

# First evaluation of possible Occlusion Technique Criteria

Sylvie GOUJON – LAB PSA Peugeot-Citroën/Renault

## 1 INTRODUCTION

The following study is the first step of a broader one designed to evaluate distraction induced by on-board systems, as well as methodology and criteria suitable to evaluate the visual distraction generated by the use of on-board systems.

This study aimed to implement the occlusion technique, and apply its first criteria proposed in the ISO Task Force.

It will be followed by a similar experiment in real conditions, with the subjects completing tasks in real driving conditions.

## 2 METHOD

### 2.1 EQUIPMENT

The experiment was conducted on two equipped commercially available cars : Peugeot 607 and Renault Laguna II. Both were equipped with a navigation system. The 607 included an integrated hand-free phone, and a FM/AM tuner with a LCD display. In the Laguna, the subjects were to use a standard mobile phone (Ericsson 388, chosen for its similarity to the 607 integrated phone).

An industrial PC was installed in the boot, but only four video cameras and the experimenter's screen and keyboard were left visible to the subjects.

The four cameras were aiming the subject's face, the concerned HMI's on the dashboard and controls behind the wheel. A microphone was present too.

Visual occlusion spectacles were driven by the industrial PC, through a specifically developed software. This allowed to change the LCD's open and closed time, and save the task's and subject's data. The spectacles consisted of four LCD screens (two on each side) all turned on or off together. The non-disturbance of the subjects by the spectacles has been checked with one task completed 3 times (after training) at start of the experiment : one time without the spectacles, once with the shutter staying opened, and once with the shutter alternating.

The shutter was repeating a cycle of open (1,7 seconds) and closed (5 seconds) states until the task successful completion. The open time includes the approximate extra focus adjusting time (200 ms) and 1,5 seconds dwell time as quoted in the "Dialog Management" CD 15005. The closed time is the same as the one used in a study by Niiya (*ISO/SC13/WG8 N289*).

## 1.2 SUBJECTS

32 subjects participated to this study : 16 young (age = 22,8  $\sigma$ = 1,86) and 16 elderly (age = 65,8  $\sigma$ = 4,15) with an equal distribution between males and females. Eight of each group completed the tasks on each car. All young participants had a “perfect vision” (no glasses or lenses correction). None of the test participants owned or had prior experience with route guidance systems before this study.

## 1.3 PROCEDURE

This experiment took place on a clear workshop, with both artificial and natural light (for a constant luminosity inside the car) in May 2001.

During the first 5 minutes, the subject was left alone to take place comfortably in the car, and explore the interior. Then the experimenter took place on the passenger seat, and explained how to use the concerned HMI's.

The subjects were asked to complete basics tasks, one by one, like entering a new destination in the navigation system. Five tasks were done on the navigation system, three on the phone, one on the air conditioning system, and one on the cluster. The tasks included the most “conventional functions” (volume increase and decrease for the tuner) commonly considered as acceptable while driving, and more complex ones, like dialling a number on the phone or answering, entering a new destination in the navigation system...

The starting and finishing states of the HMI had been clearly defined (see appendix). For each task, the experimenter was first showing how to complete the task, followed by the subject repeating it until two consecutive successful trials. Then the subject was asked to repeat the task twice : once wearing the spectacles, and once without. Half of the subjects begun with the spectacles, half without.

In each age category in each car, tasks to complete were asked to the subjects in two opposite orders.

## 1.4 DATA COLLECTED

The measures of interest were : the total task completion time (in real time through the software by the experimenter, whether the subject was wearing the spectacles or not), the number of open-closed cycles necessary for completion as well as the number of errors when completing the task with and without spectacles.

The four cameras captured information about the state of the car (through the screens and button), and the reactions of the subject : hands actions, eyes direction, speech, face expression ...

## 3 RESULTS

The results showed no noticeable gap, in completion time or error rate, between the trial with the spectacles open and without spectacles. The presence of spectacles does not generate a bias or a special behaviour of the subjects.

No significant influence of the orders was found, goggles at first or second trial, and task order.

