

The relation between executive functioning and risky driving in young novice drivers

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BACKGROUND

- Risky driving is a threat to individuals themselves as well as to other road users. It is therefore necessary to reduce risky driving behavior to improve the overall well-being of the population (Steinberg, 2008).
- Adolescents engage in more risky behavior than adults and accident rates are unacceptably high. Worldwide, of the people who die every day because of car crashes, more than 1000 individuals are under the age of 25 (Beullens et al., 2011).
- Driving is a complex, goal-directed task that places high demands on perceptual, cognitive and motor processes (Groeger, 2000). The complexity of the driving task suggests that it requires the use of executive functioning (EF) in order to promote safe driving. EF refers to a collection of cognitive functions including inhibition, working memory (WM), mental flexibility and planning (Houben, Wiers, & Jansen, 2011). These functions lead to capable self-control of behavior (Crone, 2009; Dahl, 2008).
- EF is still developing in adolescence. From 11 years on, until the age of around 30, the prefrontal cortex (PFC) and parietal lobes undergo a period of prolonged development (Casey et al., 2011). This development of the PFC is reflected by advances of EF.

AIMS

- The aim of the present study was to **investigate the relation between EF and driving performance** in a group of young novice drivers.

EXECUTIVE FUNCTIONS

- This study focused on the executive functions inhibition and WM. **Inhibition** is the ability to inhibit inappropriate response tendencies (Bunge & Crone, 2009), **WM** enables one to temporally hold on to information in order to process it (Mongillo, Barak, & Tsodyks, 2008).

