



Visual attention in a complex task: discrimination of decisional processes with eye movements patterns.

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Cognitions Humaine & ARTificielle
Human and artificial cognition

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Institut français des sciences et technologies des transports, de l'aménagement et des réseaux

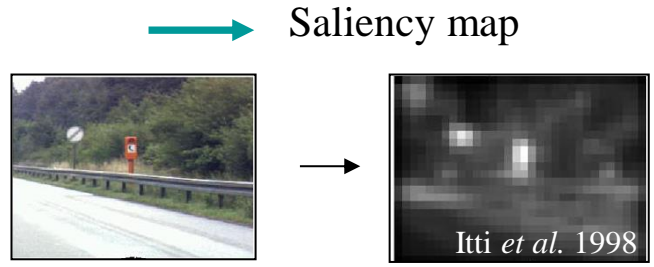
French institute of science and technology for transport, spatial planning, development and networks

LEPSiS

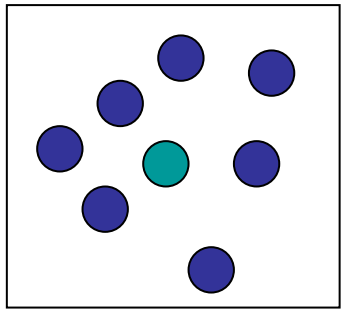


Visual attention:

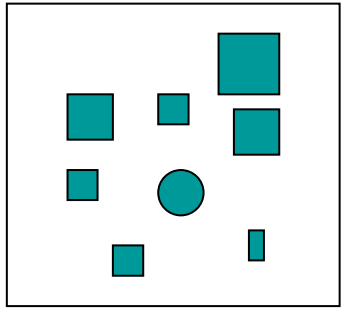
Bottom-up processing
= visual characteristics



Bottom-up

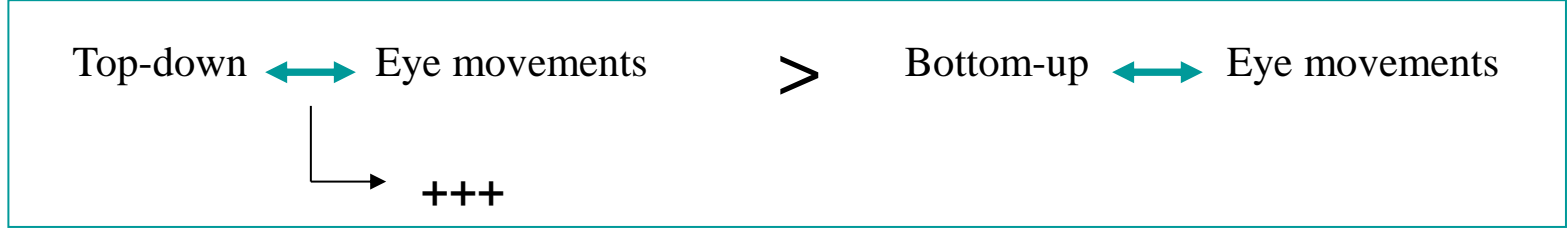


Top-down



Top-down processing
= knowledge, ongoing task, expectancy ...

Ecological & complex task

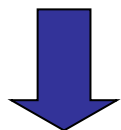


Rothkopf, 2007

Yarbus = oculomotor pattern ↔ task

To generalize:

1. Is it possible to discriminate between the mental states underlying the ongoing task, **without changing the stimulus or instruction**?
2. Is it possible to discriminate different mental states **depending on the time**?



Eye movements / cognitive processes link

Is it possible to discriminate, with oculomotor patterns, the different cognitive processes which participate to the same task, and to investigate whether these patterns change with time?



Yarbus 1967



Decision-making task

Model 1: **Theory of action phases**

Nenkov & Gollwitscher, 2012

Decision making task
= 2 action phases

- pre-decisional: **deliberation** phase
Visual attention → “a heightened receptivity to available information”
- post-decisional: **planning** phase

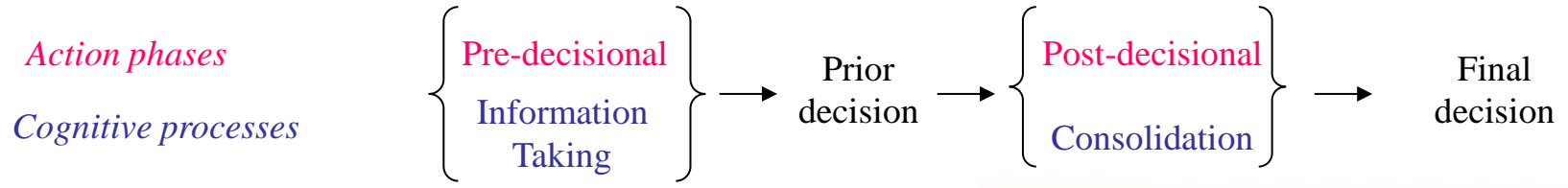


Model 2: **Differentiation and Consolidation (Diff/Con) Theory**

Svenson, 1992

Decision making task
= 2 cognitive processes

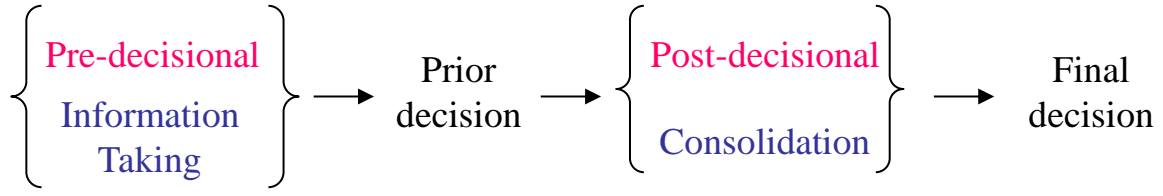
- Diff: evaluation to produce a diagnostic value
└─> Prior decision
- Con: to gather congruent information with prior decision
└─> Final decision



