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Key results of the i-DREAMS project
Determinants of risk

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Final Event
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Background

The **cornerstone of the i-DREAMS platform** is the assessment of task complexity and coping capacity with regards to risk:

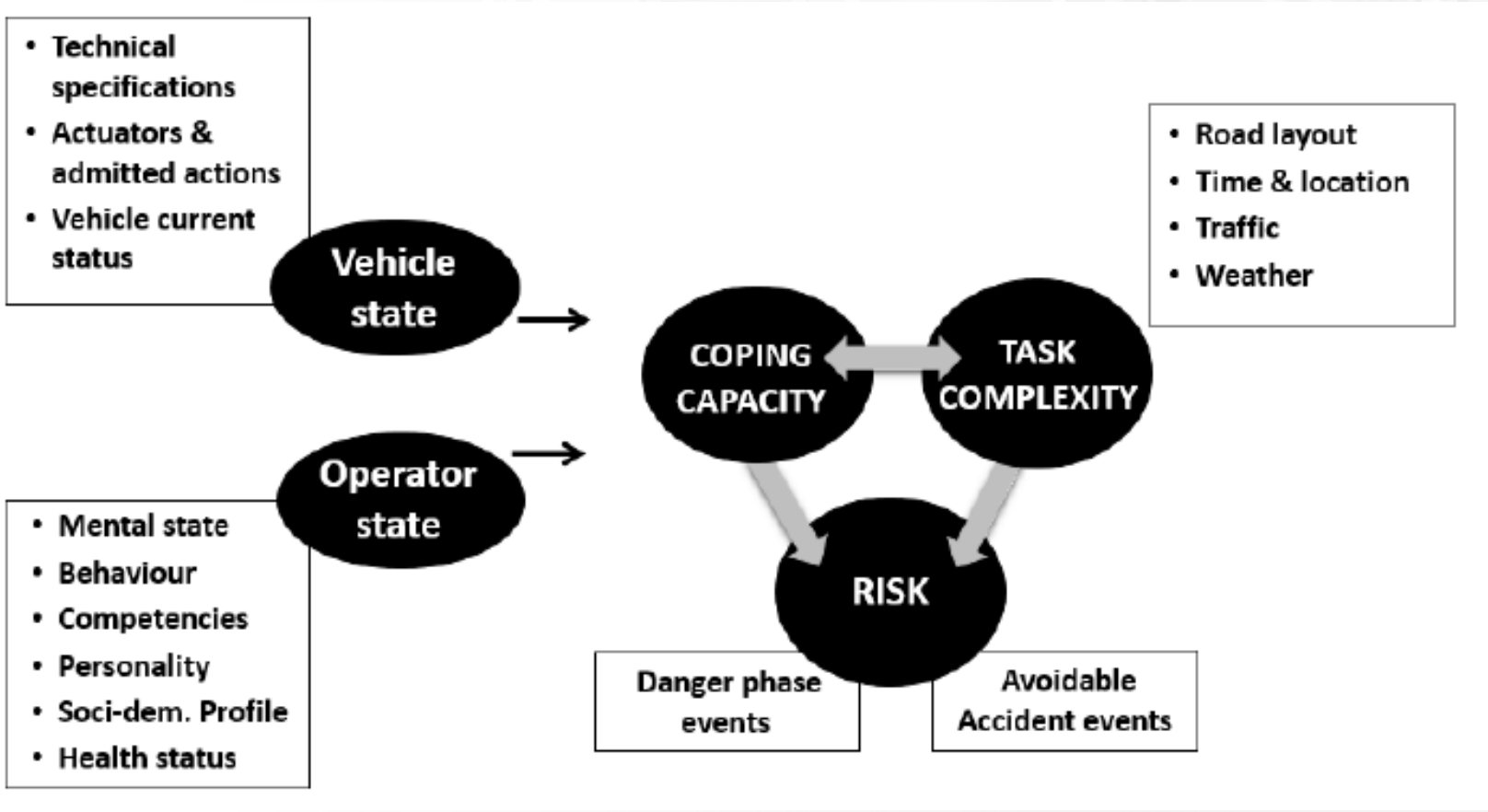
- **Task complexity** relates to the current status of the real world context in which a vehicle is being operated:
  - road layout (i.e. highway, rural, urban)
  - time and location
  - traffic volumes (i.e. high, medium, low)
  - weather conditions