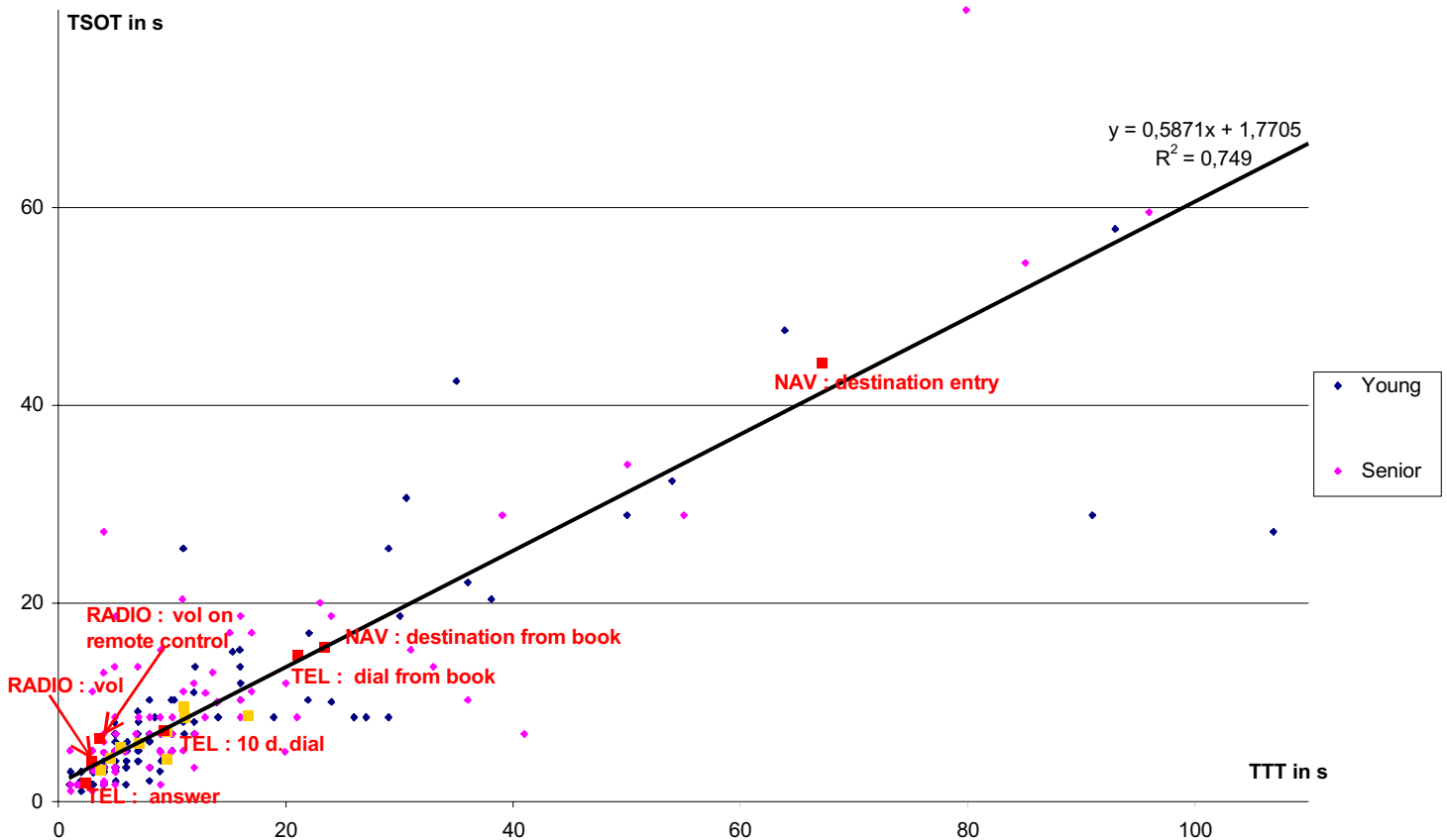
Several criteria were calculated based on task completion time with and without spectacles : Total Task Time without shutter (TTT), Total Task Time with shutter (TTToccl), Total

Shutter Open Time (TSOT), TSOT/TTT as well as the criterion proposed in the Task Force : TTToccl/(TTT+TTclose).

The mean values of these different time criteria calculated on the data are given below :

Task	TTT	TTToccl	TSOT	TSOT/TTT	TTToccl/(TTT+TTclose)
NAV destination from book	23,41	58,72	15,57	0,73	0,89
NAV destination entry	67,20	172,47	44,3	0,70	0,87
RADIO volume	2,88	13,06	4,12	1,33	0,95
RADIO volume on remote control	3,66	21,30	6,34	1,68	0,96
TEL 10 digit dial	9,31	25,22	7,19	0,79	0,89
TEL dial from book	21,09	54,65	14,80	0,78	0,89
TEL answer	2,40	3,89	1,88	1,05	0,92

A relatively good correlation was found between TSOT and TTT.



### 3.1 INFLUENCE OF THE AGE OF SUBJECTS

TSOT/TTT is significantly correlated with the age of the subjects (when TTToccl/(TTT+TTclose) is not).