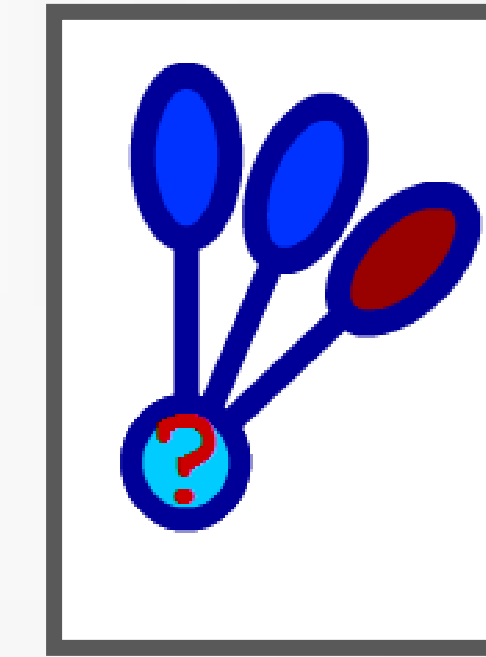
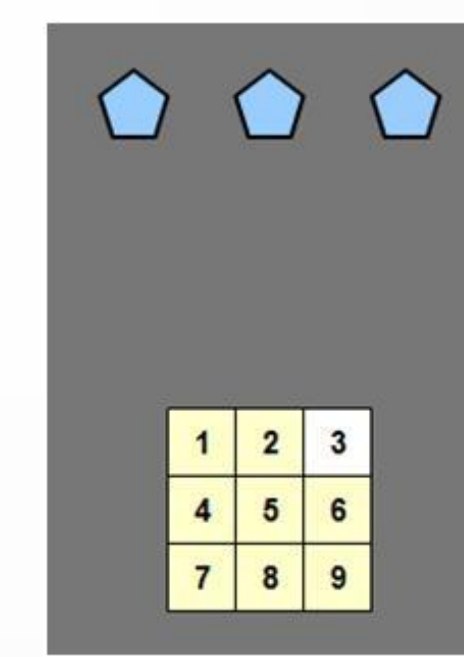
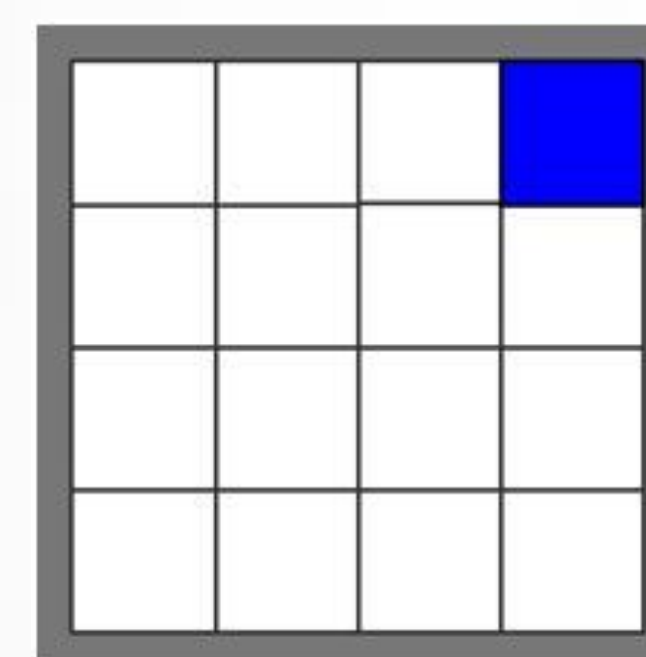
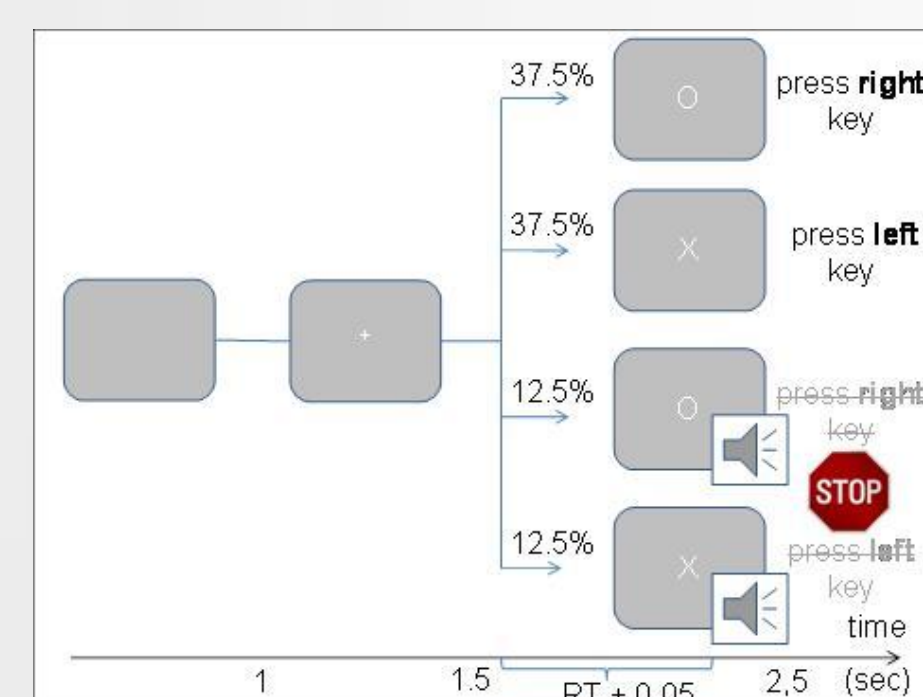
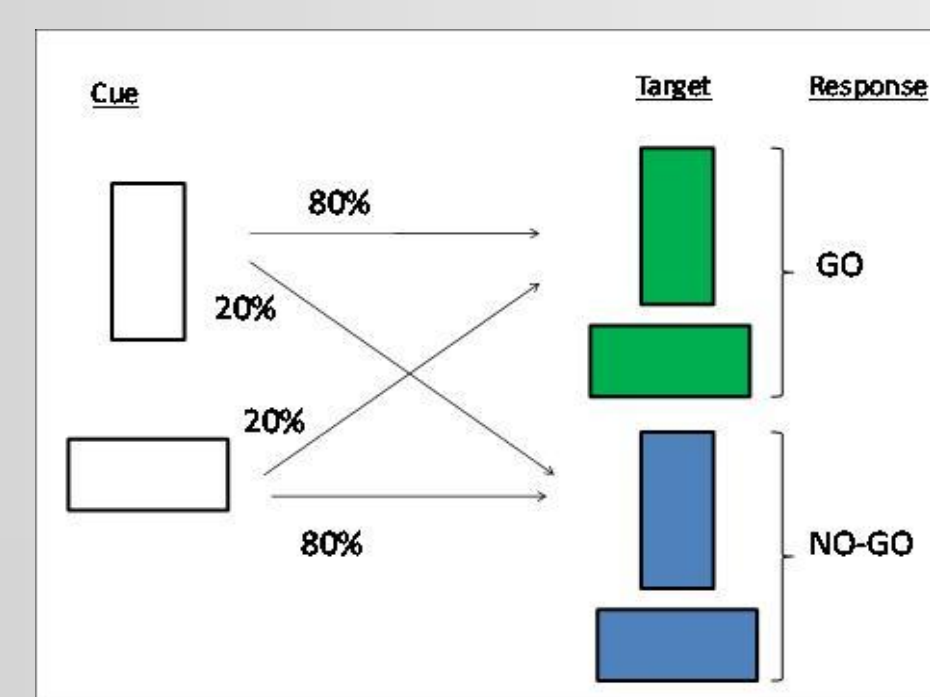
PARTICIPANTS

