pressed. At first, this seems a very limiting user interface. However, (Berbank-Green, 2005) discusses one-button games and lists many ways in which games can be played using only one button.

A one-button interface, as the name suggests, has only one control: a button which can be pressed or not pressed. This is the most minimal control a user can exercise, and so
is the most “universal”, in the sense of being accessible to the maximum number of users (Keates & Clarkson, 2004).

Such an interface clearly has its limits, and will not be suitable for all types of software. Nevertheless, it is proposed by the authors that a limited, but highly accessible interface would have legitimate therapeutic value. It provides crucial communication abilities to those disabled people who are unable to use any other kind of interface; and it provides a “stepping stone” solution that is easy to learn and use for those who may later advance to more sophisticated interfaces.

**BRAIN INJURIES**

Any brain injury which occurs after birth is called an acquired brain injury (ABI). Causes of ABI include cerebrovascular accidents, tumours, degenerative diseases, demyelinating conditions, and infectious disorders (Murdoch & Theodoros, 2001). Cerebral palsy is also an ABI, the term covers a variety of disabilities caused by damage to the infant brain (Bax *et al.*, 2005).

A traumatic brain injury (TBI) is an acquired brain injury caused by trauma such as a blow to the head, an impact with a blunt object, or penetration by a sharp object. Common causes of TBI are motor vehicle accidents, bicycle accidents, assaults, falls, and sports injuries (Lindsay & Bone, 2004). The primary mechanism in many cases of TBI is diffuse axonal injury, i.e. widespread damage to axons (brain cells) caused by shearing or rotational forces (Ponsford *et al.*, 1995). At the microscopic level, the direction of the shear may be visible (Lindsay & Bone, 2004).

**Incidence and Prevalence of Brain Injury**

Tagliaferri *et al.* (2006) report that the mean incidence across Europe for hospitalised and fatal TBI was approx. 235 per 100 000 during the period 1980-2003.

Hyder *et al.* (2007) estimate that 10 million people per year are affected by TBI globally. TBI is especially prevalent in Low and Middle Income Countries, where the risk factors tend to be higher, and health systems are inadequately prepared. Road traffic injuries in Latin America and Sub Saharan Africa are the main cause of a higher TBI incidence in these regions.

Improvements in road safety have reduced the number of people who suffer a head injury. Cook & Sheikh (2000) report a 12% reduction in cyclist head injuries in England between 1991 and 1995, ascribed to the increased use of bicycle helmets over the period. Reductions in drink-driving and increased use of seat belts, crash helmets and air bags have reduced the incidence of head injury in many countries (Lindsay & Bone, 2004, p.216). As medical care has improved, the number of people who survive a brain injury has increased (Ponsford *et al.*, 1995). Powell (1994) reports that the number of brain injured people has increased since the 1970s, because the mortality rate has dropped since that time.

Every year, 15 million people suffer a stroke. Stroke is the biggest single cause of major disability in the UK (Mackay & Mensah, 2004, p. 50).

**Assessing Brain Injury**

When a person suffers a moderate or severe brain injury, they will enter a comatose state. During this period, it is possible to assess the severity of the injury by gauging the responsiveness of the patient. The Glasgow Coma Scale, developed by Teasdale & Jennett (1974), is commonly used (Ponsford *et al.*, 1995). Upon regaining consciousness, the patient will experience a period of post-traumatic amnesia (PTA). The period of PTA is judged to have ended when the patient is able to form new memories (Ponsford *et al.*, 1995).

The periods of the coma and of the PTA give a reliable indication of the severity of the brain injury. A coma period of more than six hours, or PTA of more than 24 hours is classed
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