Spatial Application Division Leuven
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K.U.LEUVEN - BELGIUM

levenslijn
veiligheid voor kinderen!

How does a child perceive the traffic environment?

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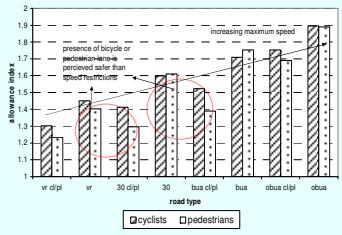
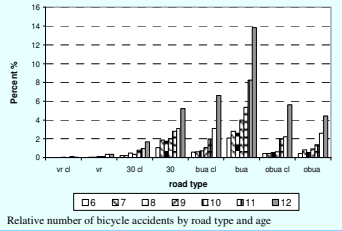
Accident statistics and travel behaviour of children (6 – 12 years)



Allowance index by road type: 1 = 100% of the children is allowed, 2 = no child is allowed.

***vr**: vehicle restricted; **30**: zone with speed limit 30 km/h; **bua**: build up area (50 km/h); **obua**: outside build up area (speed limit 70 km/h); **cl**: with cycling lane; **pl**: with pedestrian lane*



Relative number of bicycle accidents by road type and age

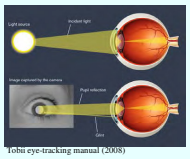
The exposure of children in traffic is greatly influenced by the parental perception of current traffic safety, which determines the allowed independent travel of children. When the traffic environment is considered unsafe, parents keep children away from the road, which is reflected in a decrease of autonomous travel. Autonomous travel helps with the development of children's social identity, their physical condition and environmental awareness and therefore it is strongly recommended to allow children some free movement. Accident statistics point out that the relationship between allowance to a certain road type and the share of accidents on that road type isn't straightforward (see figures). Relatively more accidents happen on roads without a cycling lane and a lower speed limit than on roads with a cycling lane but a higher speed limit, although the allowance on both road types is similar. Keeping children away from sites perceived dangerous will not automatically result in a decrease of accidents. It is necessary to keep investing in general traffic safety measures and also to start form the perspective of the child. Childrens's traffic behaviour itself is indeed often the cause of a traffic accident. The study of this behaviour is however difficult, because it requires "entering the children's mind".

Materials and methods: Eye tracking technology

How are eye movements tracked?

PCCR : Pupil center corneal reflection

→ Infrared illumination of the eyes.



Tobii eye-tracking manual (2008)

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Image sensors capture images of both corneal and pupil reflection patterns.

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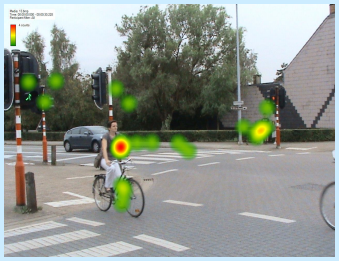
Reflection angles reveal the gaze direction and result in a dataset of timestamps attributed with x,y coordinates of the position of the foveal area (part of the eye responsible for sharp central vision) .
Fixation = period of time wherein the x,y coordinates are stable.

Fixation (attention) pattern analysis and children's traffic behavior.

Accidents, where children's behavior is the main cause of the accident, are often explained bye age related restrictions (Hoffrage et.al., 2003).

Limited domain specific knowledge Perceptual disadvantages Immature visual search strategies Distraction	**Attention allocation analysis**
Lower cognitive capacities	**Psychological analysis**
Inferior physical and motoric skills	**Physical analysis**

Analysis: Attention allocation and scan patterns



Example of a heatmap: The colors represent the number of fixations (red is high, green is low). The child saw the bicycle and pedestrians, but missed the car

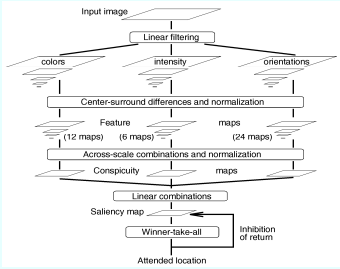
"Heatmaps" of fixation counts overlay the items fixed by children while evaluating the traffic scene. A reasonable and scientific supported assumption is that fixations correspond to attention. The fixation's locations are that part of the traffic scene where the attention of the child was on a specific moment. While assigned with a task, the child was interpreting the attended part of the scene in relation to this given task. Heatmaps show what children saw consciously and which aspects of the traffic scene they missed. Related to children's traffic behaviour, this information enhances the knowledge of possible perceptual disadvantages children have and whether they are distracted by certain items in current traffic environments. Heatmaps can also show the length of a fixation instead of the fixation count. The length can be related to the complexity of items, more complex features will have longer attention times.

Example of two scan patterns: the numbers indicate the sequence

The scan patterns show the sequence of the fixations and consequentially the sequence of the attention. To analyse these sequences it is necessary to predefine areas of interest. Areas of interest can be all kinds of aspects of the traffic environments (cars, other road users, traffic signs, trees, etc.). These areas of interest can then be lined up and analysed by sequence analysis techniques like optimal matching procedures. The scan pattern information allows to evaluate children's visual search strategies.

Fixation distributions and scan patterns help to understand several components of children's behavior in traffic and this in an objective way. A serious advantage compared to classical study methods.

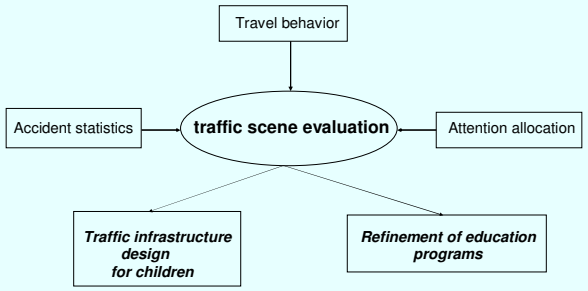
Analysis: Natural saliency



General architecture of a Saliency based visual attention model (Walther and Koch, 2006)

The children's scan patterns are compared with the outcome of the Saliency toolbox of Walther and Koch, 2006. The toolbox makes it possible to point out the items of a traffic scene that will be attended the first based on the neuronal architecture of the early primate visual system. In other words, if no task is assigned, what will be the first items that attract visual attention? The Saliency Toolbox is a collection of Matlab functions and scripts for computing the saliency map for an image, for determining the extent of a proto-object, and for serially scanning the image with the focus of attention. The algorithm makes it possible to evaluate current traffic environments like cross roads for their salient object. Comparison with the scan patterns of children will result in an evaluation of the success of those salient objects with children. Do the items that attract attention based on saliency computation, really attract the attention of young children?

Social relevance



Attention allocation analysis of young children in natural traffic scenes tries to evaluate current traffic infrastructure in Flanders objectively from the point of view of children. What is suitable and understandable for an adult is not necessarily clear for a child. Findings of this study can result in recommendations for traffic infrastructure design adapted to children's visual perception. Children are vulnerable road users, and by designing for children, infrastructure will be safer for other vulnerable road users as well.

References:
* Hoffrage U., Weber A., Hertwig M., Chase V.M.; 2003; How to keep children safe in traffic, find the daredevils early; Journal of experimental psychology: applied; Vol.9, no.4, 249-260
* Walther D. and Koch C.; 2006; Modeling attention to salient proto-objects; *Neural Networks* 19; 1395-1407.

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