

5th international conference on

Driver Distraction and Inattention

March 20-22, 2017 | Paris, France



Towards a detection of mind-wandering in driving: contributions of cardiac measurement and eye movements

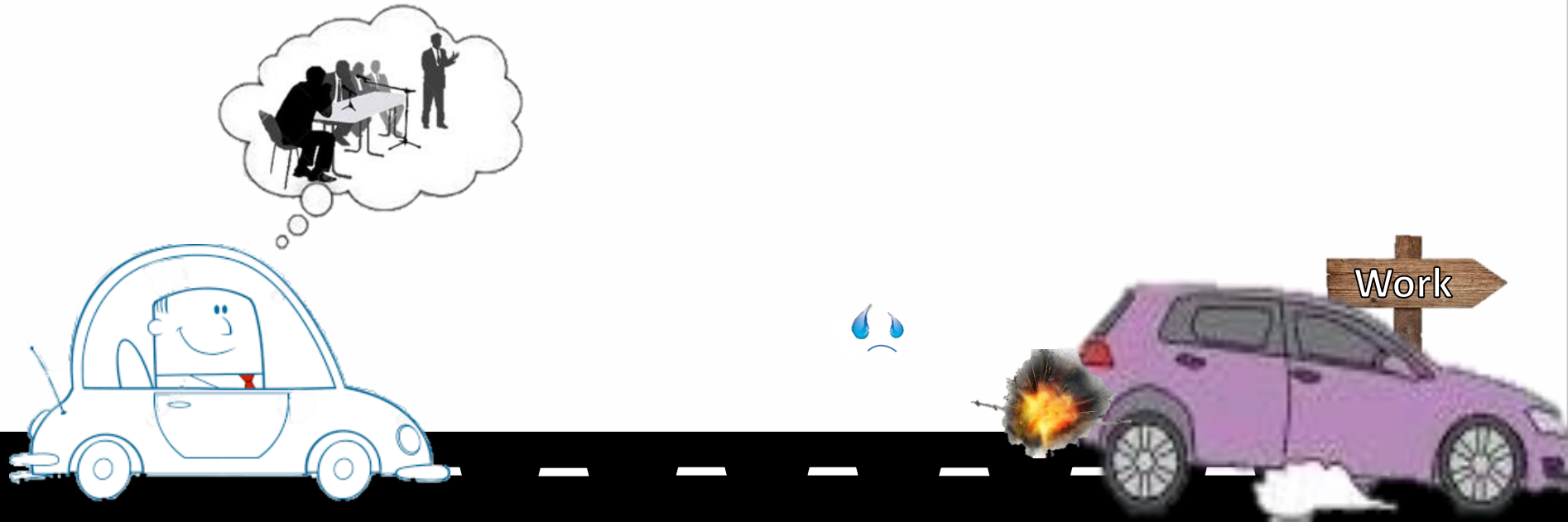
PEPIN Guillaume

Séverine Malin, Christophe Jallais,
Fabien Moreau, Alexandra Fort, Daniel Ndiaye,
Jordan Navarro & Catherine Gabaude

Driver Distraction & Inattention,
Paris, France
22/03/2017



IFSTTAR



Mind-Wandering (MW)

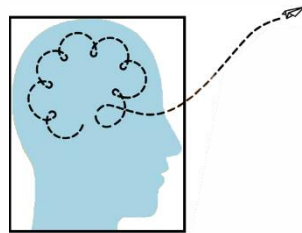


What's happening?

- Internal reorientation of attention *Smallwood & Schooler, 2015*
- Perceptual decoupling (evidence from cerebral activity)

Benefits?

- Helps to get outside of the framework
- Self-relevant concerns: solving problem



Drawbacks?

- Unconscious and fluctuating state
- Prevent working memory update

Kam et al., 2014

What about MW while driving?



Mind-Wandering and Driving

Epidemiological study:

- Inattention & Distraction → 25-50%
 - Equivalent fraction of attributable risk
- } *Galéra et al., 2012*

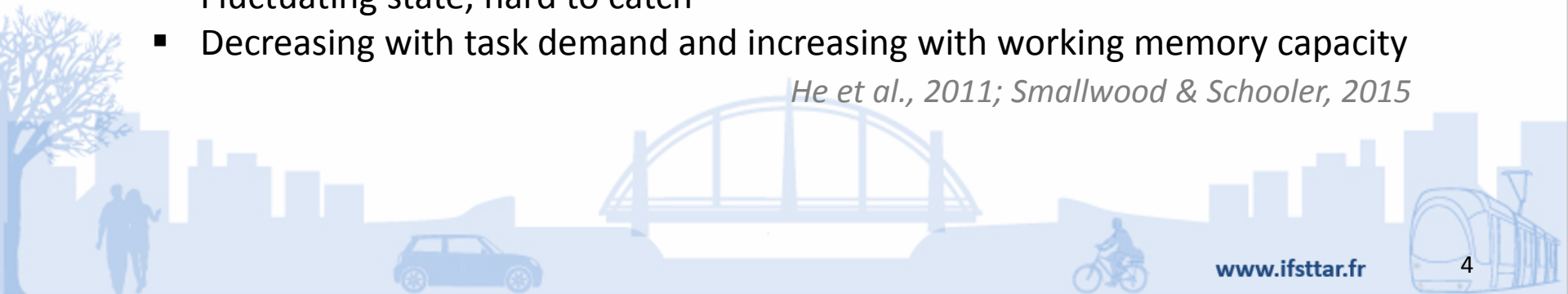
Recurring phenomenon

- Around 50% of daily living thoughts *Killingsworth & Gilbert, 2010*
- 4 drivers out of 5 and around 35% of driving time *Berthié et al., 2015*

