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BOOK OF ABSTRACTS

Risk-taking tendencies and not motor inhibition succeed to predict the capacity to drive: a large-scale population study with on-road referencing

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INTRODUCTION

Executive functions (EF) are a set of cognitive functions that are required to optimize the performance in complex tasks by regulating one's behavior according to internal goals and environmental demands [1]. The study of EF capacities, in particular inhibition, seems to be important to understand the interindividual differences in driving abilities [2,3]. In this context, many studies have focused on inhibition assessed by the interference effect in the Stroop task [3]. However, inhibition is not a unique process and involves attentional and motor aspects that are confounded in the interference effect. Few studies have investigated the implication of the motor counterpart of inhibitory mechanisms in driving abilities [3].

On another note, many studies have found a link between behavioral measures of risk-taking and risky driving in adolescents [4] and offenders [5]. To our knowledge, no study explored the impact of individual differences in performance-based measures of risk-taking on driving behavior. The aim of our study was (1) to analyze separately the predictive power of tasks involving interference resolution and response inhibition and (2) to assess the influence of risk-taking on on-road driving capacities.

MATERIALS AND METHODS

957 participants (457 females), aged from 18 to 92 years old, performed three experimental tasks: the Simon task [6], the Stop Signal task [7] and the Balloon Analog Risk Task [8], followed by an on-road test in 47 testing centers across France.

Simon task Participants performed 2 blocks of 129 trials of the choice reaction time (RT) task in which a stimulus (either a square or a circle) was presented on the right or the left side of a screen. Participants had to respond as fast and accurately as possible according to the stimulus' shape and the stimulus-response mapping: square - right finger press; circle - left finger press. Half of the trials were congruent (the stimulus's location corresponded to the expected response) and half were incongruent (the stimulus's location did not correspond to the expected response). Global RTs and error rates were collected. Interference effect was measured by subtracting the mean RTs on incongruent and congruent trials. Additionally, the Gratton effect was calculated to assess the participants' capacity to engage adequate behavioral adjustments[9].

Stop Signal task Participants performed 2 blocks of 129 trials of the choice RT task in which they had to respond as quickly as possible according to a stimulus (Go signal). In 25% of the cases, a Stop signal was presented during the course of the trial, and indicated to the participants to withhold their response by reactively inhibiting their engaged motor command. The time delay between the Go and the Stop signals was incrementally adjusted according to failed or successful stopped responses in order to compute the Stop Signal Reaction Time (SSRT), an index of motor inhibition capacities. Task design and SSRT calculation were made in agreement with the consensual recommendations of Verbruggen et al. (2019) [10].

Balloon Analog Risk Task (BART) The goal was to accumulate a maximum of points by pumping a series of 30 simulated balloons with a button press. The balloons could explode if participants reached a maximum pumping time fixed for each balloon. At any time during a trial, participants could stop pumping to save the amount of points accumulated. The average pumping time on unexploded balloons was interpreted as an index of risk-taking, where a greater time pumping indicated more risk-taking [8].

Driving performance assessment Participants performed a 30-minute on-road session with a professional driving instructor. The instructor filled a French version of the Test Ride for Investigating Practical Fitness to Drive (TRIP), which is a 62-item grid assessing multiple components of the task of driving [11]. Global score was standardized on a scale of 100. Four additional scores based on the hierarchical model of driving behavior by Michon [12] were calculated following the work of Ranchet et al. [11]: the operational score (11 items), related to immediate reactions such as braking; the tactical score (12 items), reflecting proactive components such as anticipation and safety distance; the tactical compensation score (7 items), investigating adaptive behaviors like the choice of speed; and the strategic compensation score, a 16-item questionnaire assessing the driving conditions that are usually avoided (e.g., high traffic, night driving).

Statistical analysis Linear mixed models were fitted to predict the driving performance with test variables as fixed effects and both age and monitor as random intercept effects.

RESULTS

Psychological tasks	Tests variables	Driving performance				
		Strategic compensation	Tactical	Tactical compensation	Operational	Global
Simon task	Mean reaction time (RT)	6.16*	2,55	0,01	12,97***	12,88***
	Error rate	0,02	0,97	0,11	0,11	0,85
	Interference effect	3.55.	0,57	0,28	3,01.	0,97
	Gratton effect	5,91*	0	0,05	1,75	0,27
Stop Signal task	SSRT	2,22	1,51	1,06	4,64*	1,64
BART	Average pumping time	4.03*	12,06***	3,08.	4,72*	10,68**

*Note. . = p<.10, *=p<.05, **=p<.01, ***=p<.001.*

Table 1: F-statistics of the ANOVAs for each test variable and driving score. Reaction time and error rate refer to performances obtained in the Simon task. The color code represents the direction of the significant effect (red and blue for positive and negative slopes, respectively).

Strategic compensation score increased in individuals showing higher mean RTs in the Simon task, but decreased in individuals showing higher Gratton effects or higher average pumping time at the BART. Tactical score was only predicted by the average pumping time: scores increased in individuals with higher risk-taking. Operational and global scores were smaller in individuals with higher RT and greater in individuals with higher average pumping time. Operational score also decreased with higher SSRT. Interestingly, the risk-taking index predicted the variance of almost all driving scores whereas out of the two inhibition measures (i.e interference effect and SSRT), only the SSRT predicted part of the driving performance.

DISCUSSION

The current study explored how objective scores obtained in psychological tests can predict the capacities necessary for safe driving. Higher risk-taking individuals showed better driving performances and less strategic avoidance of difficult situations. Unexpectedly, both motor inhibition and interference resolution failed to predict most of the driving performance. Risk taking tendency was however a high predictor of driving capacities.

This study showed that both types of inhibition assessed by the interference effect and the SSRT are limited in predicting driving capacity in an ecological setting. Although the executive functions are essential, our study suggests that testing them in a non-pathological population barely informs on the ability to drive. As long as executive functions are operational, personality factors such as risk-taking tendencies appear to be a much better evaluation criterion of the safety of the driving behavior.

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