- Decision-making task:



Action phases
Cognitive processes



+ if no decision task → **Baseline**

- Visual search:



Information Taking > Consolidation > Baseline

- Oculomotor pattern:

Visual search ↑ = Saccade amplitudes ↑ + Fixation durations ↓

Chapman & Underwood, 1998

A situation with:

- A central role of **perception**
 - ↳ Eye movements ↔ processes
- **No explicit** instructions
 - ↳ Close to reality
- A **time** course
 - ↳ On evolution of processes with time
- An **ecological** and complex dimension
 - ↳ To generalize

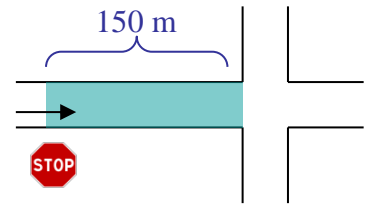
DRIVING

Other benefits:

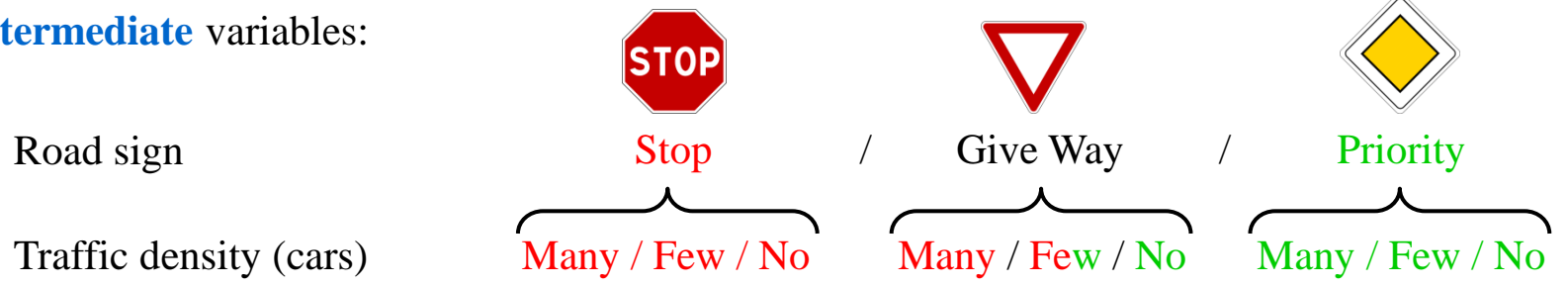
- Studied extensively
- Driving simulator
- Notion of risk

More specifically:

- the intersection approach (from 150 m before)
- decision = to **stop** or **not** (**NoGo** or **Go**) (next decision = when to restart, if stop)



Intermediate variables:



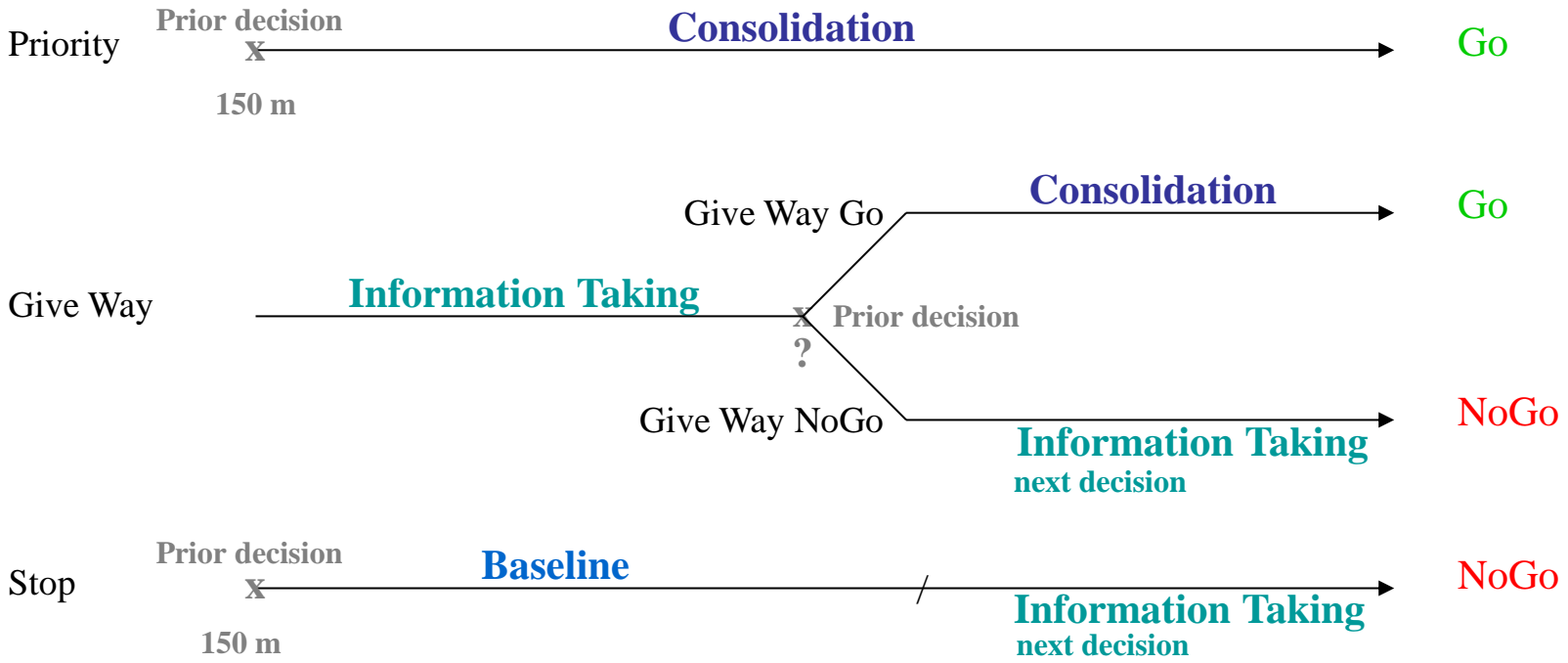
Independent variables =

- **Position** at the intersection (**Before and After** the prior decision in Give Way)
- driving **Situation** (**Stop, Priority, Give Way Go and NoGo**)