- Inclusion criteria: age between 17 and 25 years old, permanent driving license, no more than 12 months driving experience.
- Thirty-eight participants were tested (18 women; mean age 19.3; mean experience in kilometers = 2580.76 (SD = 2615.75)).

TOOLS

EF TASKS

- Inhibition: **Cued go/no-go task** and **Stop signal task**. WM: **Visuospatial span**, **Backward digit span** and **Letter span with a visuospatial component**.



DRIVING SIMULATOR

- STISIM 400 fixed-based driving simulator with a large 180° field-of-view seamless curved screen.
- Task: 25km session consisting of daylight driving scenarios on a two-lane road. Both inner- and outer-city sections were included with speed limits of 50, 70 and 90 km/hour. Road design and traffic density were based on roads in Flanders. Participants were asked to drive as they normally do.



ANALYSIS

- Multiple regression analysis was applied to determine the unique contribution of significant EF correlates in predicting driving performance measures. By only including variables that were significantly correlated with the dependent measures, an optimal trade off between statistical power (including all variables would reduce power) and completeness (not leaving out important variables) was ensured. Gender and driving experience were entered in the model, to determine the unique contribution of inhibition and WM while controlling for the effects of gender and driving experience.

RESULTS

EF WAS NEGATIVELY RELATED TO RISKY DRIVING

- Lower inhibition (i.e. stop signal task) and WM (i.e. backward digit span) significantly predicted more variability in lane keeping.
- Lower performance on both inhibition measures significantly predicted more collisions and higher reaction times in response to hazards.

EF WAS POSITIVELY RELATED TO RISKY DRIVING

- A higher visuospatial WM (i.e. visuospatial span and letter span) significantly predicted increased speeding behavior (70km/h zone), more yellow light running and a shorter following distance inside the city centre.

DISCUSSION

- Results **replicated** prior research, by showing a negative relation between inhibition/ WM and lane keeping variability (Jongen et al., 2011; Mäntyla et al., 2009).
- Results **extended** prior research by showing a positive relation between inhibition and hazard handling.
- Furthermore, this study revealed a positive relation between visuospatial WM and risky driving. Possibly, young novice drivers that have better capacities to process visual information, respond more efficiently to the dynamic car environment and feel more confident to take risks while driving.

IMPLICATIONS

- EF training programs are developed more and more nowadays since it has been shown that executive functions are flexible and can be trained, leading to improvement of EF and increased behavioral control (e.g. training inhibition to decrease alcohol intake; Houben et al., 2011).
- Improving EF by training could lead to better vehicle control (e.g. better response to hazards). Nonetheless, training EF to decrease risky driving will not always have desirable effects (e.g. more yellow light running).