Characteristics

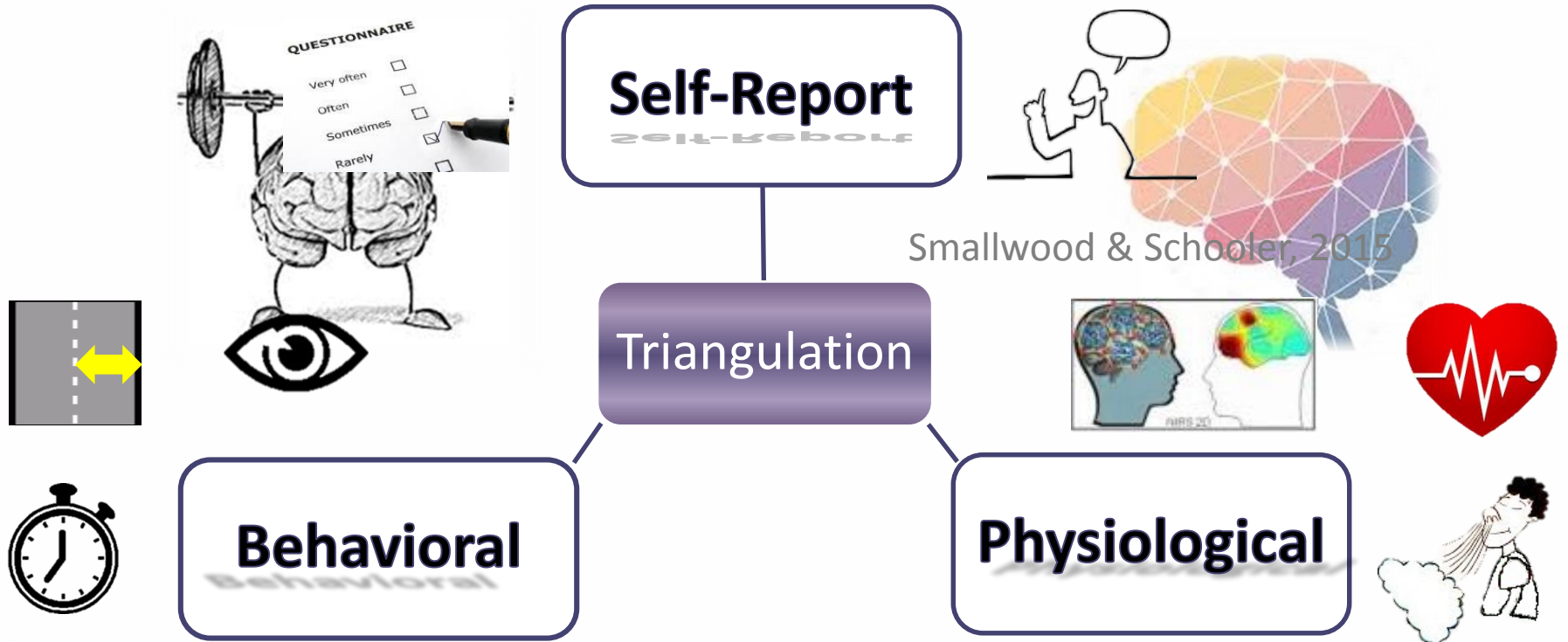
- Fluctuating state, hard to catch
- Decreasing with task demand and increasing with working memory capacity