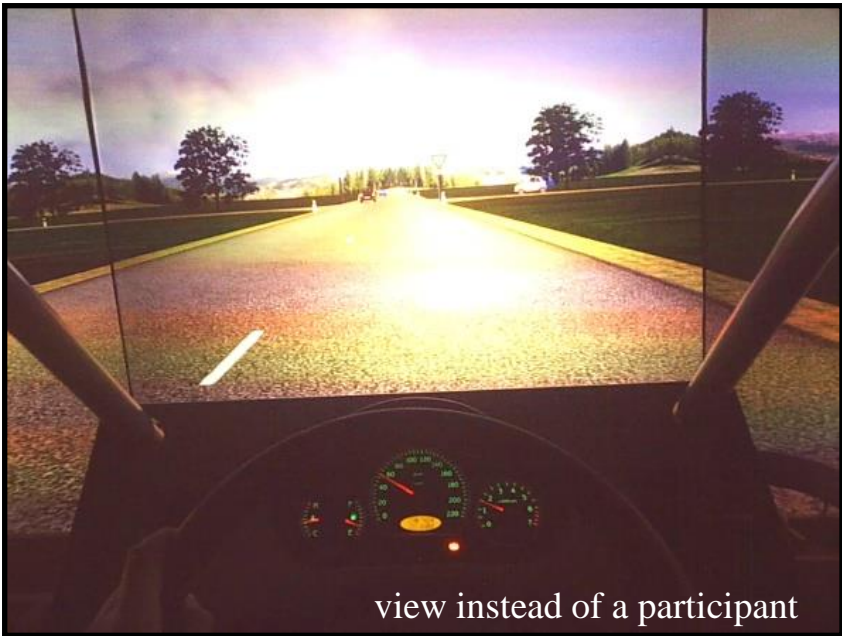
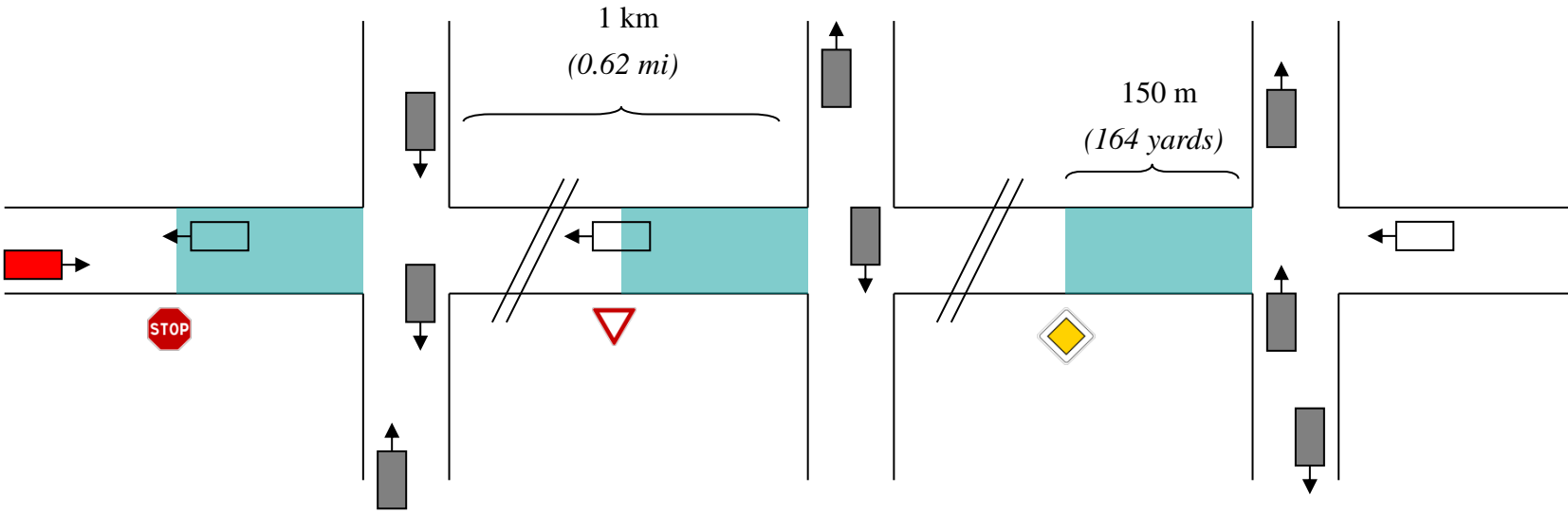
Dependant variables =

Saccade amplitudes + **Fixation** durations

- Reminders: - Visual search: **Information Taking** > **Consolidation** > **Baseline**
- Visual search \uparrow = Saccade amplitudes \uparrow + Fixation durations \downarrow