- **Coping capacity** is dependent upon two underlying factors and it consists of several aspects:
  - **vehicle state** (e.g. technical specifications, actuators & admitted actions, current status)
  - **operator state** (e.g. mental state, behavior, competencies, personality, sociodemographic profile, health status)

Task complexity	Risk
Car wipers	Headway map levels
Car high beam	Speeding map levels
Time indicator	Overtaking map levels
Distance	Fatigue map levels
Duration	Harsh acceleration
Month	Harsh braking
Day of the week	Vehicle control events

Coping capacity - vehicle state	Coping capacity – operator state	
Vehicle age	Distance	Duration
First vehicle registration	Average speed	Headway
Fuel type	Harsh acceleration	Overtaking
Engine cubic	Harsh braking	Fatigue
Engine horsepower	Forward collision warning	Gender
Gearbox	Pedestrian collision warning	Age
Vehicle brand	Lane departure warning	Educational level

Overall concept



Objectives

Identification of the most **critical precursors of risk** from both the task complexity and the coping capacity (vehicle and operator state) side

Examination of the **effect of task complexity and coping capacity** on risk across the phases of i-DREAMS road-trial

Development of an **integrated model** for understanding the effect of driver-vehicle-environment interaction with risk

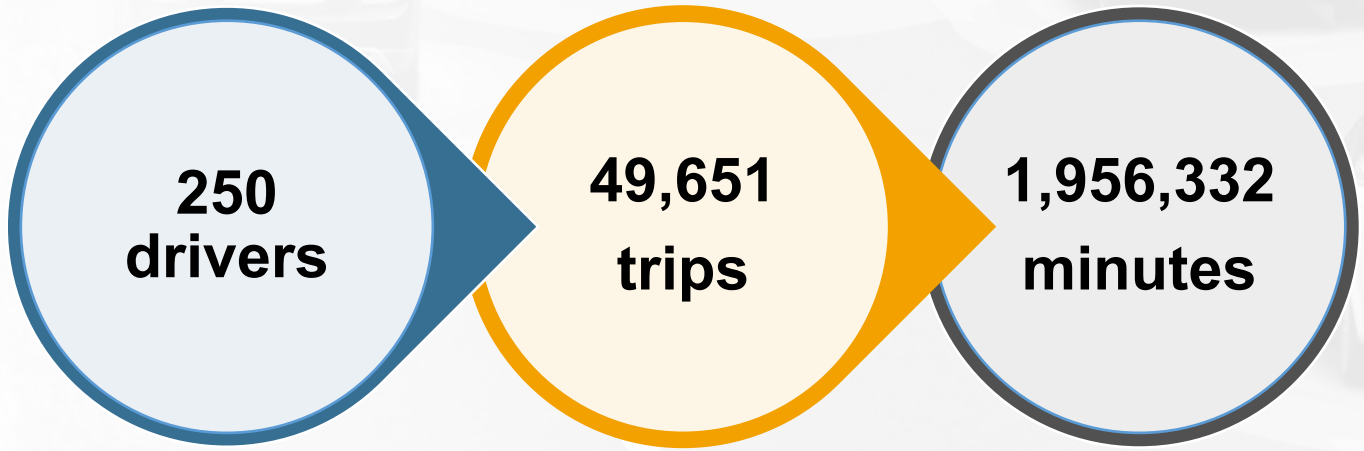
Comparison of the performance of such model on different countries

Data collection

- A **naturalistic driving experiment** was carried out involving 250 drivers from Belgium, UK, Germany, Greece and Portugal and a large database consisting of 49,651 trips was created
- **Questionnaire data** were also collected both before and after the field trials

Belgium trucks	**Belgium** cars	**UK** cars	**Germany** cars	**Greece** cars	**Portugal** buses
• 23 drivers • 6,346 trips • 59,0356 minutes	• 51 drivers • 7,163 trips • 147,337 minutes	• 54 drivers • 14,401 trips • 268,841 minutes	• 28 drivers • 5,344 trips • 84,434 minutes	• 65 drivers • 9,066 trips • 161,443 minutes	• 29 drivers • 7,331 trips • 703,921 minutes

