Neuroscience Technology and Interfaces for Speech, Language, and Musical Communication

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INTRODUCTION

Recently, in a continuously changing environment with a wide variety of trendy mobile or wearable devices, in an increasingly demanding market for additional benefits in favor of the end user, the success of a product depends on its ability to adjust to the needs and desires of the consumer. So, new concepts have emerged in spectacular pageantries for the amazed public eyes.

Within this scenic approach, the concept of Interface Design and Usability has come to surface not only for smartphones and tablets, which are definitely powerful computer devices, but also for a variety of wearable or implanted pieces of apparatuses that are in position to perform many of the functions of computing machinery.

Inevitably, the issue of Usability comes to surface, as it measures perhaps more clearly than any other factor, the ability of a product not only to affect the body but also the mind of the user. This seemed to be the situation experienced thus far only with advanced medical devices and prosthetics that enabled monitoring of subtle neurological functionality. Indeed, for diagnostic or therapeutic purposes microsensors, wearable monitoring systems and various imaging assemblages provide an enhanced telecommunication channel between the actual patient organs and the monitoring clinician (Figure 1).

DOI: 10.4018/978-1-5225-2255-3.ch512

The initial success of implanted or portable devices used for health and fitness reasons has widely promulgated mobile device applications of all types that take advantage of the affordable imaging modalities, the immediate reporting potential, the endoscopic representations of computer generated signals, the tactile sensing, the microrobotic precision, the motion tracking, the stereotactic functionality, the GPS positioning, the accelerometer measuring of shock, vibration or orientation, and many others.

As microprocessor signal pins interface with the internal neurological architecture of the human organism, they synchronize external events with the structure and functionality of the brain. The notion of Usability, extensively used in Human Computer Interaction (HCI), refers to the potency of a product that is massively deployed to end users to bring into action specific targetable derivatives under certain circumstances (Dix et al, 2004). These are measured in terms of:

1. Effectiveness, i.e. the degree to which interaction with specific computing machinery is successful in producing desirable outcomes for particular activities or purposes.
2. Efficiency, that is the design of interaction in such a way so that the ratio of useful work performed to the total efforts attempted is maximized as possible.

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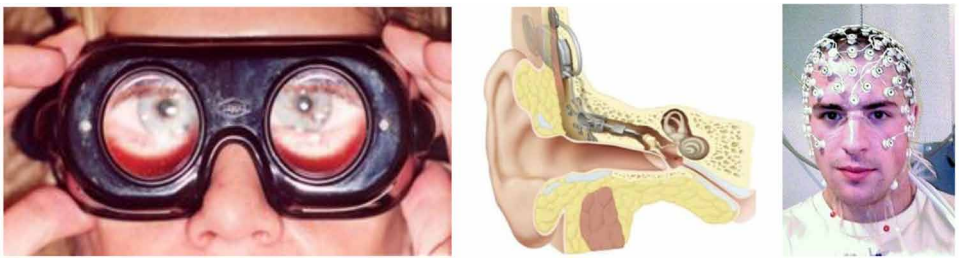
Figure 1. Wearable and implanted devices used for detecting and ameliorating oral and aural communication. Left: video Frenzel goggles that eliminate vision and provide simultaneous eye movement recording for the Dix-Hallpike maneuver that detects Benign Paroxysmal Positional Vertigo. Center: Otologic Carina™ cochlear implantation deployed within the inner ear. Right: EEG cap recording brain activity produced by electroencephalography.



3. Subjective Satisfaction, which results from the fulfillment of a user's expectations or needs while using components of electronic equipment, or the whole apparatus collectively.
4. A feature that recently has become a key element in the use of electronic devices is Learnability, which has to do with prior acquired knowledge or skill in using equipment of some kind, whether this ability has been developed by study, teaching, experience or sociability. The last factor has emerged as a new attribute of computing experience out of the personal relation with social networking.

Although the first three factors give a more mechanically driven approach to the evaluation processes of HCI, it is the fourth element that has gained momentum in terms of business intelligence. Indeed, Learnability is crucial for consumer electronics, since users flock around products that have a User Interface (UI) metaphor, a paradigm or an idiom they have previously used (Rogers et al., 2011).

By this attitude, they commit much less burden into their memory and as a result they prefer modules that have well-established UI paradigms, as is for instance the Android operating environment and the iOS paraphernalia. Indeed, the smartphone market is a classic example of an advanced and multi potent computing environment that is used globally, for really sophisticated and sometimes unconventional tasks that demand no prior formal education or training received (Nielsen & Mack, 1994; Nielsen & Budiu, 2012).

This fourth factor, when bad Interaction Design is endorsed, tarnishes the acceptance of new media accounting for them the reputation of being

- Infuriating
- Confusing
- Aesthetically unpleasant

It is exactly this attitude towards Interaction Design that makes the commercial products that come up from the medical aids arena to deploy not only a new aesthetic approach but also to seek a different endurance and a smart communication that co-exists within the user habits. Indeed, as UIs become more efficient and effective, they promote their usage as Brain Computer Interfaces (BCIs) as well (Figure 2).

BACKGROUND

Although the general public's pictorial perception for a BCI is mingled between the image of an EEG cap (an electrode studded cap that reads brain activity) and a portable device like Oculus Rift, in recent proceedings a more subtle schematic view has been emerging with devices like

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