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Visual exploration of pedestrian crossings by adults and children: Comparison of strategies

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ABSTRACT

In pedestrian crossing situations, children are less able to make safe crossing decisions compared to adults.

The aim of the present study was to analyze and compare the ocular behaviour of children and adults in the pedestrian crossing situations using the eye tracking. The study involved 22 children ranging in age from 5 years to 6 years 2 months and 22 adults. Children and adults participated in a brief eye tracking session designed to explore field of view in road crossing scenarios. They were presented with four pictures of pedestrian crossing and instructed to observe the pictures as if they were on the sidewalk getting ready to cross the road. The eye movements of the subjects looking at the pictures on the screen were collected through the eye tracker.

The results showed that adults used a far more intense exploration of the useful visual field of view. They looked at all the different areas of the field of view more frequently and for a longer time. Another interesting point is that the children gazed at areas and elements that are irrelevant to a safe crossing but prove salient for various reasons. Implications for road safety training are discussed.

1. Introduction

Pedestrians are the most vulnerable road users worldwide. More than 270,000 pedestrians die annually in road traffic crashes, constituting 22% of all road deaths (World Health Organization, 2013). In Italy, 21,353 pedestrians had been involved in traffic injuries in 2014 (ISTAT, 2015: www.istat.it).

Especially in urban contexts, pedestrians are most likely to be involved in crashes, and the highest incidence of these injuries occurs at authorized pedestrian crossings. Therefore, it is very important to analyze pedestrian behaviour and the causes of pedestrian injuries to reduce mortality rates, especially in urban areas (Sun, Zhuang, Wu, Zhao, & Zhang, 2015).

Overall, some studies have suggested that pedestrian crossing behaviour could vary according to the age, gender, expertise, and own driving skills (Holland & Hill, 2007). In general, older pedestrians tend to be more cautious compared to younger adults when crossing through traffic, whereas children are less able to make safe crossing decisions compared to teenagers or adults (Havard & Willis, 2012; Oxley, Ihsen, Fildes, Charlton, & Day, 2005). For several reasons, children are the most exposed and vulnerable road users, as they are (together with the elderly) at the highest risk of death or injuries, and their risk of collision was estimated to be about four times higher compared to adult pedestrians (Thomson, 1996).

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1.1. Children's perceptual and cognitive road skills

In Italy, 526 children under five years of age were involved in road injuries involving vehicles in 2014 (ISTAT, 2015), even though they are unlikely to walk alone or spend much time in traffic. Therefore, the origin of injuries should be identified by considering specific developmental characteristics and behaviours of young children rather than only the exposure to traffic.

Children do not have the perceptual and cognitive abilities that allow them to move independently and safely in traffic. According to Sandels (1970) who was the first to investigate children's road skills, adults and children see and perceive the road and the traffic differently.

First, the visual field of children is reduced compared to the visual field of adults. Due to height differences, adults and children have very different points of view. Second, adults and children differ greatly in many essential skills required to navigate in traffic. Specifically, about 30% of six years old children make mistakes in localizing sounds, for instance, children confuse the right and left sides more often compared to adults, they are not always able to understand the cause-effect relationship, and they are not always able to think and process multiple elements at the same time (Sandels, 1970). Such abilities develop progressively in parallel with the improvements in walking ability, new experiences gained from exploring their environment, enhanced analytical and global perception, and the achievement of perceptual constancies that are critical to move safely.

Furthermore, the maturation of multiple sensory systems is required to develop the complete adult vision. In addition to a reduced visual field, preschoolers have a lower visual acuity to distinguish an object's details and shape, specifically about 7–8/10 at age 3 and 10/10 (adult value) at age 4–5. From age two to six, the ability to focus and identify details improves dramatically, and children's ability to recognize very far and small objects develops rapidly. From the perspective of perceptual development, young children capture the most visible stimulus of the visual field. Their perception is global and undifferentiated and neglects the relationships among the parts. This is defined as *child syncretism* (Werner, 1948). With the complete maturation of perceptual function (in early adolescence), individuals can use and integrate both analytical and synthetic perception effectively. For example, initially, it is possible to break up the parts of the whole and subsequently return to a global perception, which allows one to integrate the parts that had been analyzed previously. In traffic, young children might pay attention to specific objects of road environment but not necessarily to the elements that constitute possible sources of risk. On the contrary, using the integrated information, adults can shift from global to specific perception of the details to adjust their motor behaviour on the road.

1.2. Children's skills in crossing tasks

The competences needed to safely and autonomously cross the road (e.g., pick up selectively relevant information regarding incoming vehicles or hazards, recognize hazardous features of crossing situations, identify a safe place to cross, judge vehicle speed and gaps in oncoming traffic, estimate the time it takes to cross the road, integrate all information to make a safe decision, coordinate the action with dynamic information to moving objects) develop from the preschool to adolescence. As children grow older, they become more competent in the crossing tasks. For example, as Thomson, Tolmie, Foot, and McLaren (1996) stressed, from five to twelve years of age, children become more efficient at noticing salient information, making decisions based on such information, and organizing appropriate actions. Moreover, when developing road-crossing abilities, children must learn to employ their skills more strategically. The development of these competences depends on the interaction between maturation and specific experiences in traffic. For example, the ability to combine different information regarding the distance and the speed of oncoming vehicles on the one hand and the time it takes to cross, on the other hand require logical abstract thinking (this normally occurs around 11 years of age) (Piaget, 1955). In this regard, different studies have shown that most children between 11 and 12 choose the safe time to cross while younger children are unable to make such decision. This ability keeps increasing up to about age 14 in connection with perceptual-motor functioning that involves the complex task of moving the self in relation to other moving objects, which improves from early to middle adolescence (Plumert, Kearney, & Cremer, 2007). This does not mean that the ability to cross the road safely is only the manifestation of natural maturational advances; specific experiences (therefore specific training) are needed to learn and carry out the safe behaviour. The most recent advancements in Piagetian model of cognitive development consider the Piagetian stages as more flexible and suggest that the expertise plays a key role in the development of specific competences. The maturation supports the development of the competences through increased number of traffic experiences and opportunities to use these competences more effectively as children grow older.

Based on the developmental changes that occur in children, training programs aimed at enhancing pedestrian skills could be offered to children of different ages to teach them safe behaviours. For example, it is possible to train young children (5–6 years old) under adult supervision to recognize hazard and dangerous features of a pedestrian crossing (Thomson & Whelan, 1997) and identify safe crossing places (Thomson et al., 1992); moreover, the same age specific training could improve visual timing skills (Demetre et al., 1993). Similar improvements in road skills were obtained by a training program on the road safety under parental guidance (Limbourg & Gerber, 1981).

1.3. The visual exploration in crossing tasks

To avoid crossing injuries, individuals have to develop essential ocular skills necessary for the visual exploration of the road. Teaching appropriate strategies necessary for visual traffic explorations could help prevent crashes.