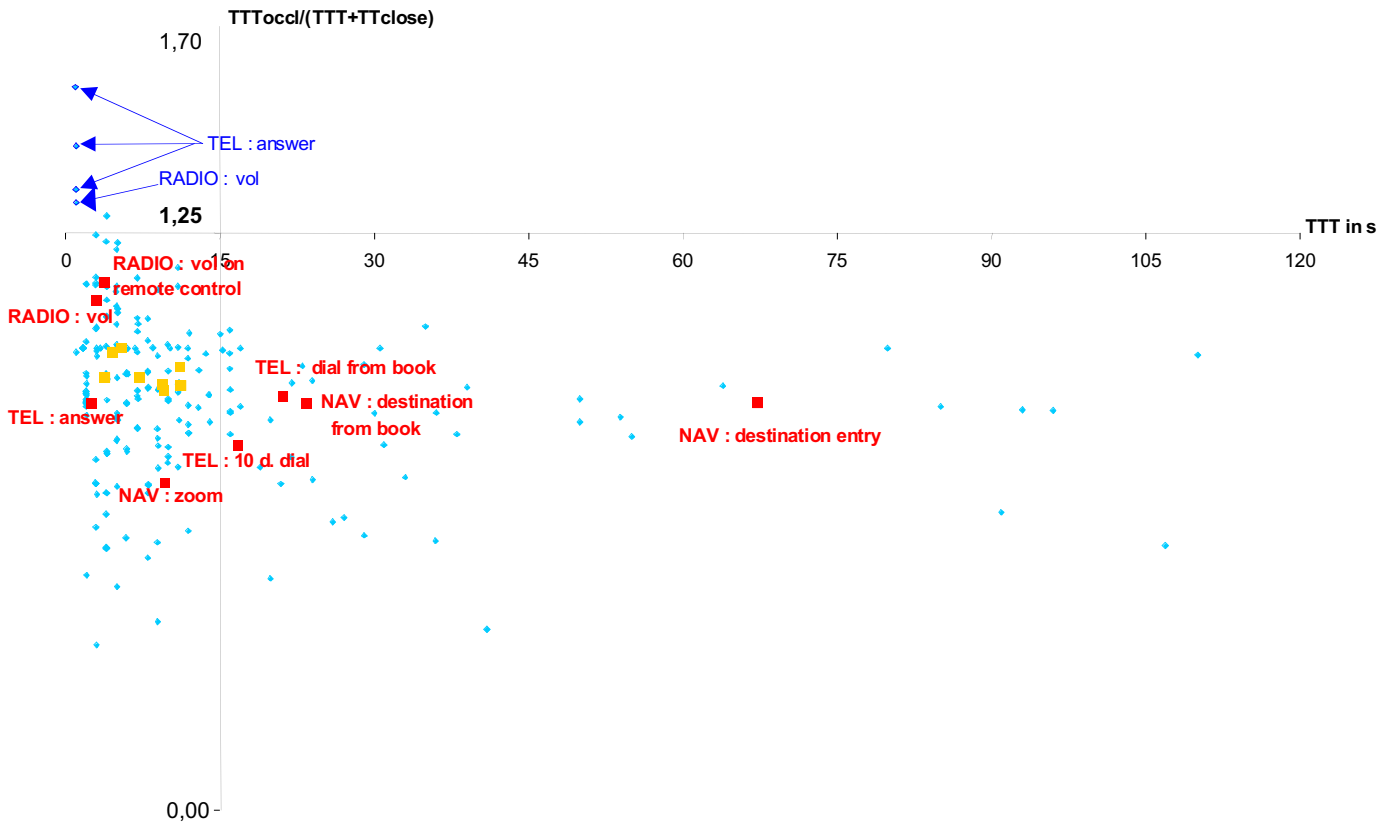
	YOUNG	SENIOR	General	p
TSOT/TTT	0,826 ( $\sigma=0,369$ )	1,078 ( $\sigma=0,993$ )	0,928 ( $\sigma=0,703$ )	0,005

But this significant correlation is essentially due to very brief tasks like answering phone or tuning radio volume whereas values obtained for "navigation tasks" are comparable. Elderly people are not "more disturb" by the use of the goggles than the younger ones.

## 4 DISCUSSION ON CRITERIA

### 4.1 PROPOSED CRITERION " $TTToccl < 1,25 * (TTT + TTclose)$ "

The proposed criterion  $TTToccl < 1,25 * (TTT + TTclose)$  was applied to our data.  $TTToccl / (TTT + TTclose)$  was calculated for all tasks. Results of this calculation is illustrated on Graph 2 :