Total



Experiment phases

Phase 1 (Baseline)

- **Intervention:** NO
- **Description**: a reference period after the installation of i-DREAMS system to monitor driving behaviour without interventions
- **Duration**: 4 weeks

Phase 2

- **Intervention**: Real-time
- **Description**: a monitoring period during which only in vehicle real-time warnings provided using adaptive ADAS
- **Duration**: 4 weeks

Phase 3

- **Intervention**: Real-time + Post-trip
- **Description**: a monitoring period during which in addition to real-time in vehicle warnings, drivers received feedback on their driving performance through the app
- **Duration**: 4 weeks

Phase 4

- **Intervention**: Real-time + Post-trip + Gamification
- **Description**: a monitoring period during which in vehicle real-time interventions were active along with feedback but at the same time gamification elements were also active
- **Duration**: 6 weeks

Methodology

STZ level:
normal phase, danger phase & avoidable accident phase

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Particular emphasis was given to:
speeding, headway, overtaking, fatigue, harsh acceleration & harsh braking

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Explanatory analyses were performed:
Generalized Linear Models

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Latent constructs were implemented:
Structural Equation Models - the most appropriate technique to identify the relationship between observed (e.g. number of speeding events) and latent or unobserved variables (e.g. crash risk)

↓

Machine learning algorithms were applied:
- **Real-time:** Neural Networks, Long Short-Term Memory Networks
- **Post-trip:** Grouped Random Parameters Binary Logit Models, Ordered Probit Fractional Split Models