He et al., 2011; Smallwood & Schooler, 2015



Neuroergonomics Approach

Parasuraman, 2003



Highlight physiological and behavioral indicators of MW while driving

Materials & Methods

20 participants (age 34.15 ± 11.93), 10 males

Material

Driving simulator, electrocardiograph, eye-tracker

Measurements

Heart rate, gaze behavior

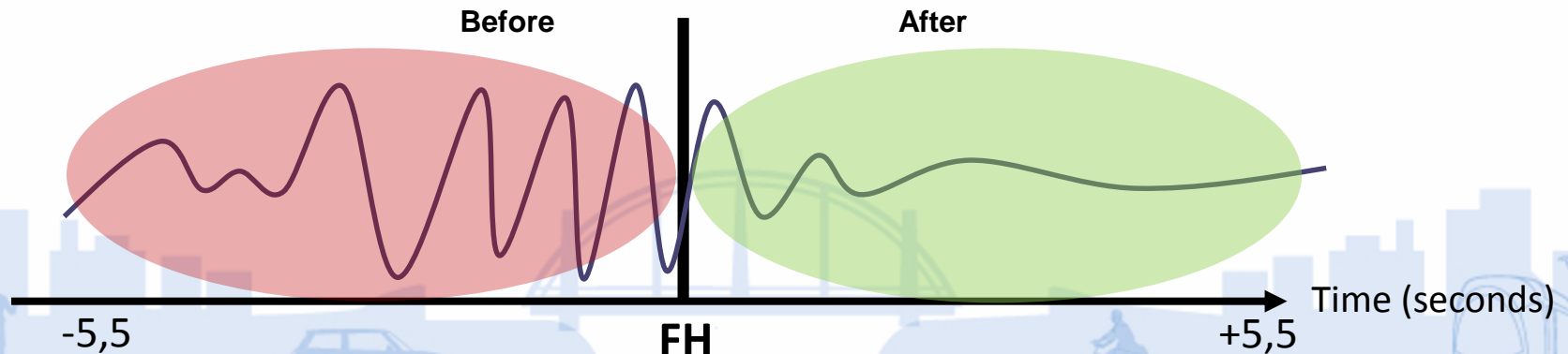
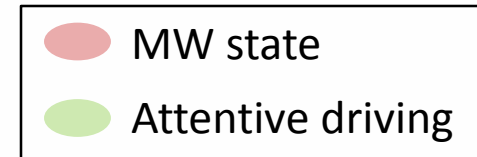
Instructions

Flash the Headlights (FH) when becoming conscious of MW
then focus on driving

Analysis

Comparisons between before $[-5.5; 0]$ and after $[0; +5.5]$

Flashing the Headlights (FH)



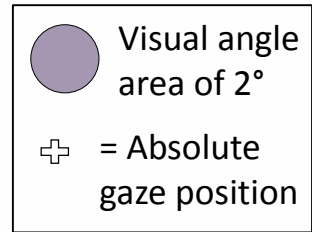
Preprocessing



Cardiac signal to instant Heart Rate (HR)

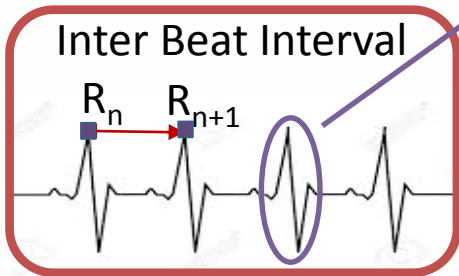
- $IBI_n = R_n - R_{n-1}$
- $HR_n = \frac{60,000}{IBI_n}$

Gaze Position (GP) to Gaze Fixity (GF)

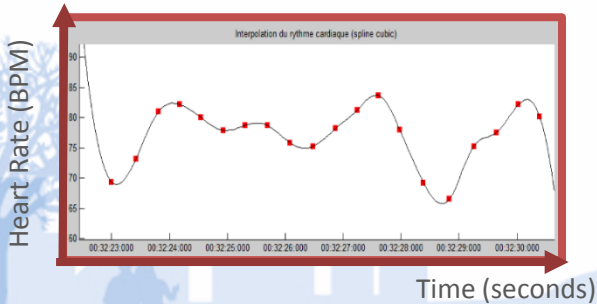


90% of GP values contained in a visual angle area of 2° for more than 1 s

Marquart et al., 2015



QRS complex



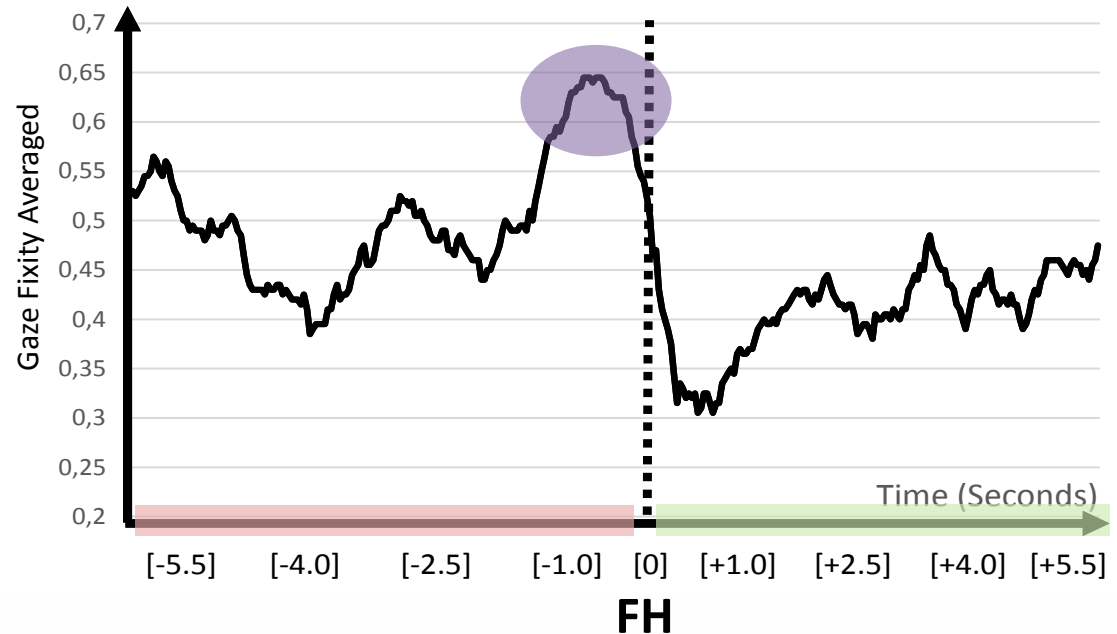
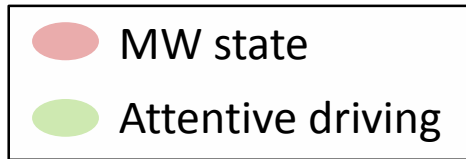
Gaze is considered as fixed