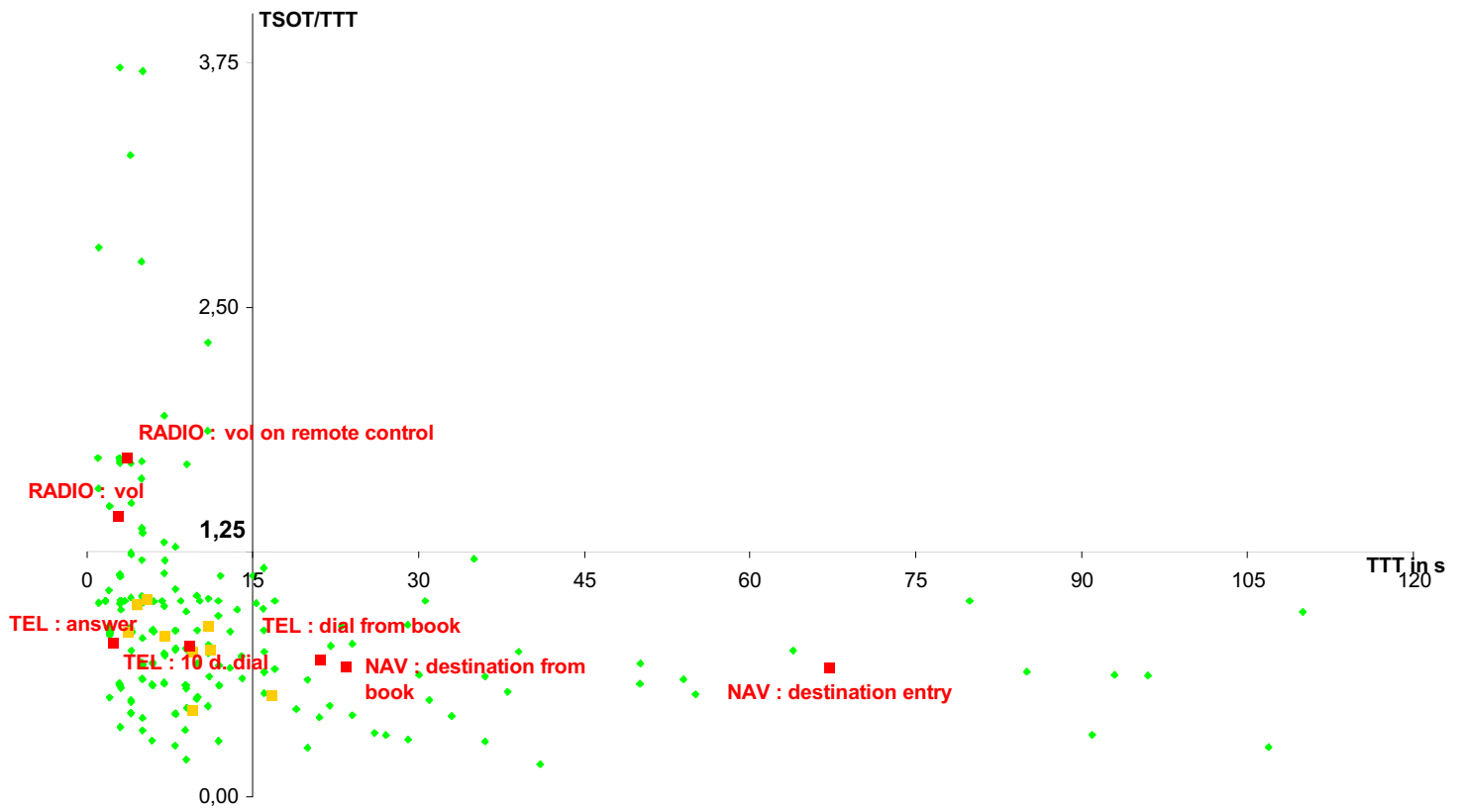


- All the performed tasks pass the criterion. Nevertheless, two mean values are significantly higher than the others and closer to the criterion. They are related to "conventional tasks" and these high values of the ratio are mainly due to the low value of TTT and do not reflect an important TTToccl value.
- Excepting these two particular values, all the tasks have almost the same "criterion value" without correlation with their complexity.
- This criterion appears to be very sensitive to the absolute value of TTT rather than to the complexity of the task.

### 4.2 RATIO BETWEEN TSOT AND TTT

An other possible criterion is to evaluate directly the ratio between open times with and without goggles that is in fact the ratio between TSOT and TTT

Results are illustrated in Graph 3



The same observations as in the paragraph before can be made. This criterion is very sensitive to the TTT value and not to the task complexity.

## 5 CONCLUSION

The occlusion technique is an interesting path to explore, as it reproduces visual time sharing between the road and TICS. However, the results of this experiment leads us to the conclusion that an isolated criterion based on the ratio of Total Shutter Open Time or Total Task Time with occlusion on Total Task Time, as it is essentially sensitive to the value of TTT (especially for small values), is not appropriate to determine the visual distraction induced by the use of a system by the driver.

# **Occlusion Technique :**

## **First Evaluation of Possible Criteria**

# Purpose of the experiments

- ◆ The following study is the first step of a broader one designed to evaluate distraction induced by on-board systems, as well as methodology and criteria suitable to evaluate the visual distraction generated by the use of on-board systems.
- ◆ This study aimed to implement the occlusion technique, and apply its first criteria proposed in the ISO Task Force.
- ◆ It will be followed by a similar experiment in real conditions, with the subjects completing tasks in real driving conditions.

# Limitation of the study

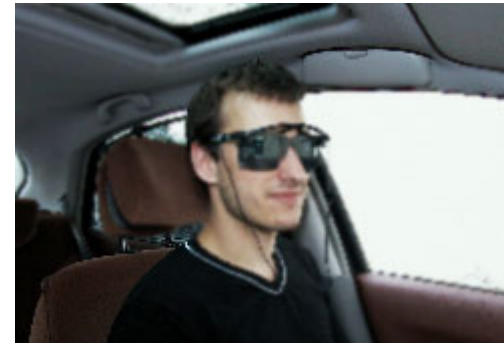
- ◆ Because the main objective of this experiment is to be compared with dynamic results, only a first analysis on possible criteria was conducted with the data.

# Method : experimental set-up

- ◆ The experiment was conducted on two equipped commercially available cars : Peugeot 607 and Renault Laguna II with a navigation system. The 607 included an integrated hand-free phone
- ◆ In the Laguna, the subjects had to use a standard mobile phone (Ericsson 388)
- ◆ Four cameras were aiming the subject's face, the concerned HMI's on the dashboard and controls behind the wheel.

# Method : experimental set-up

- ◆ The shutter was driven by the industrial PC, through a specifically developed software. It consisted in four LCD screens all turned on or off together.



- ◆ Shutter open time was 1,7 s (200 ms focus time + 1,5 s dwell time as quoted in the “Dialog Management” CD 15005)
- ◆ Shutter close time was 5 s as in Niiya's study.

# Method : subjects

- ◆ 32 subjects participated to this study :
  - 16 young (age = 23  $\sigma= 1,9$ )
  - 16 elderly (age = 66  $\sigma= 4,1$ )with an equal distribution between males and females.
- ◆ All the participants declared to normally drive without glasses.
- ◆ None of the test participants owned or had prior experience with route guidance systems before this study.

# Tasks to be realised

- ◆ On Navigation system :
  - enter a new destination
  - choose a registered destination
  - change the scale of the map
  - activate route guidance
  - stop route guidance
  
- ◆ On Phone :
  - answer a call
  - dial a 10 digit number
  - call a registered number

# Tasks to be realised

- ◆ On radio :
  - change volume (on dashboard and on steering wheel)
  - change frequency (on dashboard and on steering wheel)
  - modify the balance
  
- ◆ On Air Conditioning :
  - change temperature
  
- ◆ On Cluster :
  - reach a specified screen with the on-board computer

# Procedure

## ◆ Getting familiar with the experiment

- general presentation of the experiment, vehicle and shutter
- 15 min to get used to the car and embedded systems
- 15 min to get familiar with the shutter