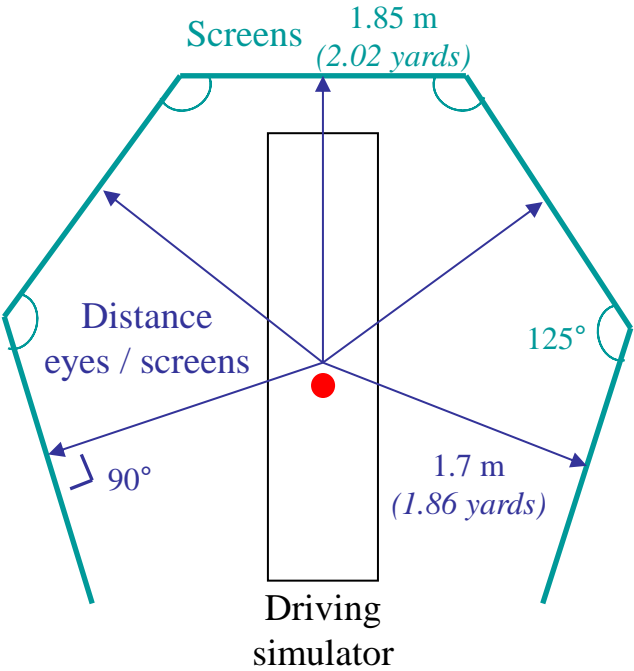
Virtual environment:



Legend

- Participant car
- Traffic density: no, few, many cars
- Control cars: ↑ immersion
- Portion of the road analyzed later

Apparatus:



Total angle = 275°

Procedure:

45 trials = 3 Road signs x 3 Traffic density x 5 Repetitions

Intermediate variables: Road sign & Traffic density

Traffic density	Decision: NoGo			Decision: Go		
	Give Way	Priority	Stop	Give Way	Priority	Stop
No car	7	0	153	155	163	10
Few cars	73	0	157	93	162	2
Many cars	136	0	160	26	163	1

