Investigating the influence of working memory capacity on driving behavior when combined with cognitive load: an LCT study of young novice drivers

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BACKGROUND

- Distraction refers to any activity that takes the driver’s attention away from the driving task. At least 25% of the car crashes in the United States can be related to some form of driver distraction
- Working memory capacity (WMC) is related to a person’s ability to become more important secondary task’s auditory performance; 3) the influence of WMC on LCT performance when combined with technologies (e.g., hand free phone; Neyens & Boyle, 2007)

LANE CHANGE TASK (LCT)

- LCT Sim v1.2, developed by Daimler AG
- Three-4m road tracks with 18 lane change signs
- • Six tracks:
  - • 1-2: training
  - • 3: baseline
  - • 4-6: combined with the auditory-verbal N-back with increasing complexity (counterbalanced among participants)
- Instruction:
  - • Change lanes immediately when you recognize the information on the sign. The change should be in a deliberate manner; as quickly and as efficiently as possible and should be completed before reaching the sign.
  - • For task 4c: balance your effort between both tasks, both are equally important.
- Dependent measures:
  - • Mean deviation (MDEV), lane change initiation (LCI) and percentage correct lane changes (PCL)

RESULTS

1) Cognitive load impairs driving performance

MDEV: more deviation from normative model with increasing complexity cognitive load

LCD: lane changes initiated more slowly with increasing complexity cognitive load

PCL: more erroneous lane changes are made with increasing complexity cognitive load

WMC TASKS

- • Visualspatial WM capacity: Visualspatial Span (VS)
- • Verbal WM capacity: Letter Span (LS)

DISTRACTION

Auditory-verbal response N-back WM task (Mehtler et al., 2011)

- • Resembles distracting tasks such as cell phone conversations
- • Demands temporary storage and manipulation of information
- • Numerical values
  - • 3 complexity levels:
    - • 1-back: repeat out loud the last number you heard
    - • 2-back: repeat out loud the number before the last number that you heard
    - • 3-back: repeat out loud the number that you heard two numbers ago

AIM & HYPOTHESES

Aim: To investigate, for young novice drivers (> 51; mean age 19.42), the influence of WMC on LCT performance when combined with cognitive load. Hypotheses: 1) Cognitive load will impair driving performance; 2) Increased WMC will be related to superior driving performance; 3) Driving performance of participants with high WMC will be less degraded when cognitive load is increased. Due to the secondary task’s auditory-verbal nature, higher WMC is expected to become more important when cognitive load is increased.

DATA ANALYSIS

- • Exploratory analyses to identify outliers per cognitive load level, and per dependent measure.
- • Repeated measures ANOVA on the secondary task to test if the distraction was effective.
- • Repeated measures ANCOVA to assess: 1) if cognitive load had detrimental effects on LCT driving behavior (main effect cognitive load); 2) if WMC was positively related to LCT driving behavior (main effect WMC); 3) if the effect of cognitive load on driving behavior was dependent on WMC (interaction effect cognitive load * WMC). Separate models were analyzed per dependent measure. Outliers were removed from the relevant analyses

DISCUSSION

- • Replication of previous research:
  - • Cognitive load degraded LCT performance
- • With increasing load, participants deviated more from the normative model (MDEV), reacted slower to signs (LCI) and made more erroneous lane changes (PCL) (Harblik et al., 2007; Enström & Markula, 2007)
- • Participants with higher WMC showed less overall deviation from the normative path (Mäntylä et al., 2009)
- • Extension of previous research:
  - • The results support multiparticle recourse theories (Wickens, 2008) since VSWM/VWM influenced driving performance independently.

IMPLICATIONS

- • Training WMC could lead to overall better driving performance

LIMITATIONS

- • The LCT transferable to real-life driving? It only requires lane changes over a constant time period; not other driving tasks are required. The instruction to change lanes in a deliberate manner may not resemble daily driving conditions. However, the LCT has been proven a valid way for measuring distraction effects (Enström & Markula, 2007) and lane keeping and detection measures resemble necessary functions for real-life driving.

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