Gaze is not considered as fixed

Results: gaze fixity

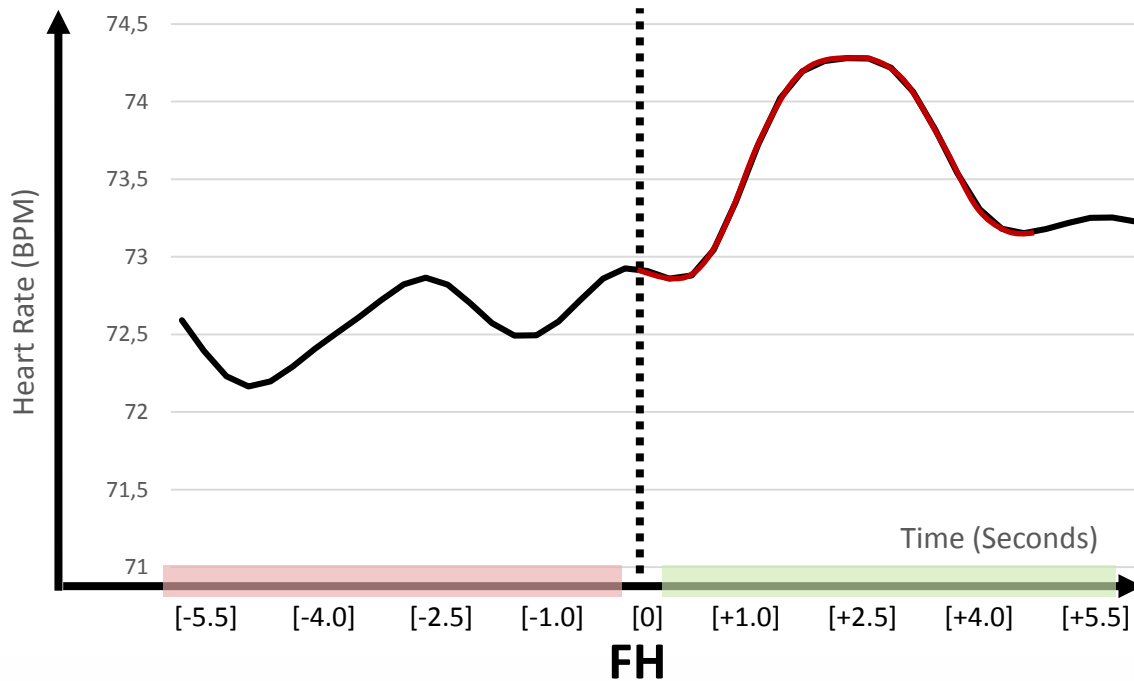
Data averaged over 200 events



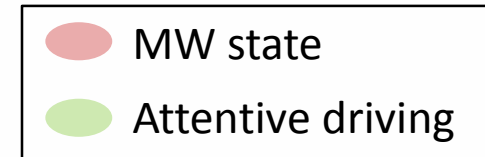
- Higher gaze fixity during MW ($m = 0.48$) than during attentive driving ($m = 0.41$), $p < .001$
- Highest gaze fixity spike: 65% *

* = Gaze Fixity was present on 65% of 200 events (130)