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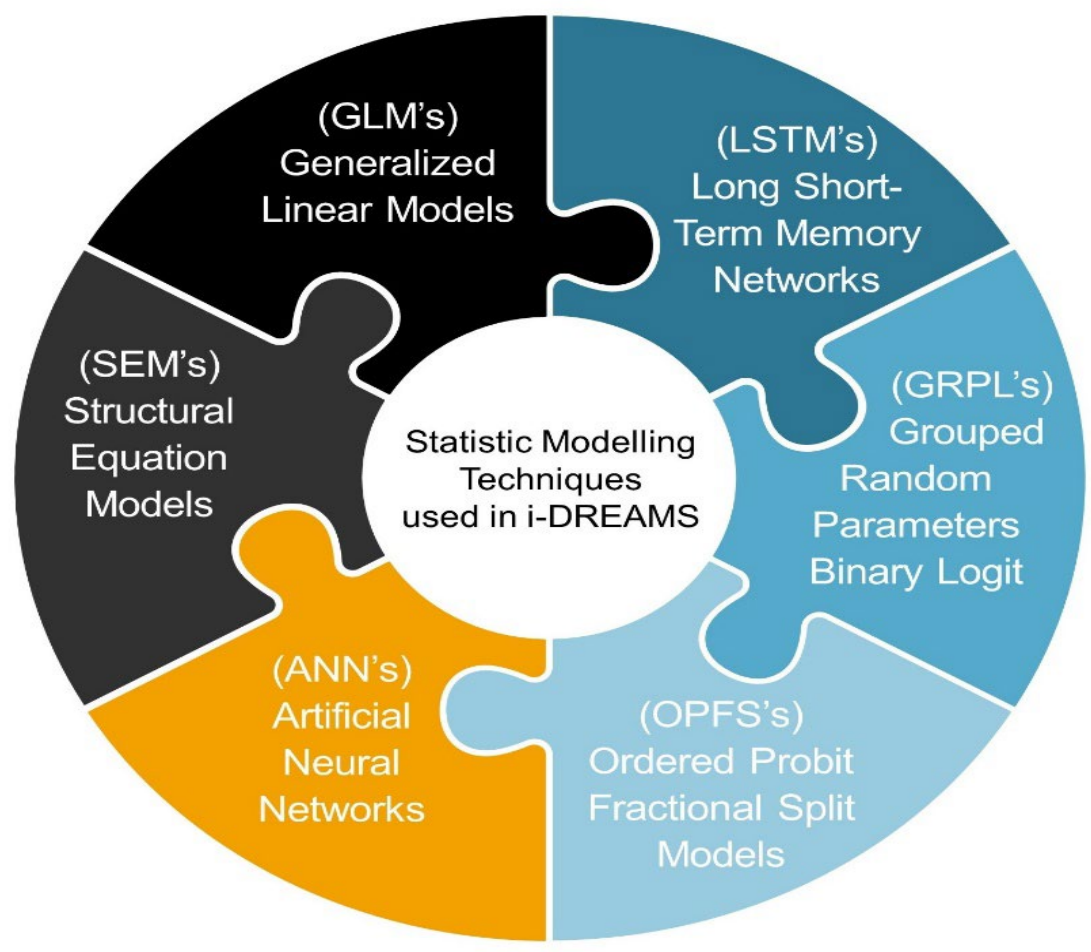
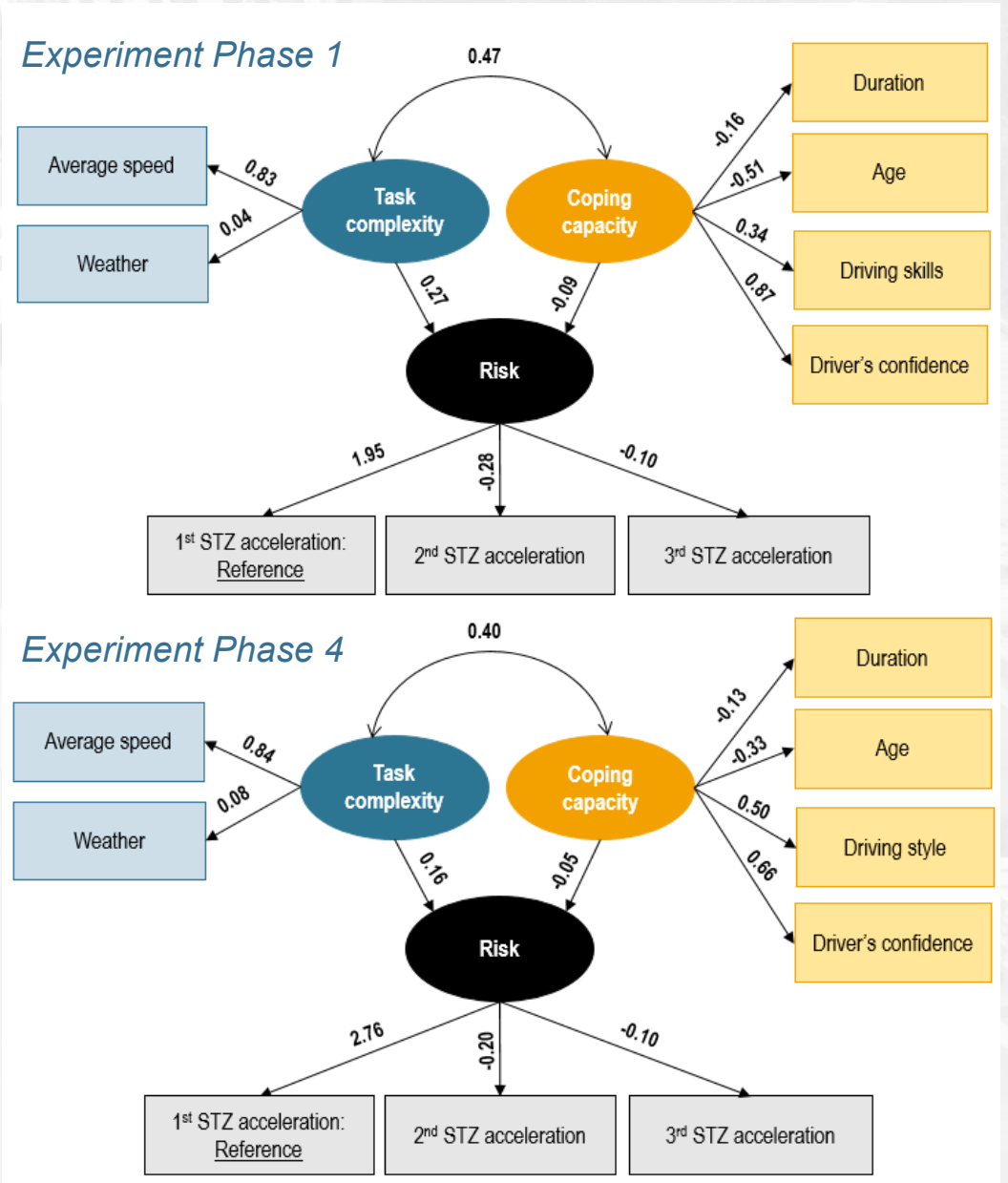
Overall validation and quality performance assessment:
- satisfactory results
- statistical significance
- high prediction accuracy