## ◆ Training and test trials

For each task to be evaluated

- explanation given by the experimentator
- practice trials (without shutter)
- first test trial
- NASA rTLX
- second test trial
- NASA rTLX

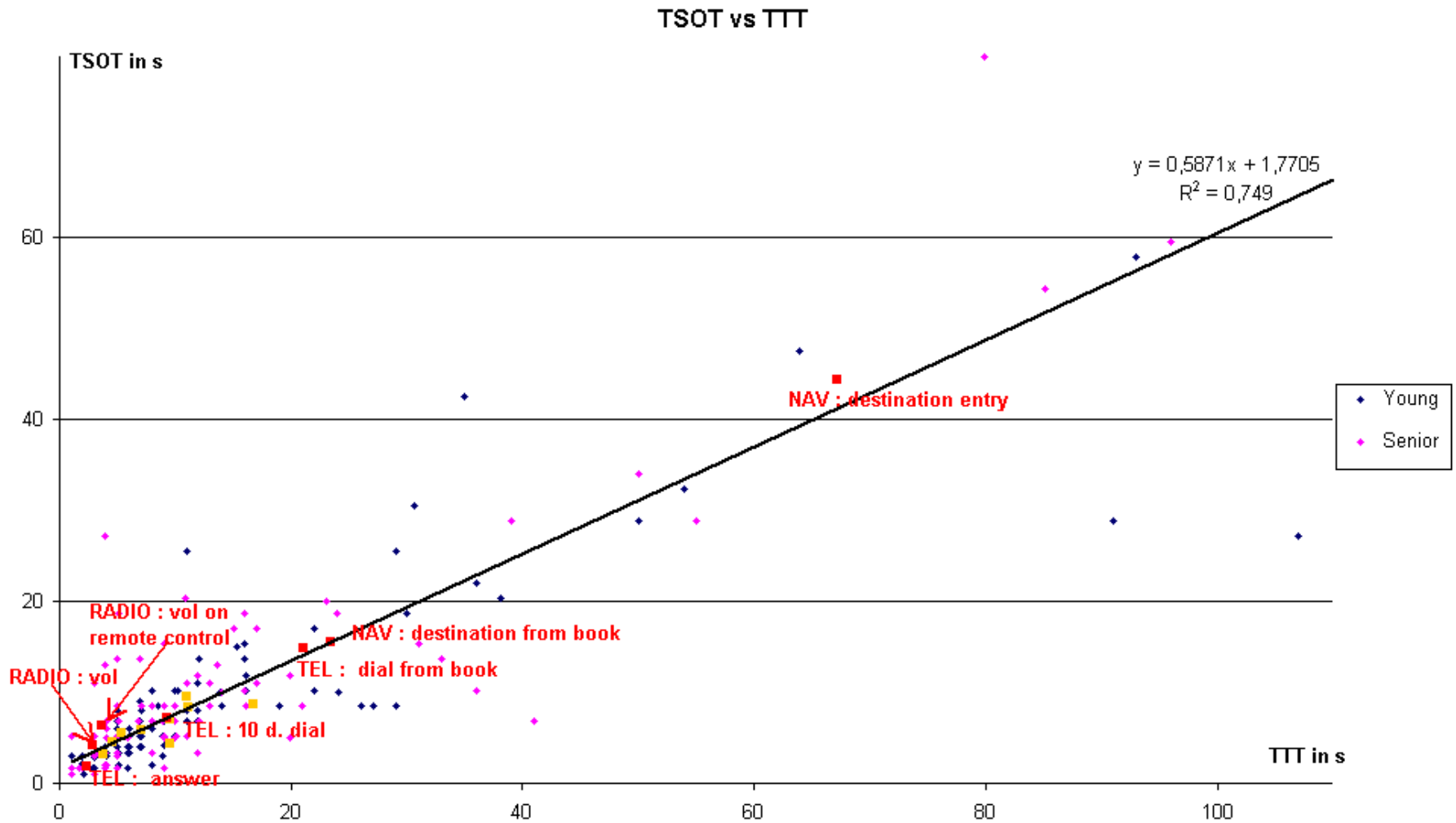
# Data collected

- ◆ Task duration :
  - Total task time without shutter (including computational time) : TTT
  - Total task time with shutter : TTToccl
  - Total Shutter Open Time : TSOT
  
- ◆ Video data
  - Visual behaviour
  - Errors and strategy
  
- ◆ Subjective evaluation
  - NASA rTLX with shutter
  - NASA rTLX without shutter