Total number of trials = 1461

Trials removed from the analysis

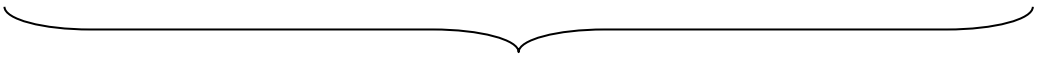


Give Way NoGo

Stop

Give Way Go

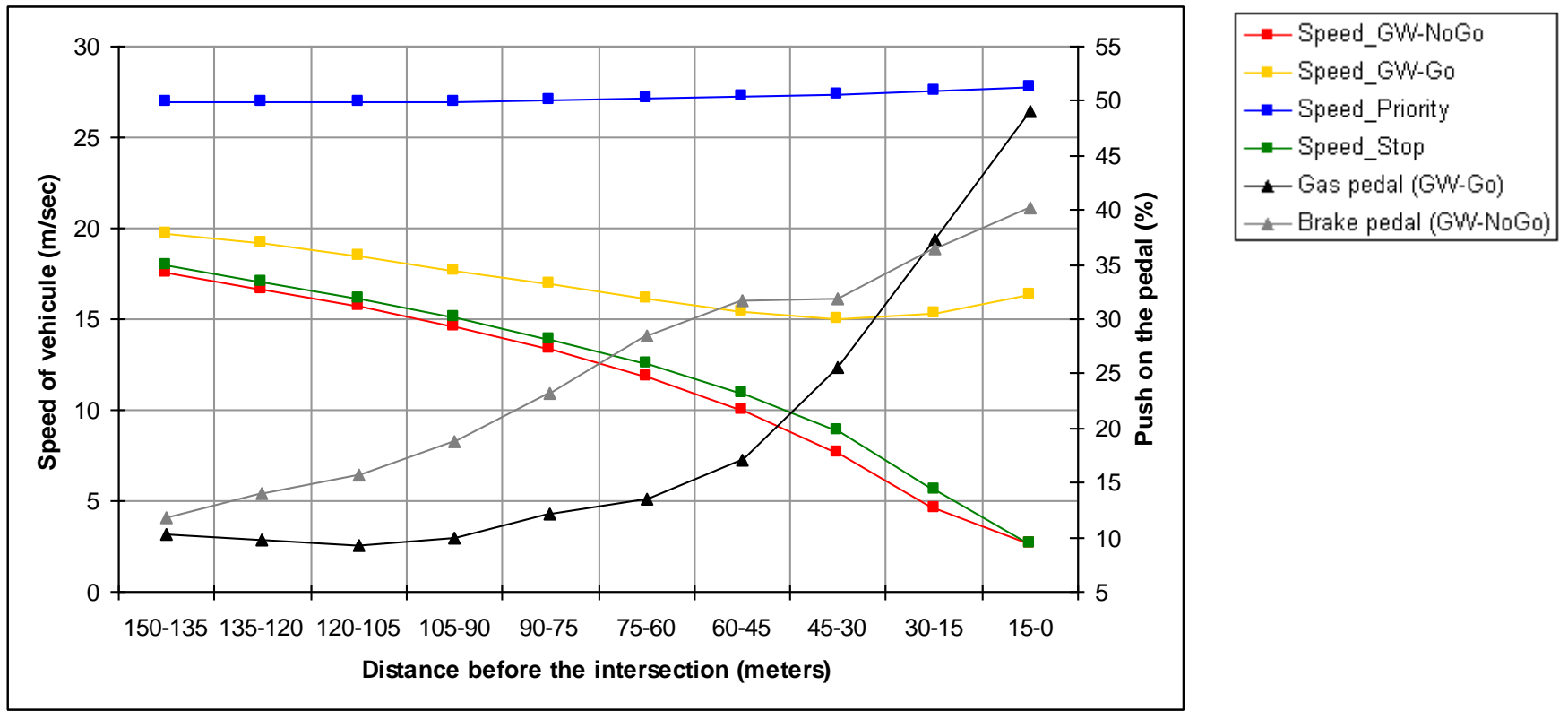
Priority



Independent variable of Situation

Results: Preliminary analyses: Situation / Position

Data analyses: Before / After



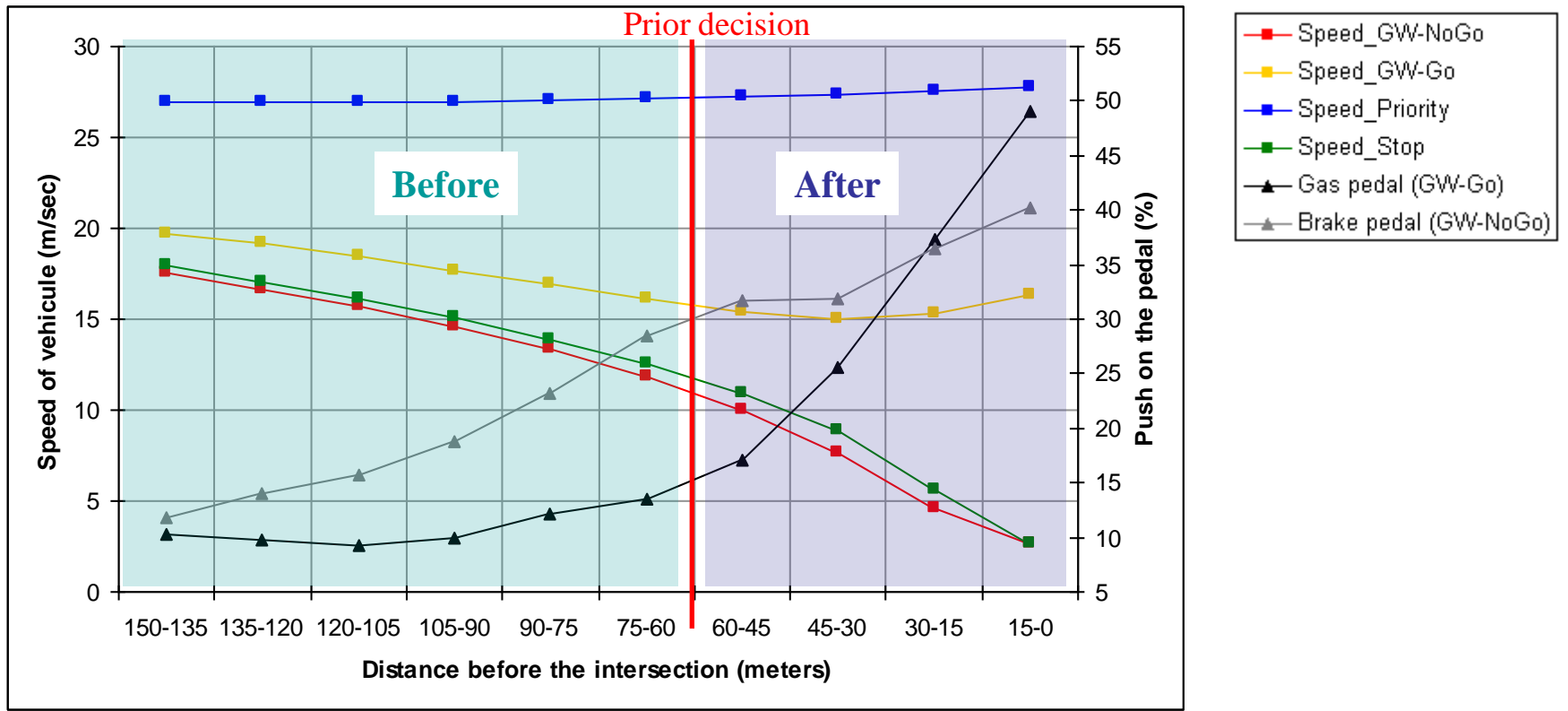
Newman-Kleus test:

- Brake pedal
- Gas pedal

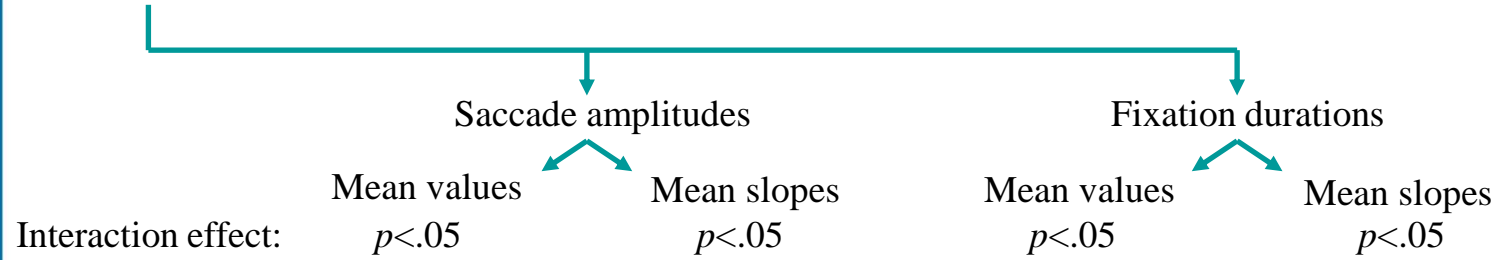
Distance	150-135	135-120	120-105	105-90	90-75	75-60	60-45	45-30	30-15	15-0
150-135		.474	.420	.141	.000	.000	.000	.000	.000	.000
135-120	.874		.843	.711	.013	.000	.000	.000	.000	.000
120-105	.940	.909		.856	.045	.000	.000	.000	.000	.000
105-90	.932	.843	.828		.059	.000	.000	.000	.000	.000
90-75	.610	.782	.815	.822		.012	.000	.000	.000	.000
75-60	.498	.572	.531	.574	.538		.041	.080	.001	.000
60-45	.025	.025	.013	.019	.055	.092		.919	.216	.001
45-30	.000	.000	.000	.000	.000	.000	.000		.116	.000
30-15	.000	.000	.000	.000	.000	.000	.000	.000		.024
15-0	.000	.000	.000	.000	.000	.000	.000	.000	.000	