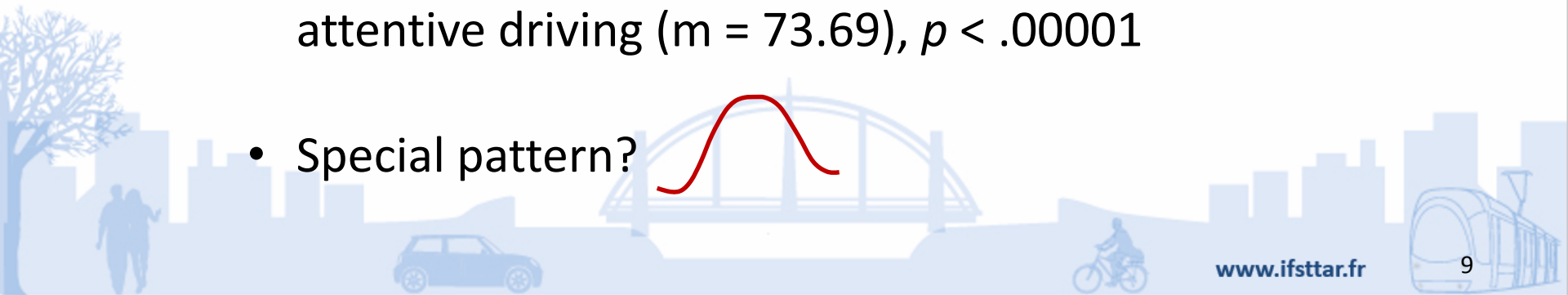
Results: heart rate



Data averaged over 216 events



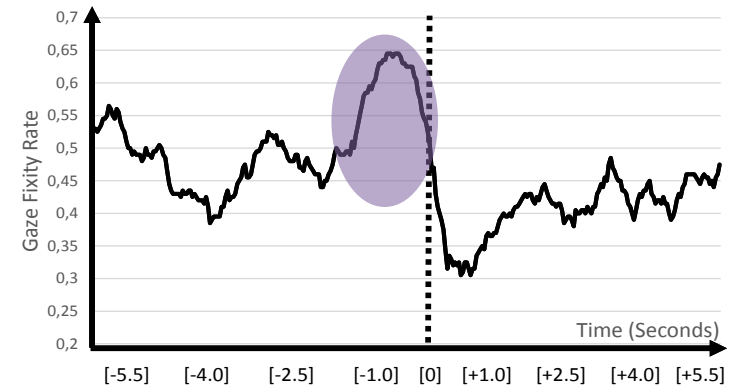
- Lower heart rate during MW ($m = 72.67$) than during attentive driving ($m = 73.69$), $p < .00001$
- Special pattern?



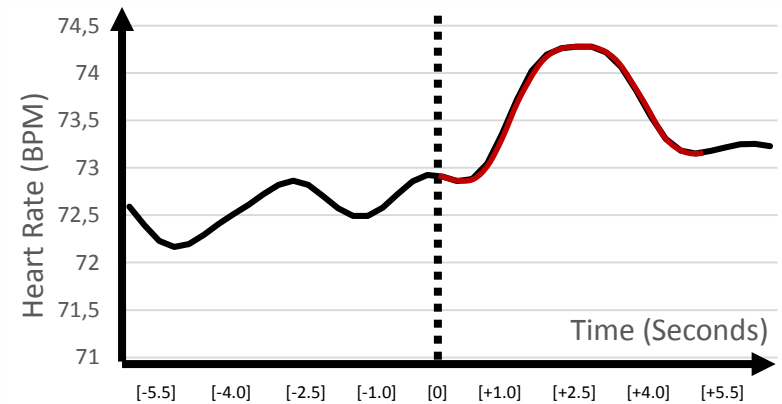
Results

To summarize:

- Gaze fixity is higher during MW
- A special cardiac pattern found after MW



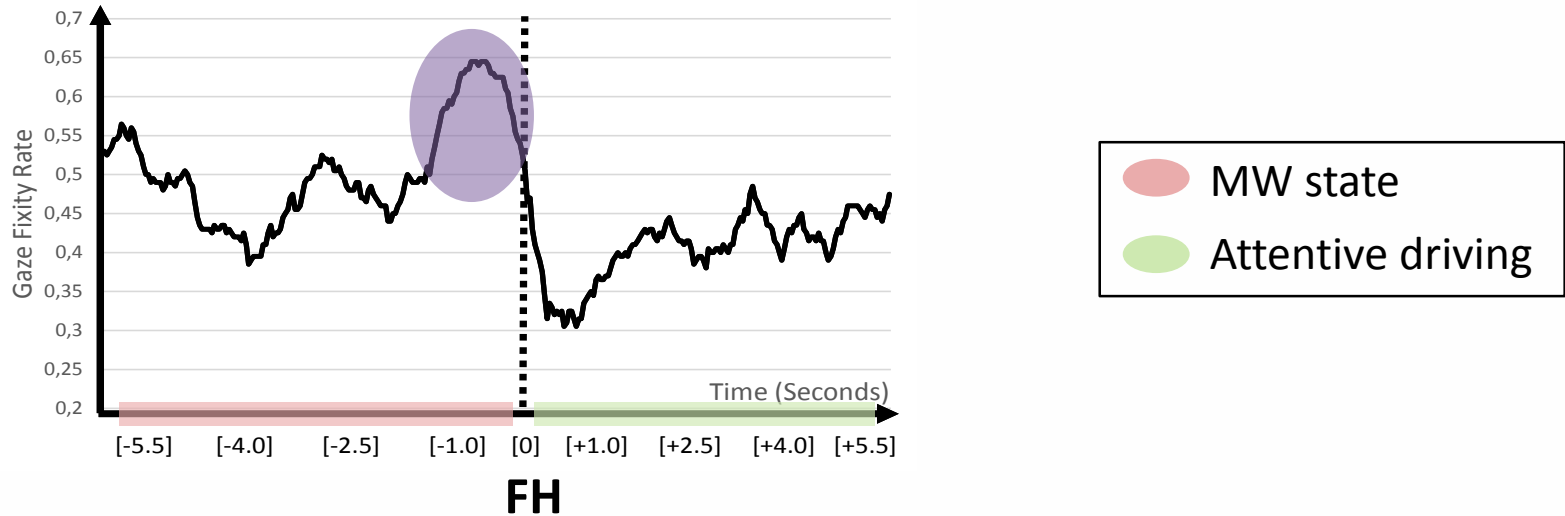
FH



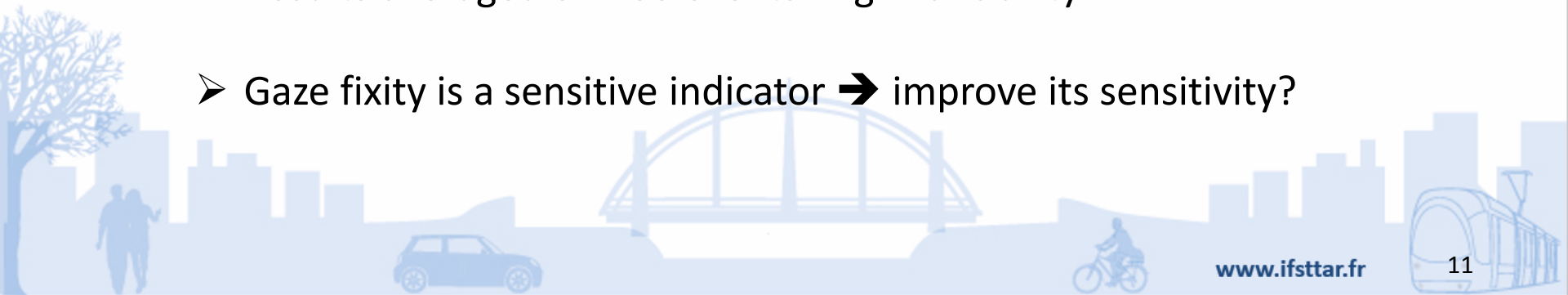
FH



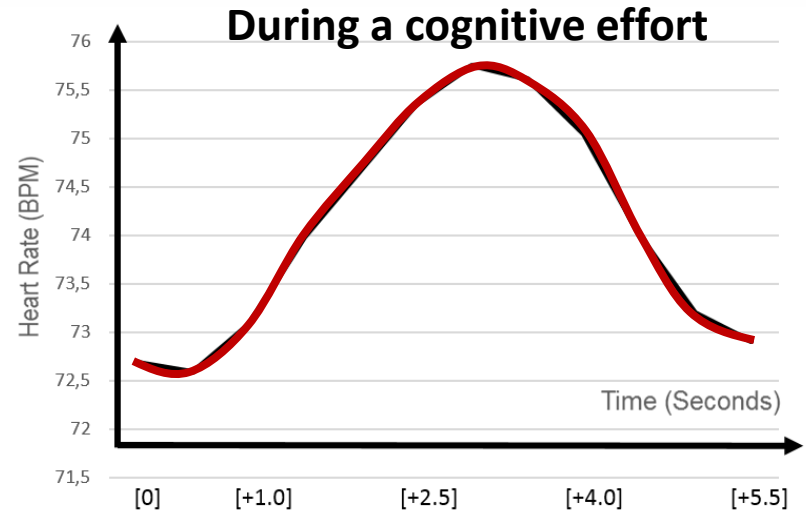
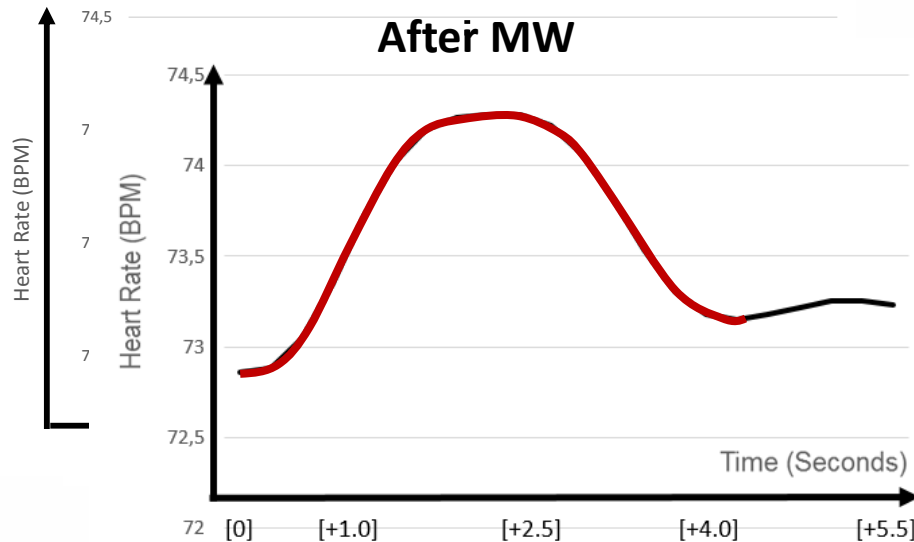
Discussion: gaze fixity



- Could explain the part of the higher crash risk associated to MW
- Results averaged on 200 events: high variability
- Gaze fixity is a sensitive indicator → improve its sensitivity?




