

Effect of phone conversations on tactical components of the driving task

Marie-Pierre Bruyas, Alexandra Fort, Valérie Lancelle

3rd DDI - Gothenburg



IFSTTAR

Introduction

- Part of a larger study included in the INTERACTION European project (2009-2012).
 - Aim: to analyze drivers' use of in-vehicle technologies (CC, SL, NS & MP)
 - Austria ([FACTUM](#)), Czech Republic ([CDV](#)), Finland ([VTT](#)), France ([IFSTTAR](#), [INTEMPORA](#), [ERT](#)), the Netherlands ([SWOV](#)), Portugal ([Universitas/ADI/CIGEST](#)), Spain ([CTAG](#)), United Kingdom ([TRL](#)) & Australia ([MUARC](#), [GI](#))
 - Naturalistic and experimental on-road observations
- Impact of phoning on the driving
 - Many studies focused on operational level of the driving ([Horrey and Wickens, 2006](#); [Caird et al., 2008](#) etc...)
 - Fewer focused on tactical components

Tactical level = make decisions about actions that are about to be executed (changing lane, overtaking, adapting speed...)

([Brown et al., 1969](#); [Anttila and Luoma, 2005](#); [Cooper et al., 2009](#); [Beede and Kass, 2006](#)...)



Method

- Participants: 24 drivers
 - 16 males, 8 females
 - 30-50 year old (mean age 39,1; SD 5,5)
 - Criteria: reporting driving at least 2000 km/month
- On road experiment
 - Drive 1 of 3 equipped cars: sensors (vehicle acceleration, position, actions on pedals and commands) 4 cameras (road view, dashboard, driver's face and driver's feet).
 - Drive 2 times (interval of 2 weeks in-between) on same predefined route
 - Driving environments: motorway & urban area.
 - Motorway section (9 km): 2 consecutive segments with different speed limits (110 km/h & 130 km/h)
 - Urban section (4.5 km): 5 intersections with traffic lights (1 turn left and 4 straight on) & 2 roundabouts



Method

- Phone conversation

- Hands-free kit
- Blocks of short questions involving various aspects of a natural conversation: description of places or objects, sentence repetitions, questions true or not, logical problems, lists of words to produce

- Data analysis

- Motorway
 - **Mean drivers' speed** according to speed limits (110 km/h vs. 130 km/h)
 - **Lane change frequency** = number of time driver changed lane per minute
 - **Time spent on the different lanes** = % time spent on the right, center or left
 - **Time spent on left or central lane before moving back** = time spent on these lanes without overtaking any slower vehicle, or after having doing so
- Urban area
 - **Hard braking** = mean number of decelerations $> 0.2g$
 - **Driving errors** = forgetting to turn the indicator on, taking the wrong way, or running a traffic light