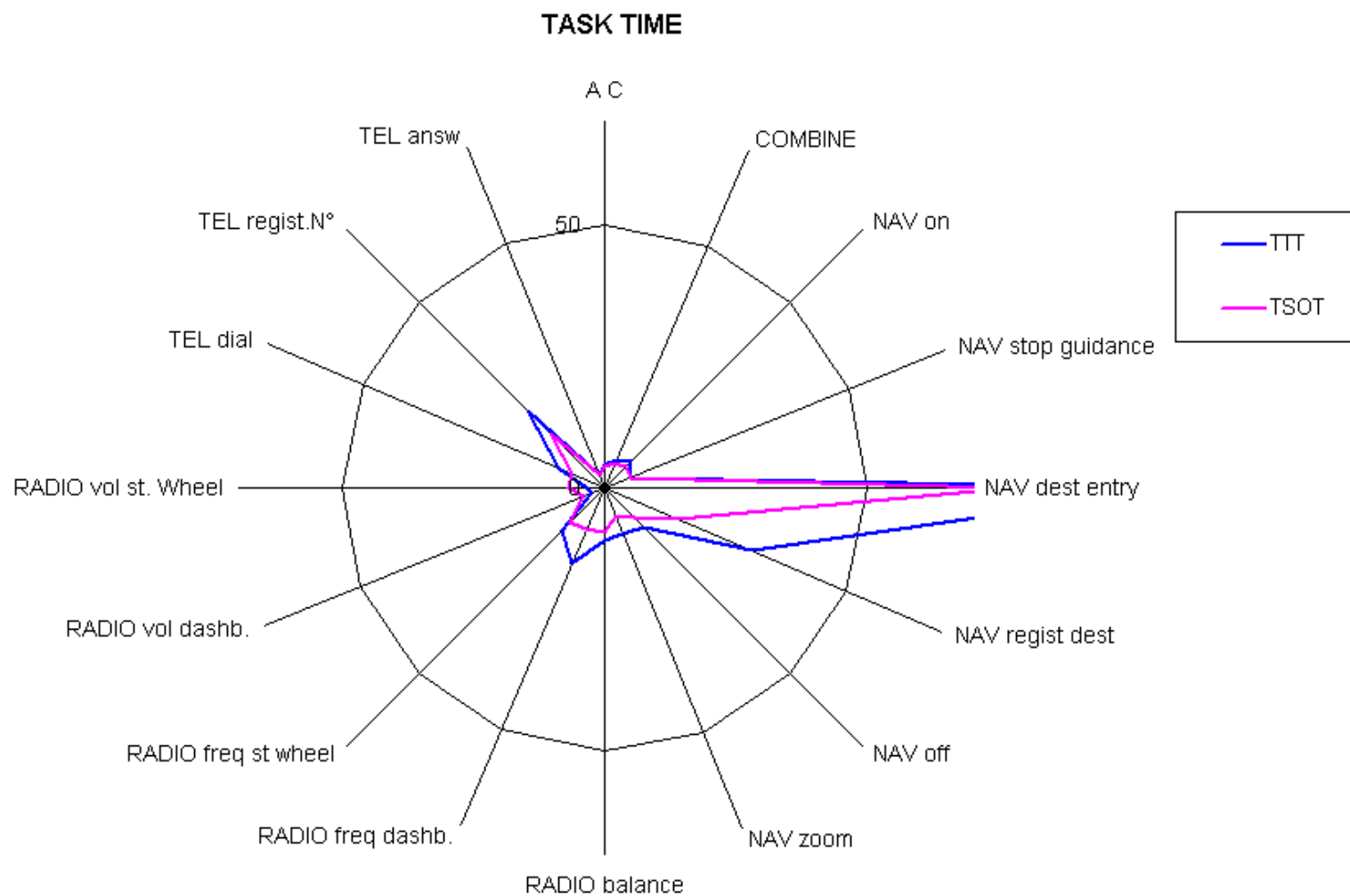
# Preliminary results

- ◆ Compatibility with glasses
  - The presence of shutter is not compatible with glasses
  
- ◆ Influence of shutter
  - The presence of (open) shutter does not generate a bias or a special behaviour of the subjects.
  - No significant influence of the orders was found, shutter at first or second trial.
  
- ◆ Error rate as criterion :  
Many subjects (especially young subjects) adopted an "alternative strategy" to realise the task with shutter
  - Comparison of error rates with and without shutter is not a appropriate criterion