Results: Preliminary analyses: Situation / Position

Data analyses: Before / After

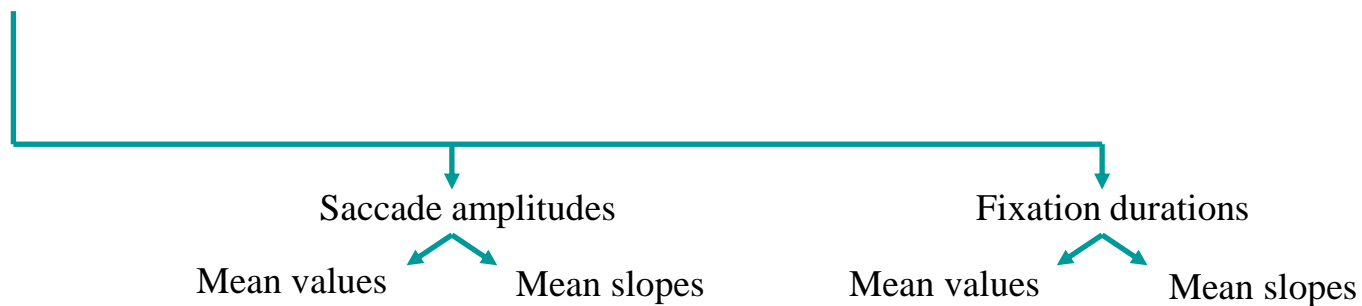


4x2 ANOVAs = Situation (Give Way Go / Give Way NoGo / Stop / Priority) x Position (Before / After)

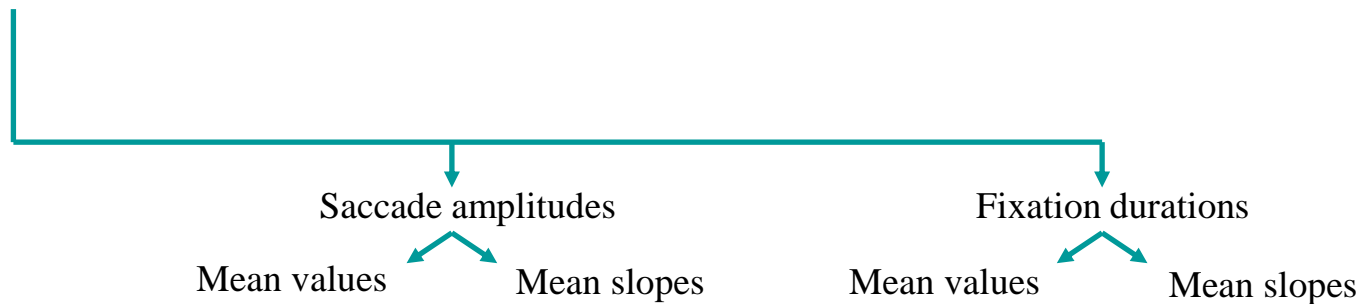


Consistency between the behavioral data and the oculomotor data.

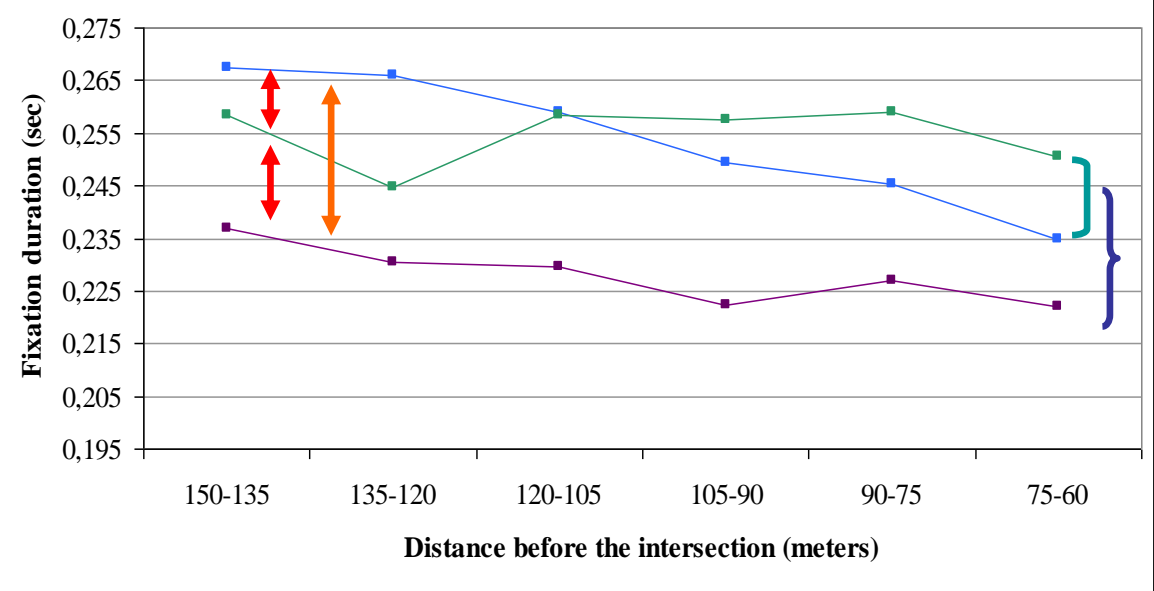
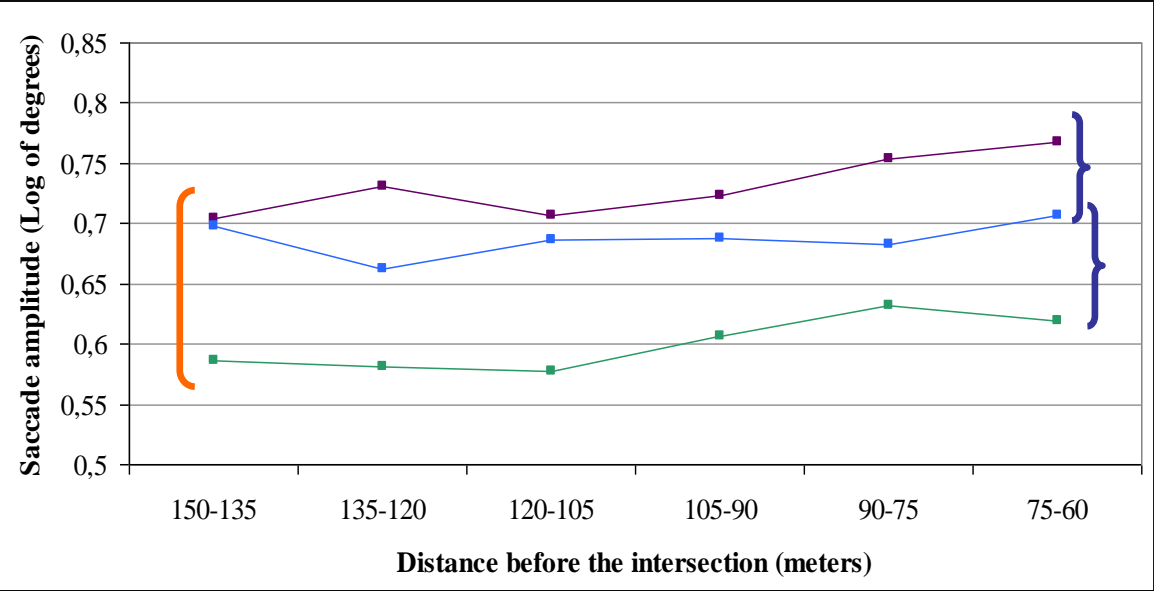
Before: Situation = Give Way + Stop + Priority



