

Chapter 10. Emerging Technologies

The Young Brain – Auto-biographical memory and the brain from birth

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Communicating with the world - A Window on the Brain

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Abstract Eye-based assistive technology pointing devices, or eye mice, are used to enable computer control for people with high-level motor disabilities in a similar manner to standard hand-held desktop mice, by simply moving the computer cursor to where a user is pointing or gazing with their eyes. Eye mice have been available to the motor-disabled community for many years but over this time there has not been widespread acceptance and adoption of these devices. Anecdotal evidence has suggested that eye-based pointing has been widely and quickly dismissed as a usable means of pointing, and hence computer interaction, in assistive technology due to difficulty of use and inaccuracy. However, there are many potential advantages of eye-based pointing that could greatly enable people with motor disabilities who would otherwise have few alternatives for computer control. It is necessary to understand in detail what the limitations of eye-based pointing and eye mice are, and so determine how these can be overcome to enable effective use of such devices. To do this, performance comparisons with head-based pointing, which is an established and accepted technique of assistive technology computer interaction, were used to assess the performance of an eye mouse. The results of a comparison of the two devices when used on a standard computer interface showed that the overall performance of the

eye mouse was poor in comparison to the head mouse. The results revealed two main factors that limited eye mouse performance; these were target size on the computer screen and user experience with the device. Analysis of performance by the size of the targets revealed a trend of increasing performance with target size for the eye mouse, ranging from comparatively very poor performance to a performance that approached or equalled the head mouse for larger target sizes. Examining user experience revealed that highly experienced eye mouse users could exceed their comparative performance with the head mouse. However, this came at a cost of a much longer learning time with the eye mouse than with the head mouse. The deterrent of poor initial performance and long learning time may well be the reason for the low uptake of eye mice by the motor disabled community. The two dominant limiting factors of target size and user experience for an eye mouse can both be overcome. This suggests that an eye mouse could become a very effective and enabling computer control device when used with interfaces or devices that provide increased target sizes or when used by highly experienced users. For these reasons the research suggests that the use of eye mice and eye-based interaction with computers should be re-visited for people with high-level motor disabilities.

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Wear and Tear – Iron accumulation as a cause of neurodegeneration

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Iron accumulation as a cause of neurodegeneration. A popular theory postulates that the ageing process is triggered by cellular accumulation of oxidative damage to DNA, proteins and lipid macromolecules. Age-related neurodegenerative disorders such as Alzheimer's disease, Parkinson's disease, amyotrophic lateral sclerosis and Huntington's disease are characterised by the deposition of abnormal forms of specific proteins in the brain. In each of these cases, there is strong evidence for a role of oxidative stress as a factor in neuronal cell death. The amount of iron in the normal brain increases with age but abnormal accumulation has been observed in these neurodegenerative conditions where it shows correlation with the particular regions affected. However, there is much uncertainty over whether the iron is a cause of the degenerative process or arises as a consequence of it. The properties of such redox-reactive transition metals which make them essential for life, can, on their misregulation, provide a potent source of oxidative stress which is a threat to cell survival. We describe a local family with unique neurodegenerative symptoms caused by a mutation in the main iron storage protein, ferritin. Although we still need to understand much about the pathology of the disorder and how the mutation affects ferritin function, this finding strongly implicates iron itself as primary to the degenerative process.

The older brain - The biological basis of brain ageing and cognitive decline

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Age is the biggest single risk factor for dementia, with approximately 600 000 older people in the UK affected by this condition. Three disorders – Alzheimer's disease, dementia with Lewy bodies and vascular dementia – alone or in combination account for almost 90% of cases of late-onset dementia. The molecular and pathophysiological substrates underlying these disorders are being characterised and multiple genetic, systemic (eg cardiovascular), and environmental risk factors have been proposed. The 'upstream' (in time) determinants of age-related vulnerability to such risk factors are largely unknown but there is growing interest in candidate mechanisms since these could provide the basis for early screening and therapeutic intervention.