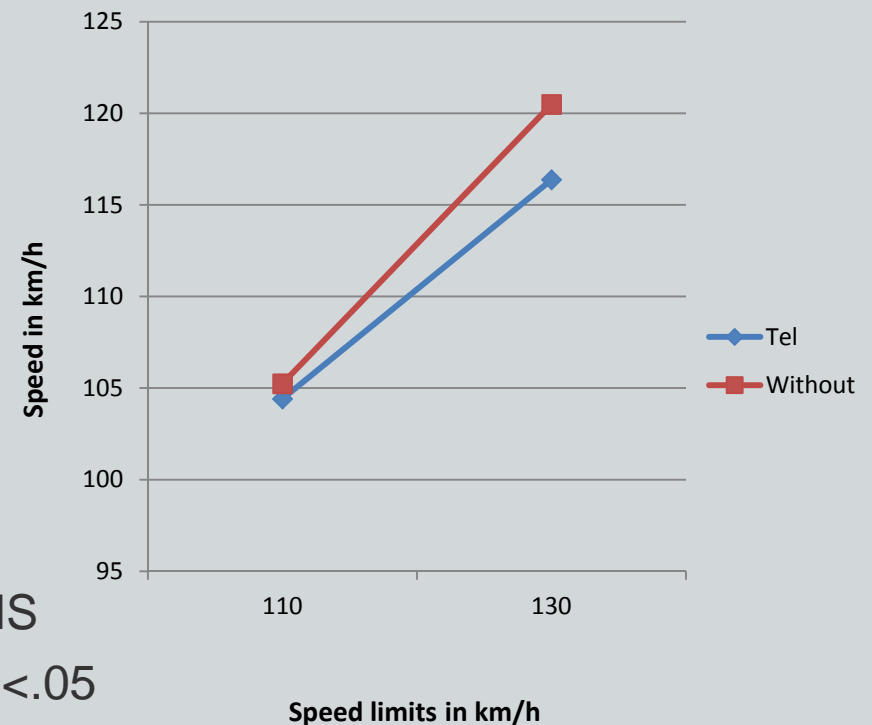
Results

- Phone conversation answer
 - All drivers were used to phone while driving (only 3 of them declared they might have avoided to answer here, especially in urban area)
 - None decided not to answer, to postpone or to interrupt the conversation, although they were given this possibility
- Phone conversation duration
 - Mean duration of phone calls
 - on motorway = **4 minutes** (mean = 242 seconds; SD = 20.30)
 - in urban area = **6 minutes** (mean = 349 seconds; SD = 45.18)



Results

- Driver speed on motorway
 - Data under strong traffic excluded
 - Effect of phone ($p=.019$)
 - Effect of speed limit ($p<.001$)
 - **Interaction phone / Speed limit** ($p=.024$)
 - Pair comparisons (Bonferroni)
 - Phone with/without for 110 = NS
 - Phone with/without for 130 = $p<.05$



Results

- Lane changes and lane position on motorway
 - Data under strong traffic excluded
 - Effect on lane change frequency [KW, $z = -2.798$; $p = .003$]
 - Drivers tend to spend less time in the left lane when phoning [KW, $p = .068$]
 - Effect on time spent on central or left lane before moving back [KW, $p = .026$]

	Phoning	Without phoning
Lane change frequency (Nb. of lane changes per minute)	1.19 (± 0.75)	1.82 (± 0.80)
Time spent on left lanes (%)	9% (± 0.16)	11% (± 0.13)
Time spent on center lanes (%)	63% (± 0.22)	61% (± 0.19)
Time spent on right lanes (%)	28% (± 0.22)	28% (± 0.21)
Time spent on central or left lane before moving back (%)	40% (± 0.14)	33% (± 0.15)



Results

- Hard braking in urban area

- Drivers tend to brake hard more often [KW, $z = -1.500$; $p = .067$].

	With phone	Without phone
Number of hard braking per driver	3.17 (± 1.90)	2.63 (± 1.41)

- Driving errors in urban area

- Most errors occurred in the phone condition
- 8/24 drivers forgot turn indicator in at least one intersection (6 while phoning only & 2 in both with and without phoning condition)
- 5 took at least once a wrong way while at the phone
- 2 run at least one amber traffic light (1 run 1 & 1 run 2) while at the phone
- 14/24 made at least one of these errors while phoning, only 2 made also one error without phoning [KW, $z = -3.464$; $p < .001$]



Discussion

- Effect of phone conversation on drivers' speed on motorway
 - Drivers drove significantly slower while at the phone
 - Absence of effect under 110 km/h limit in line with other studies
 - Caird et al (2008): reducing speed while phoning would be associated more with hand-held phone use than with hands-free phone use
 - Distracted drivers did not increase speed under 130 km/h limit
 - indicator of an **adaptive behaviour**? => make the decision not to increase their speed even if they could when speed limit changed, to reduce the driving demand
 - drivers may also have **not perceived and/or not processed** speed modification while phoning => could not decide to adapt their speed, because not aware of the modification?



Discussion

- Modifications of the driving behaviour on motorway

Drivers spent less time on the left lanes, changed lane less frequently and kept more time before moving back to the right after overtaking slower vehicles

- Cf. Cooper, 2009; Beede and Kass, 2006 (simulated driving)
- **Decision to simplify the driving task**
- neglecting some peripheral driving tasks **to devote more attentional resources** to the dual task

- Increase of hard braking in urban area

Consequence of increase in response times

- => begin to press on brake later, but compensate by braking harder
- => Due to a **reduction in visual control** of the environment

- More driving errors in urban area

Difficulties to **perceive and/or process information** from driving environment while phoning



Conclusion

- **Minimizing the driving demand** (keeping same speed instead of accelerating, changing lane less frequently) and avoiding less important driving sub-tasks => to allocate more attentional resources to the dual task
 - **Adaptive behaviour** which enhances safety, by mitigating the effect of the conversation on the driving
 - Could also reveal **difficulties to process all needed information** to execute complex manoeuvres (overtaking in surrounding traffic, adapting to modification of driving condition)
 - Hard braking and errors = consequences of this deterioration of information processing.
 - Avoiding sub-tasks while making more errors and violations supports deterioration in situation awareness



Thank you!

marie-pierre.bruyas@ifsttar.fr



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