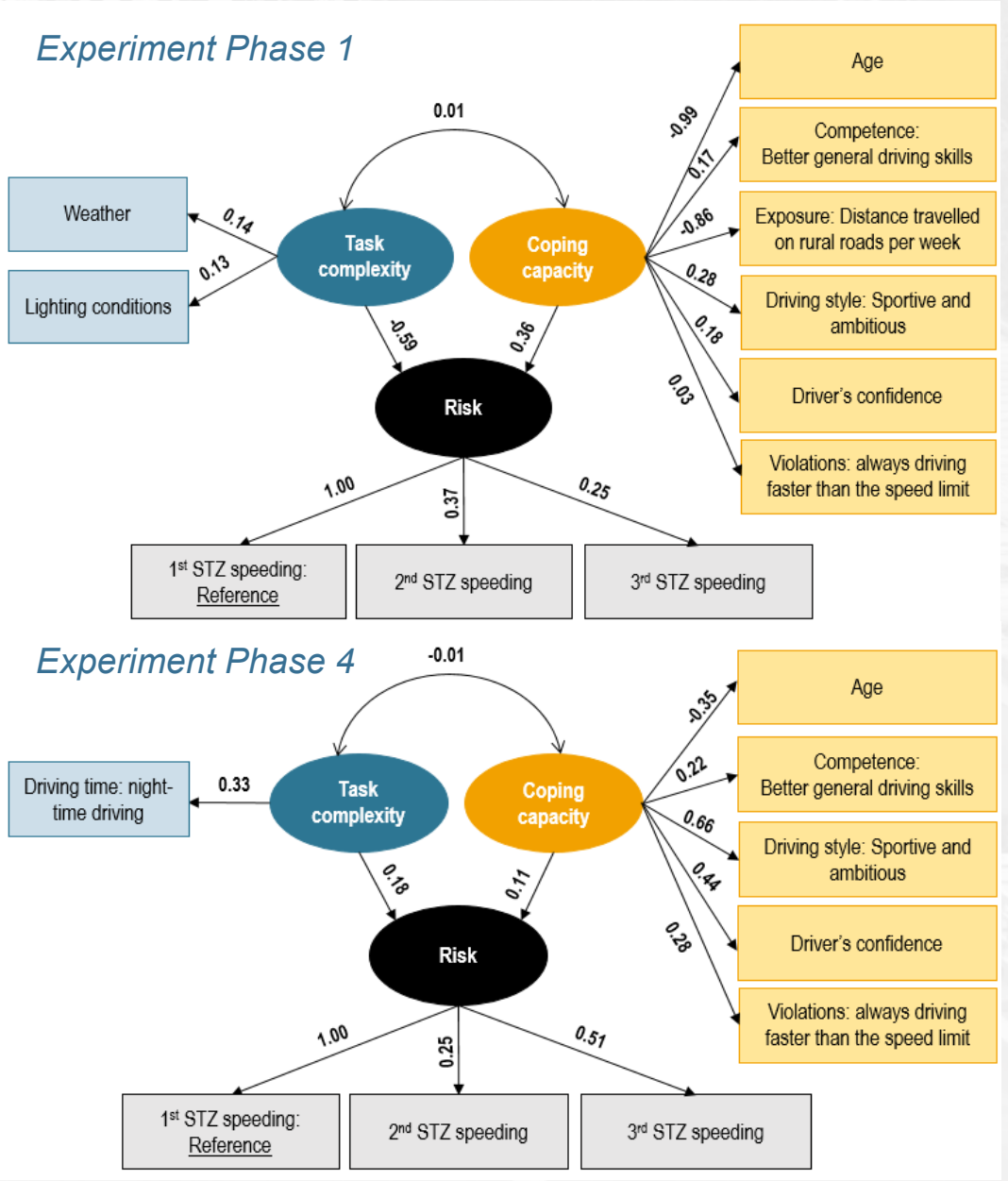
Belgium - trucks

- Higher task complexity is **associated with higher coping capacity** implying that drivers coping capacity increases as the complexity of driving task increases
- Younger, more confident truck drivers exhibited **(higher risk) lower normal driving** in this experiment, in terms of exceeding the STZ acceleration boundaries, without however taking into account the variations of their state during these trips
- The loadings of the observed proportions of the STZ of acceleration are **consistent among the different phases**. The loading of 1st STZ level becomes notably higher in phase 4 of the experiment. This may indicate that drivers tend to have normal behaviour in phase 4 in the presence of all interventions



Belgium - cars

- Task complexity and coping capacity **were positively correlated** in the majority of the models, which means that with higher task complexity comes higher coping capacity
- **Greater loadings** of task complexity on risk were identified, but that effect dropped when observing trips from phase 1 to phase 4 of the experiment
- In many of the developed models, the loadings revealed a spike in their values during phase 3 of the experiment and a small drop in phase 4, which points to the fact that the combination of real-time and post-trip feedback **significantly influenced** the relationship between task complexity, coping capacity and risk

