

The contribution of visual information to human brake behaviour

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Introduction: To be successful in the confusion of daily traffic, visual information about the time available before making contact with the obstacle (time to contact or TTC) is necessary, but there are several ways of obtaining this information. As an object approaches, its retinal projection increases, hence TTC can be obtained directly from the inverse of the rate of dilation on the retina of the monocular eye by $\tau \dot{\tau}$ (1). In a more indirect way, perceived distance and velocity parameters can be combined to obtain TTC ($TTC = D_{\text{perceived}} / V_{\text{perceived}}$). The latter assumption has two implications. First, because depth perception by which distance is perceived is more accurate under binocular than under monocular vision (2), less accurate brake behaviour is expected in a braking task under monocular vision. Second, as the use of peripheral vision contributes to the perception of the drivers' velocity (3), a restriction of peripheral vision mortgage appropriate brake behaviour. The purpose of present experiments was to investigate brake behaviour under monocular/binocular and central/peripheral vision.

Methods: In the first experiment 13 female participants drove a go-cart along a linear trajectory at a speed of approximately 11 km/h. They could start braking at 4, 7 or 10 meters from a target vehicle when a red lamp on the rear of this vehicle was lit. The momentaneous position of the go-cart was measured at 200Hz with a laser (Noptel CMP2-30). Several distance and time parameters throughout the braking process were calculated as principal dependent variables. The same braking task was executed in a second experiment by 17 male participants. Participants wore specially taped safety goggles in order to create 3 different visual conditions: normal vision (NV), central vision restricted to an angle of 10° (CV), and central vision (10°) + 10° restricted peripheral vision (CPV). ANOVA's with repeated measures were undertaken on all dependent variables.

Results: As expected given the set-up, a significant main effect of distance was found on all dependent variables in both experiments ($p < .01$). The greater the distance in which participants were allowed to brake, the more time and distance was used. No significant differences were found between the monocular and the binocular condition in the first experiment. In the second experiment, several significant interactions were apparent, with an overall increase of difference between the visual conditions when the distance from which braking was allowed, increased. Under restricted vision, TTC at the onset of braking was perceived sooner ($p < .01$), the participants took more time braking ($p = .056$) and stopped at a greater distance ($p < .01$), mainly in the longest distance-condition.

Conclusions: Out of the data from the first experiment, it seems that monocular information of the optical variable $\tau \dot{\tau}$ can play an important role in the visual control of braking. The second experiment shows evidence that when there is enough time available for braking, the human system seems to use information out of peripheral vision in order to brake adequately. When put the two experiments together, evidence was found for directly as well as indirectly visually guided brake behaviour. It seems that humans are capable to use the visual information which is available at that particular moment in order to brake appropriately.

References

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