# "Task duration" Criteria



# "Task duration" Criteria



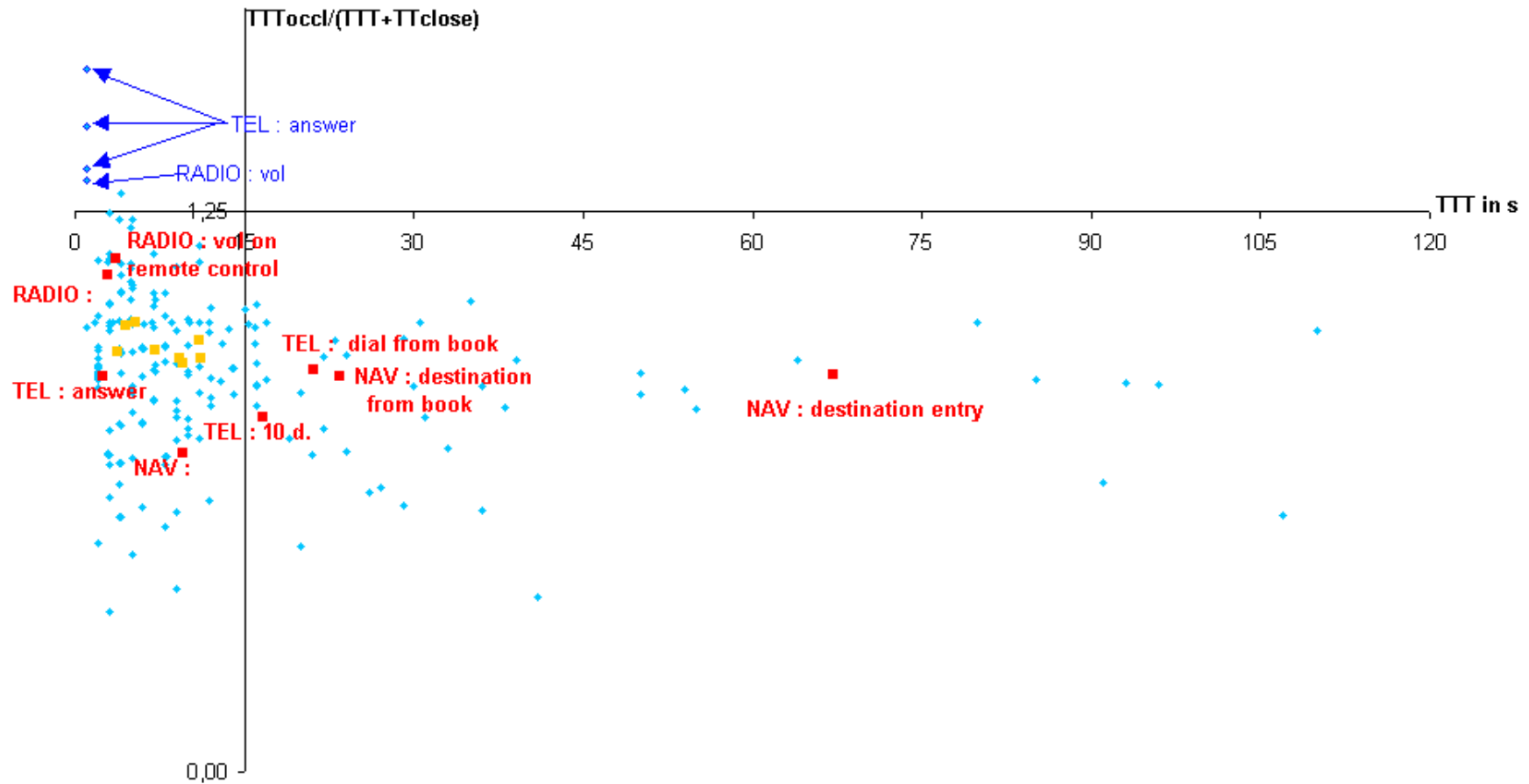
# "Task duration" Criteria

## ◆ Conclusion

→ From our result, occlusion technique associated with TSOT criterion makes no significant difference with the use of TTT to discriminate "distractive" tasks