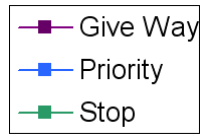
After: Situation = Give Way Go + Give Way NoGo + Stop + Priority



Data analyses: Before / After



Legend:

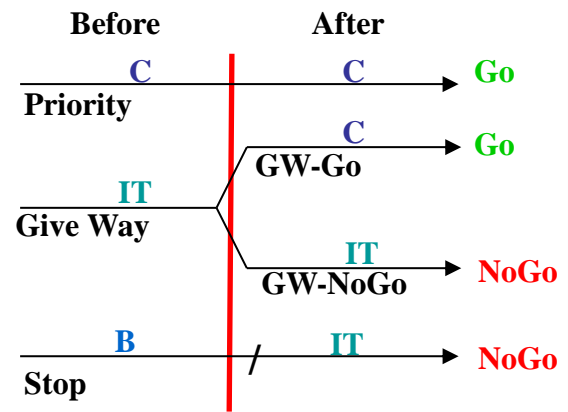


Mean values:
 Mean slopes:
 <math><.05 / *</math> (purple bracket)
 ns. (green bracket)
 <math><.05 / *</math> (red double arrow)
 ns. (orange double arrow)

Reminders:

Visual search \uparrow = Saccade amplitudes
 + Fixation durations \downarrow

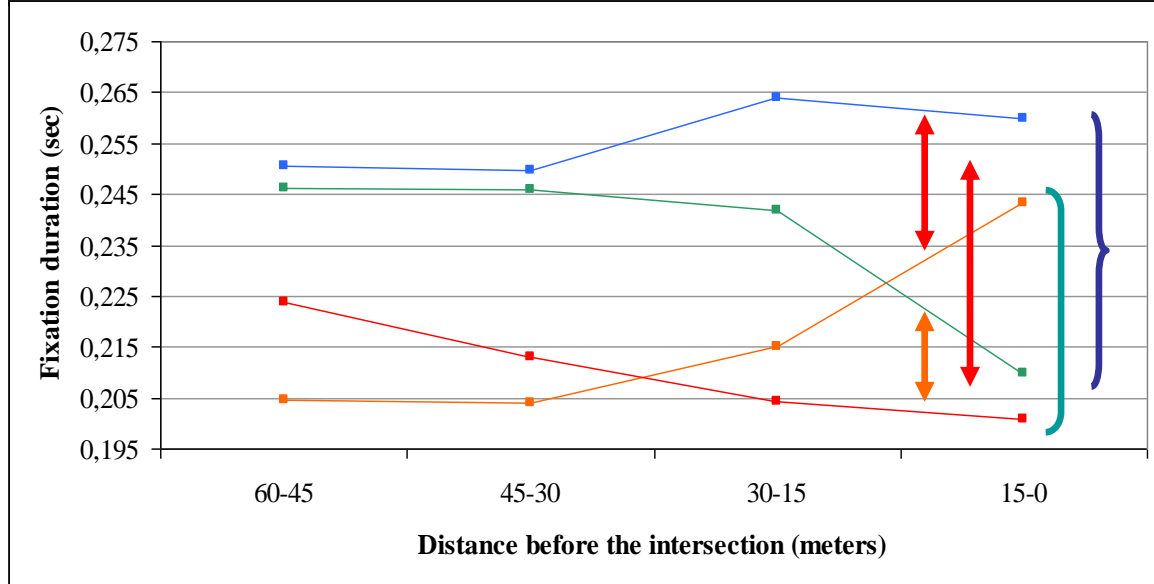
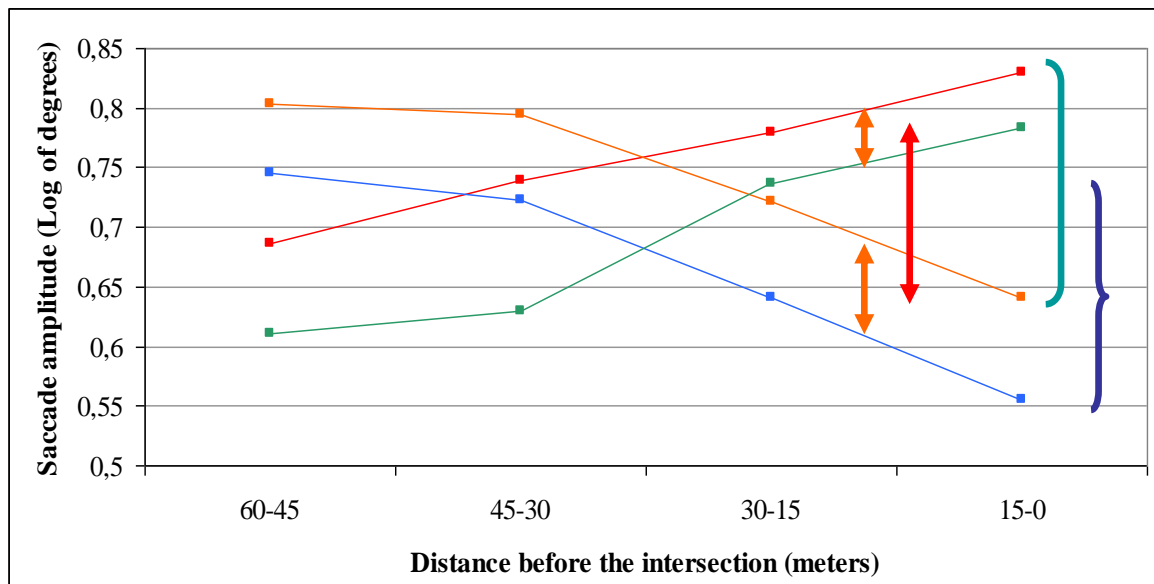
Reminders predictions:



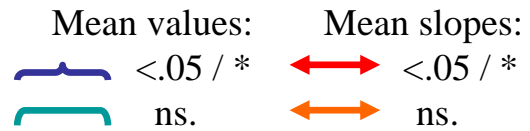
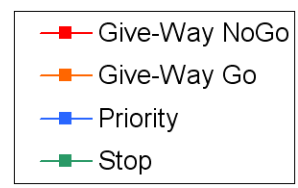
→ Visual search: Give Way (IT) > Priority (C) > Stop (B)

Results: Preliminary analyses: Situation / Position

Data analyses: Before / **After**



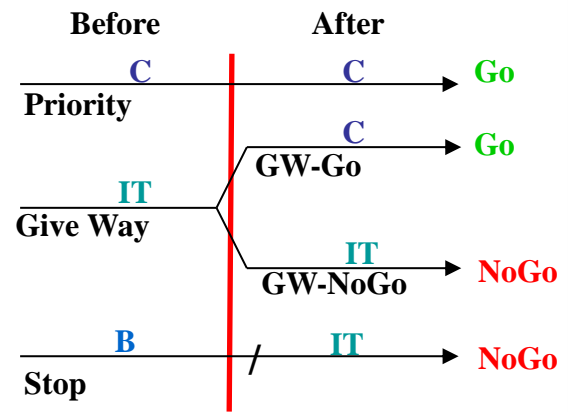
Legend:



Reminders:

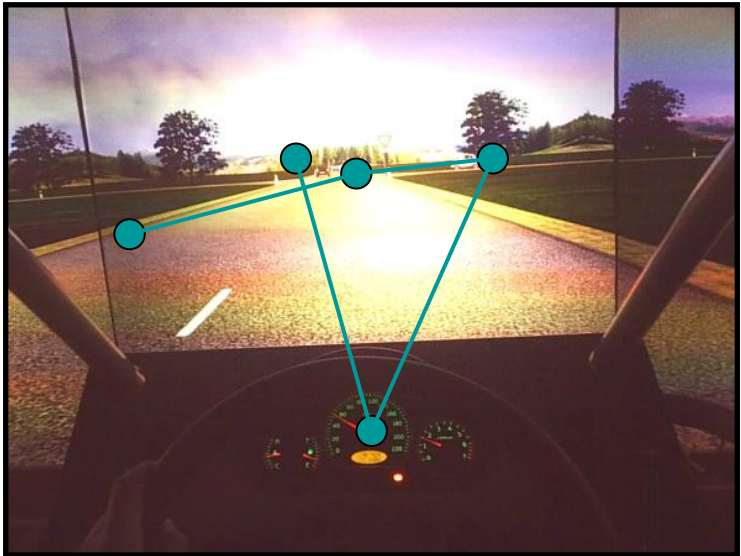
Visual search \uparrow
 = Saccade amplitudes
 + Fixation durations \downarrow

Reminders predictions:



→ Visual search:
 GiveWay NoGo(IT) = Stop(IT) > GiveWay Go(C) = Priority(C)

Eye movements:
saccade amplitudes + fixation durations



≠



Visual attention → decision-making task



= Process 1

≠



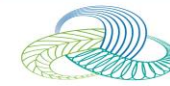
= Process 2

Thank you for your attention



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30-15	.000	.000	.000	.000	.000	.000	.000	.000		.024
15-0	.000	.000	.000	.000	.000	.000	.000	.000	.000	

