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Research Statement

My research focuses upon the effects of altered sensory experience on the development of visual cognition skills. In particular, I ask how the absence of a sensory modality (as in deafness) affects the remaining senses and impacts upon cognitive processes. In the visual domain, by comparing control groups of children and adults with those who were deafened from birth, I have been characterizing the normal path of visual cognitive development and trying understand which parts of that development are plastic and susceptible to modification as a result of experience. In addition to studying deaf populations, I also study the impact of enhanced visuo-motor experience on visual and attentional performance. Children and adults who play action video games serve as tools that are allowing me to assess the impact of a visually complex and cognitively demanding experience in a population with an intact visual sensory system. My research aims to understand how altered sensory experience affects visual skills at both a theoretical and a practical level, with the prospect that this knowledge will benefit the educational and social experiences of deaf children and adults as well as patients recovering from brain injuries.

Effects of deafness on visual cognition. Differences in the default spatial distribution of visual attention in deaf children may have important consequences for the development of a range of skills, including reading and joint attention [1, 2], and may also play a key role in the appropriate diagnosis of attention deficits and other learning disabilities in deaf populations. My current work on the effects of deafness focuses upon the development of visual attention skills. Following on from the work of Bavelier and colleagues, I am using a range of experimental paradigms to assess the development of spatial aspects of visual attention in deaf and hearing children. I have employed the Useful Field of View, Multiple Object Tracking and Attentional Blink tasks to determine how deafness affects the distribution of visual attention across space and how it is assigned to multiple, independent objects within that space. The data so far suggest that the distribution of attention in the peripheral visual field is enhanced by congenital deafness[3], and that deaf children continue to improve within this domain from early childhood through adolescence, whereas no such development is seen in hearing peers of similar age[4]. Work using the Attentional Network Test and manipulating perceptual and spatial properties of flankers surrounding a target has demonstrated redistribution of attentional resources in deaf adults[5]. I am also working with Peter Hauser at RIT in an investigation of how deafness may influence perceptual processing. One recent study looked at how deafness affects performance on a range of clinical measures of visual skills [6].

Much work remains to be done in mapping out which aspects of visual attention are altered as a result of early auditory deprivation, and which are due to the influence of learning a visual, signed language. An important control group consists of individuals who are hearing children of deaf parents, because they acquire a signed language from birth but have no auditory deprivation. An understanding of these processes in adults can then inform developmental work that examines when these changes occur in the lifespan and how the deaf individual's visual cognition develops differently. One series of studies that I am currently planning will investigate a range of possible factors that may influence the degree and type of plasticity observed in deaf individuals, such as age of onset of deafness, degree of hearing loss and how long an individual has been deaf.

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Action video game playing and visual cognition. Action video games are an increasingly popular media format, and it is important to understand how their uptake affects not only social but also cognitive skills. The audience for these games is predominantly male, and uptake is much lower along poorer social classes. It is therefore possible that cognitive changes resulting from the game playing experience will not be equitable. To the extent that visual skills are required in standardized instruments used for assessment and placement, there is a need to understand how different media interact with the development of those skills.

The second key strand of my research programme looks at the effects of action-based video games on the development of visual attention skills. Unlike in deaf populations, action video game players have intact sensory systems, but are exposed to a visually complex and cognitively demanding activity. The experience provided by these video games typically goes beyond what would be encountered in everyday life. As a result, action video game players provide an opportunity to explore plasticity in the 'intact' cognitive system and to manipulate the sensory experience in a controlled manner. This allows me to examine the extent to which aspects of the mature human visual system remain trainable.

Currently, I am looking at the effects of action video game playing in children (both hearing and deaf). We are examining a range of visual attention skills in 7 to 17 year old school children, measuring the effects of age and then determining the remaining variance accounted for by action video game playing [7, 8]. So far we have seen a range of enhancements in visual cognitive skills, both spatial and temporal. Playing these types of game results in an enhanced distribution of attention to the peripheral visual field (Useful Field of View), an ability to apprehend a greater number of objects simultaneously (Multiple Object Tracking) and faster recovery of visual attention resources (Attentional Blink). Importantly, it is not the case that playing action video games modifies all aspects of visual attention. For example, using the Attentional Network Test we have found that the way an exogenous cue attracts and focuses attention is similar in gamers and non-gamers alike [9]. This is despite the pervasive nature of such cues in action video game environments.

To be of practical use in the rehabilitation of children with visual and/or attentional deficits, more work is needed to establish a causal link between action video game playing and the enhancement of visual attention in children. While this has been done in adult populations, ethical concerns make it impossible to assign young children to an action video game condition that they (or their parents) would not choose because of its violent nature. Future work also needs to establish which aspects of the gaming environment are responsible for the enhanced skills, and to attempt to create a suitable environment that allows causal inferences to be demonstrated for young children.

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