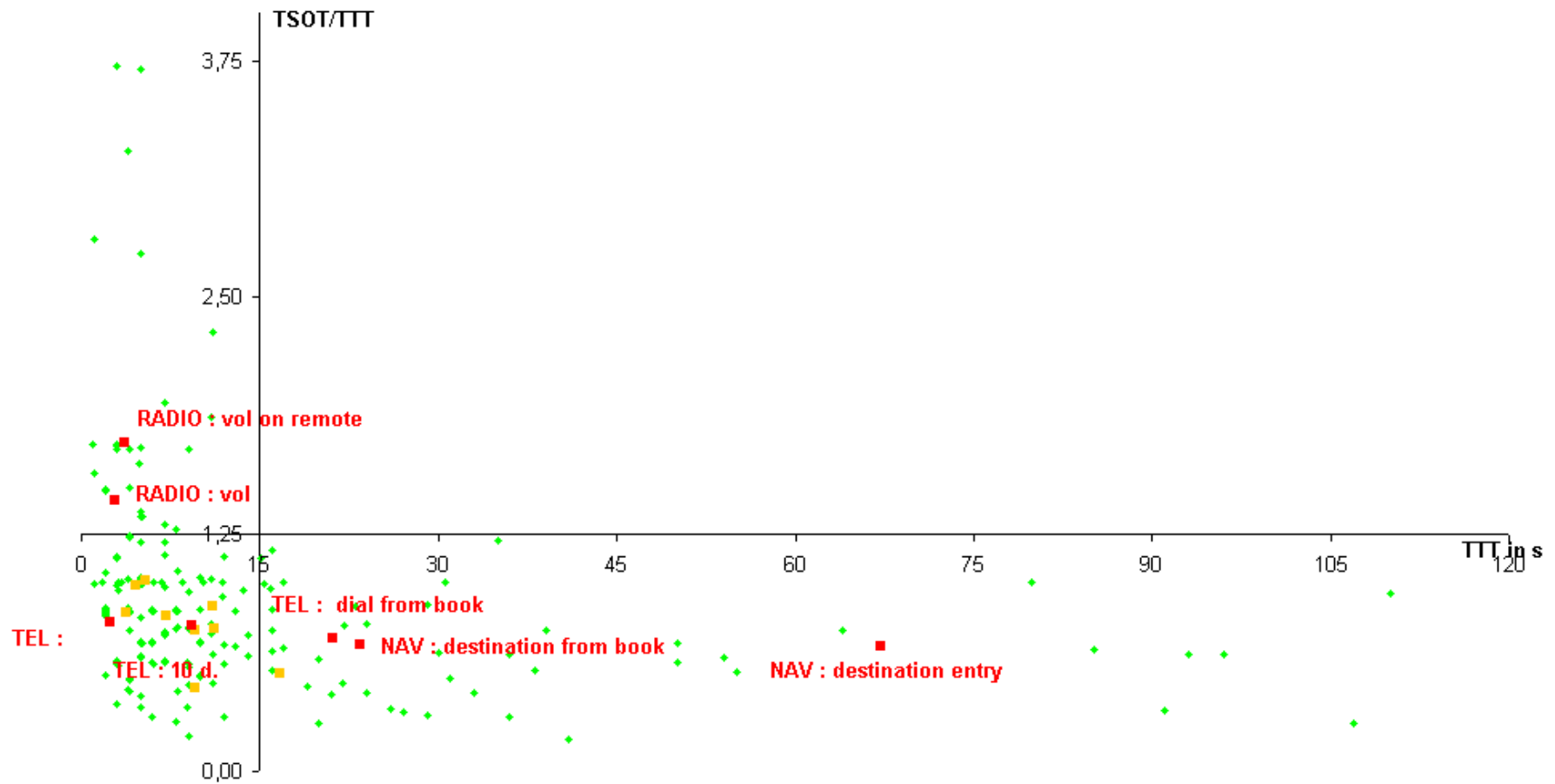
# "Ratio" Criteria

TTToccl/(TTT+TTclose) vs TTT



# "Ratio" Criteria

TSOT/TTT vs TTT

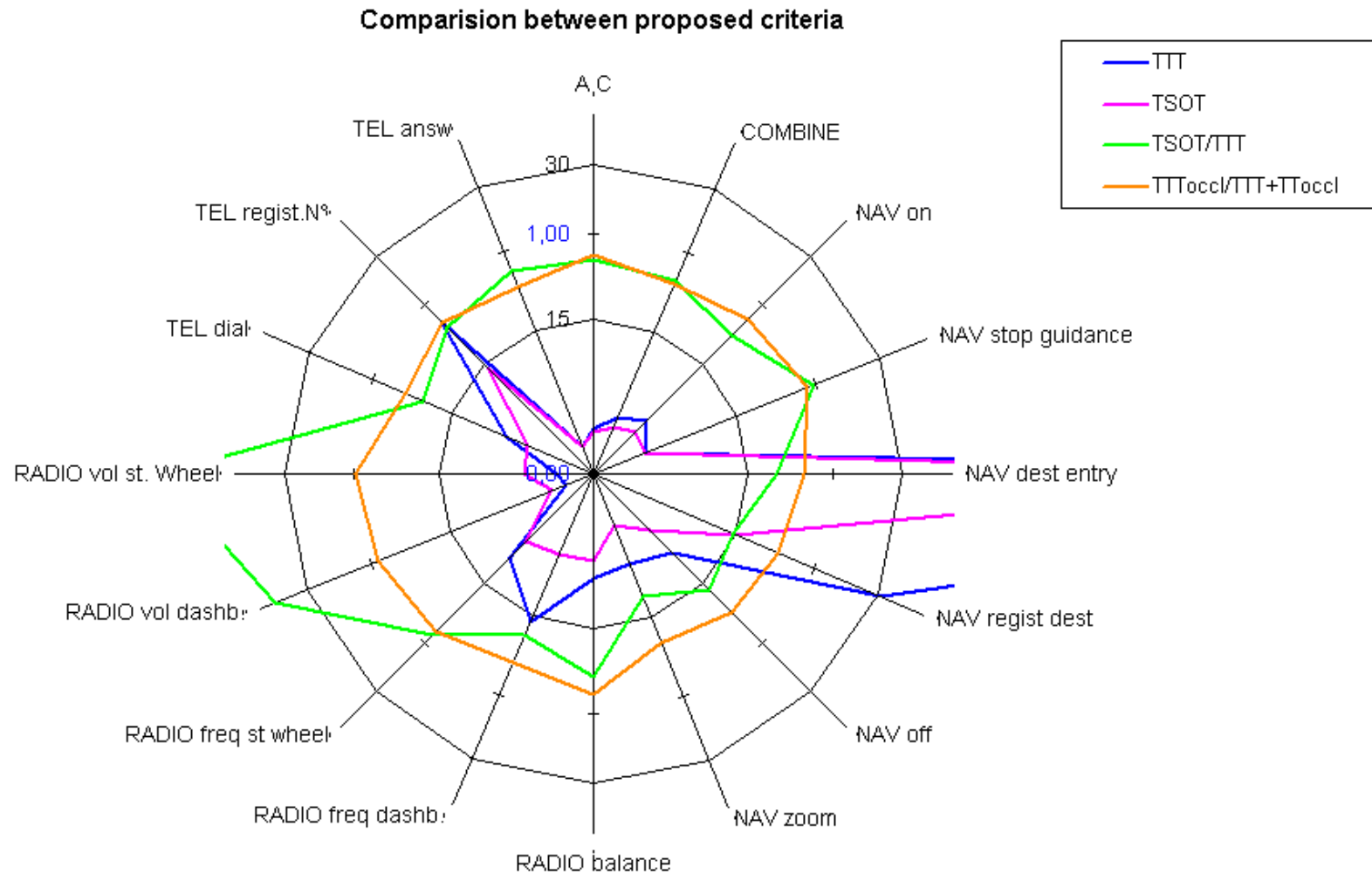


# "Ratio" Criteria

## ◆ Conclusion

→ "ratio criteria" like  $TSOT/TTT$  or  $TTT_{occl}/(TTT+TT_{close})$  are very dependant on TTT and not appropriate for "short tasks"

# Comparison between criteria



# Comparison between criteria

## ◆ Conclusion

→ The same technique associated with "ratio criteria" or "duration criteria" gives very different results when evaluating the functions.

# Conclusion

- ◆ Occlusion technique is promising because it is easy to set-up and reproduces the visual sharing phenomenon between the road and TICS
- ◆ From our result, occlusion technique associated with TSOT criterion makes no significant difference with the use of TTT to determine "distractive" tasks.
- ◆ "Ratio criteria" are not appropriate for "short task".

# Conclusion

- ◆ The same technique associated with "ratio criteria" or "duration criteria" gives very different results.
- ◆ Criteria based on error rates are not appropriate because shutter induces different strategies.

**Occlusion technique needs further  
research and validation**