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Visual search strategies of pedestrians with and without visual and cognitive impairments in a shared zone: A proof of concept study

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ABSTRACT

Shared zones have gained increasing popularity in urban land use and design as a means of incorporating the needs of multiple modes of transport, while at the same time promoting social interaction between users. Interactions within shared zones are based on a set of informal social protocols, communicated via eye contact and social cues. This proof of concept study utilised eye-tracking technology to examine the visual search strategies of individuals, with and without visual and cognitive impairments as they navigated a strategically chosen shared zone. In total 3960 fixations were analysed and the fixations were distributed across the shared zone and a pedestrian crossing. Those with impairments were more likely to fixate on traffic specific areas and objects compared to those without, suggesting that they required more input ascertaining when and where it was safe to perform tasks. However, the duration of fixation was not significantly different for an object whether it was traffic related or not, indicating a global need for increased processing time of the surrounding environment. Shared zones are claimed to increase driver awareness and safety and reduce congestion, but the implications on participation and safety for those with visual and cognitive impairments is yet to be extensively explored.

1. Introduction

Urban design aims to create towns, cities and spaces that promote people to engage with others and their environment (Hamilton Baillie, 2005; Sallis et al., 2004). Built environments can both act as a barrier, or facilitator to activity participation, and as such have an important influence on both physical and mental health (Anaby et al., 2009; Levasseur et al., 2008; Noreau and Boschen, 2010; Sallis et al., 2004). Especially the physical health aspect of land use in urban planning has attracted attention (Barton, 2009), where walking has been promoted as a means to increase public health (Smith et al., 2008). While studies have suggested a positive relationship between physical activity, specifically walking, and health outcomes (Feng et al., 2010), it remains "*...an association pending further verification for causality...*" (Sung et al., 2015; p.153). Regardless, to increase the opportunity for urban citizens to walk rather than drive or use public transport, health-integrated planning is required, preferably at the local level, to optimise land use from this perspective (Carmichael et al., 2013). Key to this is fostering a sense of security for pedestrians so that they feel safe when accessing their community. In order to successfully achieve these outcomes urban designers are seeking ways to incorporate multiple users within the same shared space. Shared zones/spaces (henceforth referred to as shared zones) have been presented as a vision for how such a radically different traffic environment may be created (Hamilton Baillie, 2005). The idea of shared zones has gained increasing popularity in urban planning as a means of incorporating the needs of multiple modes of transport while at the same time promoting social interaction between users (Hamilton-Baillie, 2008).

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Fig. 1. Example of a shared zone located in Perth, Western Australia (Google map).

A shared zone, according to Hamilton Baillie (2005), is a "living street" that promotes equality between users: pedestrians, cyclists and motorists. Shared zones are regulated by basic traffic rules, e.g., on which side to drive, yielding to road users coming from the right/left and by specific rules for the shared zone, e.g., vehicles should give way to pedestrians and/or low speed regulation for vehicles, as shown in Fig. 1. Shared zones are characterised by the absence of markings, gutters and kerbs that traditionally have differentiated carriageways from footpaths (Hamilton Baillie, 2005). This removal of traditional traffic management methods is believed to result in increased engagement between users, which is claimed to increase driver awareness, encourage reduced vehicle speeds, improve safety and reduce congestion (Hamilton Baillie, 2005). However, while shared zones continue to be incorporated into urban areas, there is a paucity of research examining how multiple users interact within these spaces (Hamilton Baillie, 2005). Specifically, there is a need to understand how pedestrians navigate shared zones and the possible challenges that these spaces present for those with impairments (Hamilton Baillie, 2005).

Interactions within shared zones are based on a set of informal social protocols, communicated via eye contact and social cues (Hamilton Baillie, 2005). Successful navigation of these spaces is dependent upon the ability to perceive and interpret these social cues and immediately respond to potential hazards. Shared zones require immediate problem solving, a process underpinned by perceptual and cognitive functions (Jonassen, 2000).

Visual perception is the process by which visual information is received and processed in the brain. Initially, visual information is positioned on the fovea through saccades; however, little information is obtained at this time (Falkmer et al., 2008). Subsequent fixation on the external stimulus allows visual information to pass to the appropriate centres in the brain (Falkmer et al., 2008). At this point the individual processes the information, identifying the stimulus and retrieving information from past experiences. This process provides the information needed to inform an appropriate course of action (Falkmer et al., 2008).

Regardless of any impairments, an individual's visual attention is most significantly influenced by his/her cognitive processes (top-down) (Einhäuser et al., 2008). These include, but are not limited to, personal expectations and the "task at hand". Additionally, an individual is able to process areas of interest within their environment by directing their foveal vision (Findlay and Gilchrist, 2003). At the same time, the focus of an individual's foveal vision is influenced by factors within their field of vision (Henderson, 2003). To illustrate that this process applies to all, it is known that persons with intellectual disability attend and respond to visual stimuli as typically developing individuals would (Danielsson, 2006), but the length of cognitive processing time is increased. As such, processing speed may limit their ability to attend to, and prioritise, important information critical to maintaining safety and task completion in a complex environment, such as a shared zone. It is therefore vital to explore how individuals with, and without, cognitive impairment directs their visual attention and prioritise visual stimuli within this environment.

Individuals communicate considerable amounts of information regarding their attention and intent via their gaze, such as their intent to act and the direction of these actions (George and Conty, 2008; Itier and Batty, 2009). Furthermore, when eye contact is made an individual may assume that their intentions have been identified and that others will respond accordingly. In order for this to occur, individuals require sound social functioning abilities. Impaired social functioning is common among those diagnosed with Autism Spectrum Disorder (ASD), and as such is part of the diagnostic criteria. Deficits in social functioning are often explained as being a symptom of an impaired theory of mind (Baron-Cohen et al., 1985). Theory of mind is defined as having the ability to attribute mental states not only to oneself but also to other people (Baron-Cohen et al., 1985). It allows for an individual to anticipate what others will do in a given situation (Baron-Cohen et al., 1985). Individuals with impaired theory of mind may not be able to prioritise, interpret and react to social stimuli appropriately, nor may they be able to give the appropriate cues signalling their own intent to others. This suggests that those with an impaired theory of mind may not be able to successfully or safely participate within a shared zone. However, it is neither feasible, nor ethical, to exclude an individual from an environment because of impairment. Hence, it is