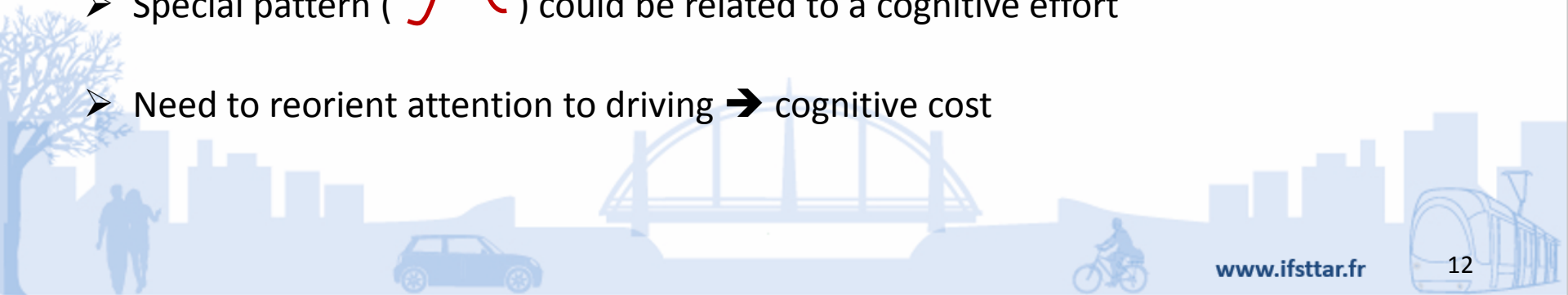
Discussion: heart rate



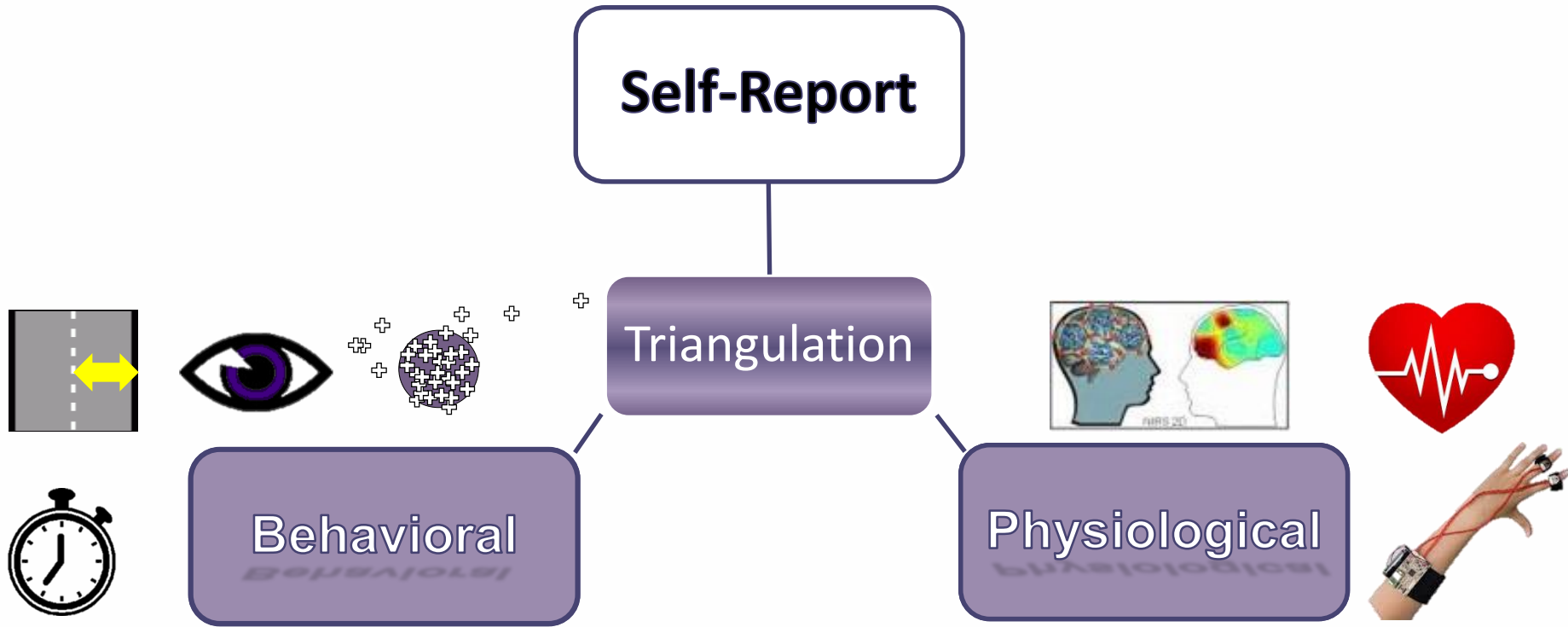
Pepin et al., 2017

Towards a real-time detection of cognitive effort in driving

- Heart Rate is **not a sensitive indicator** of MW
- Special pattern () could be related to a cognitive effort
- Need to reorient attention to driving → cognitive cost



Conclusion

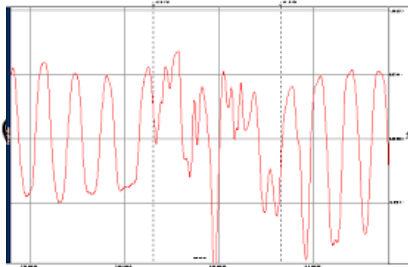


He et al., 2011
Yanko & Spalek, 2014
Lemercier et al., 2014
...

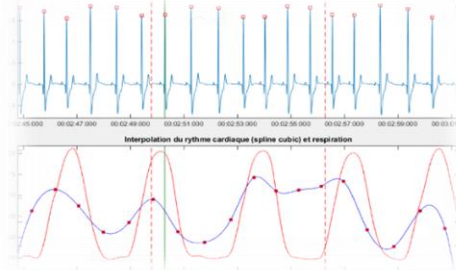