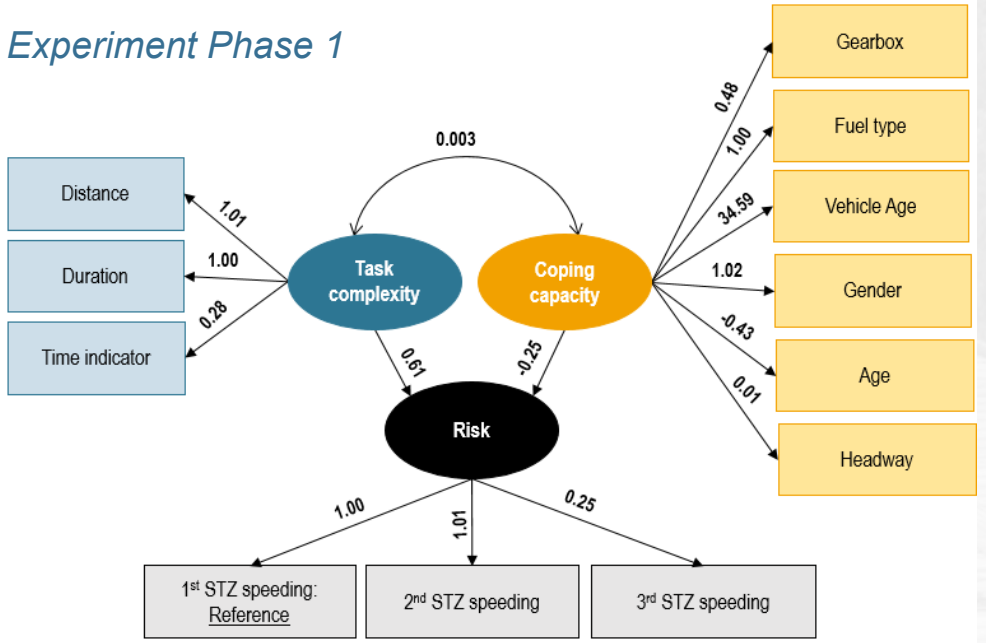


Germany - cars

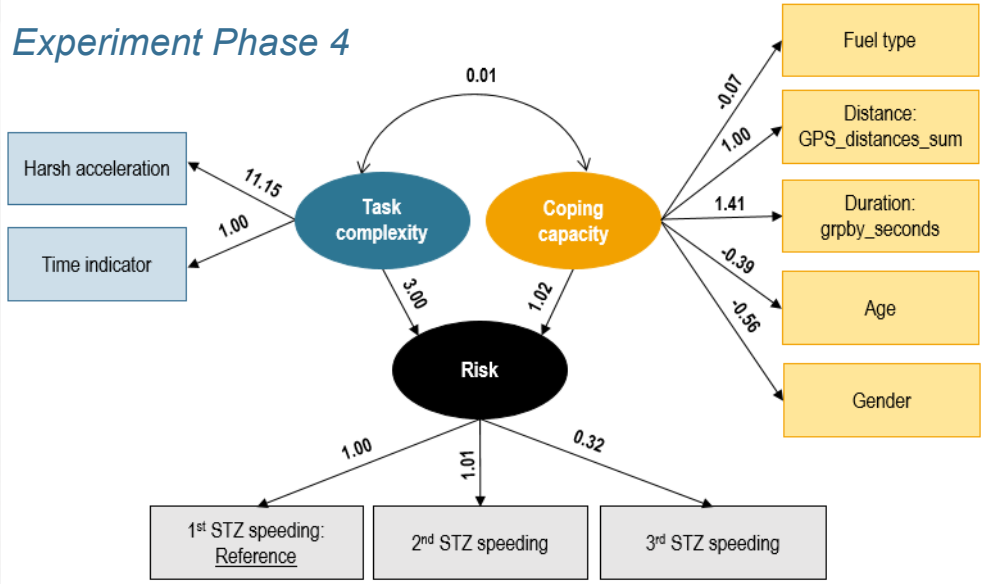
- In Germany, the model for speeding revealed a **positive correlation** of task complexity and coping capacity with risk, but with the largest correlation in phase 2 of the experiment, where real-time warnings were introduced

- At the end of the experiment (phase 4), coping capacity was found to have its **largest correlation** with risk, while task complexity had its greatest loading during phase 3 of the experiment