Ottaviani et al., 2015
Smallwood et al., 2011
Baird et al., 2011
Christoff et al., 2009
...



Breathing data



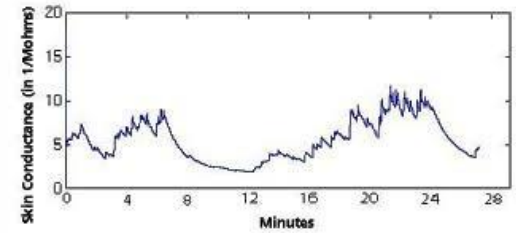
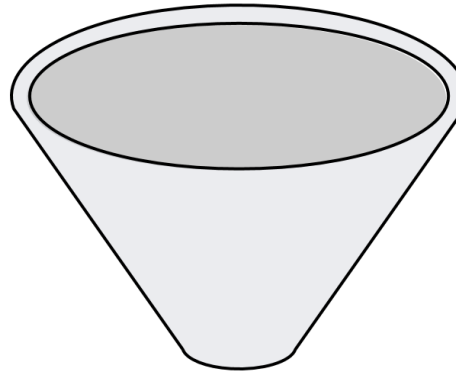
Cardiac data



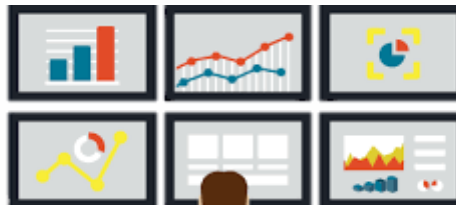
Driving behavior



Gaze Fixity



Galvanic Skin Response



Detect MW on-line

Thank You For Your Attention

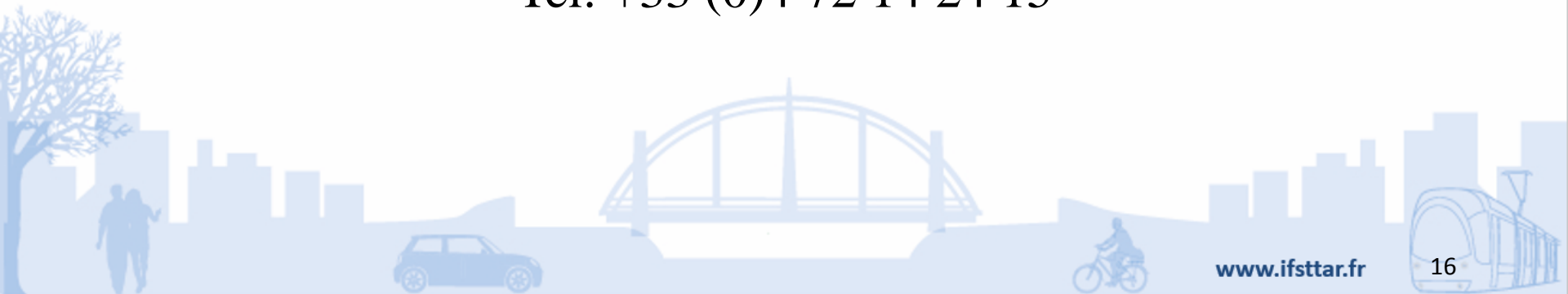
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Very long-term objective: BCI