Experiment Phase 1



Experiment Phase 4

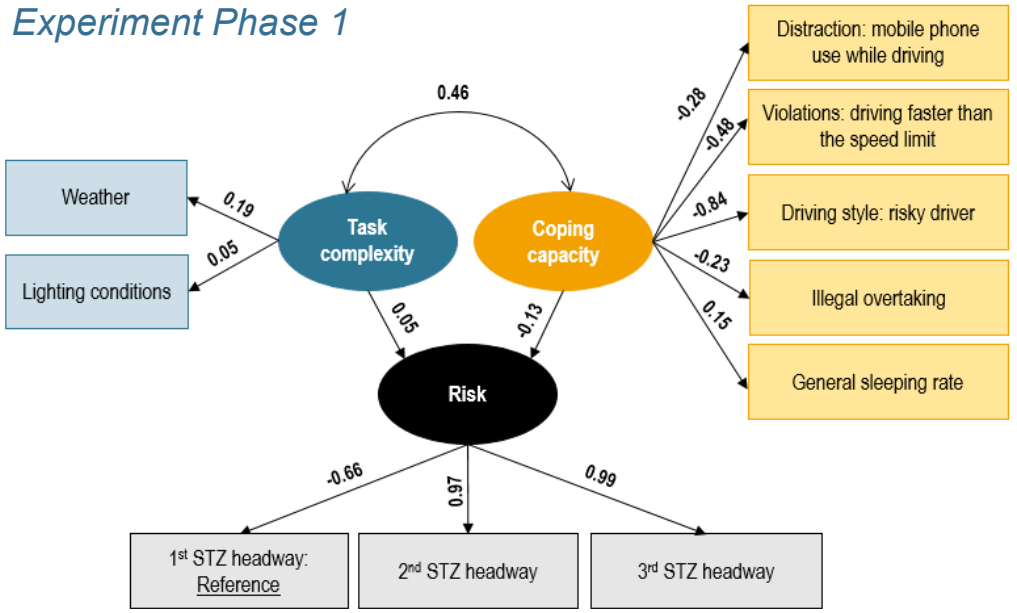


UK - cars

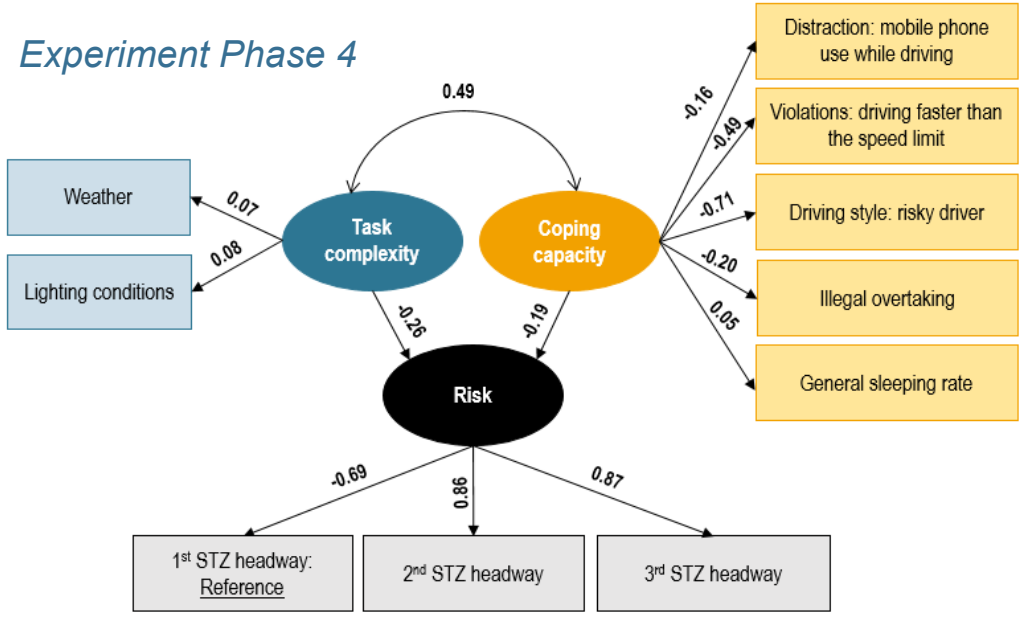
- In UK, loadings from the SEM models demonstrate that coping capacity and task complexity **were positively correlated** in phase 1 and 3, but had no significant relationship in phase 2 and phase 4

- Like in Belgium, task complexity had a **stronger impact** on risk, with phase 3 showing the greatest effect

Experiment Phase 1



Experiment Phase 4



Greece - cars

- XXX

Portugal - buses

- XXX

Discussion

- For the majority of the risk factors investigated, it was found that higher task complexity levels lead to higher coping capacity with the drivers. This means that drivers, when faced with difficult conditions, **tend to regulate well their capacity** to apprehend potential difficulties, while driving

- When looking into the **relationship among the interaction** of task complexity and coping capacity and its effect on risk, in Belgium and Germany, the influence of task complexity on risk was greater than the effect of coping capacity. Mixed results were observed in the UK

- The comparison of models fitted on data from the different phases of the experiments, validated that in the majority of the countries the interventions had a **positive influence on risk compensation**, increasing the coping capacity of the drivers and reducing the risk of dangerous driving behaviour

Country (transport mode)	Indicator	Phase 1		Phase 2		Phase 3		Phase 4	
		TC	CC	TC	CC	TC	CC	TC	CC
Belgium (cars)	speeding	-	+	-	+	-	+	+	+
	headway	-	+	-	+	-	-	-	+
Belgium (trucks)	speeding	-	-	-	-	-	-	-	-
	ha	+	-	+	-	+	-	+	-
	headway	-	-	-	-	-	-	+	-
UK (cars)	headway	-	-	+	-	-	-	-	-
Germany (cars)	speeding	+	-	+	-	+	-	+	+
Greece (cars)	speeding	+	-	+	-	+	-	+	-
	headway	+	-	+	-	+	-	+	-

**TC refers to Task Complexity and CC refers to Coping Capacity*

Challenges

- **Not an easy process** to create an integrated dataset for the analysis

- **More effort** than expected to prepare the dataset because of the different complexities:
  - linked underlying datasets
  - time synchronization
  - data/variables definitions
  - missing data

- Naturalistic data were **'dirty'** and therefore a lot of time was needed to process them

Team effort *was the key for successful data processing and statistical analyses*

Conclusions

- The i-DREAMS system itself can directly **improve safety once launched**, but also additional safety benefits can be envisaged in the medium and long term as it is built on and further adapted to different contexts and industry needs, thanks to its modular nature

- The **integrated treatment** of task complexity, coping capacity and risk can improve behavior and safety of all travellers and all transport modes, through the unobtrusive and seamless monitoring of behaviour

- **Authorities may use data systems** at population level to plan mobility and safety interventions, set up road user incentives, optimize enforcement and enhance community building on safe travelling

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