Quantifying the Impacts of Real-time Travel Information on Route Choice Behavior using Psychophysiological Analysis

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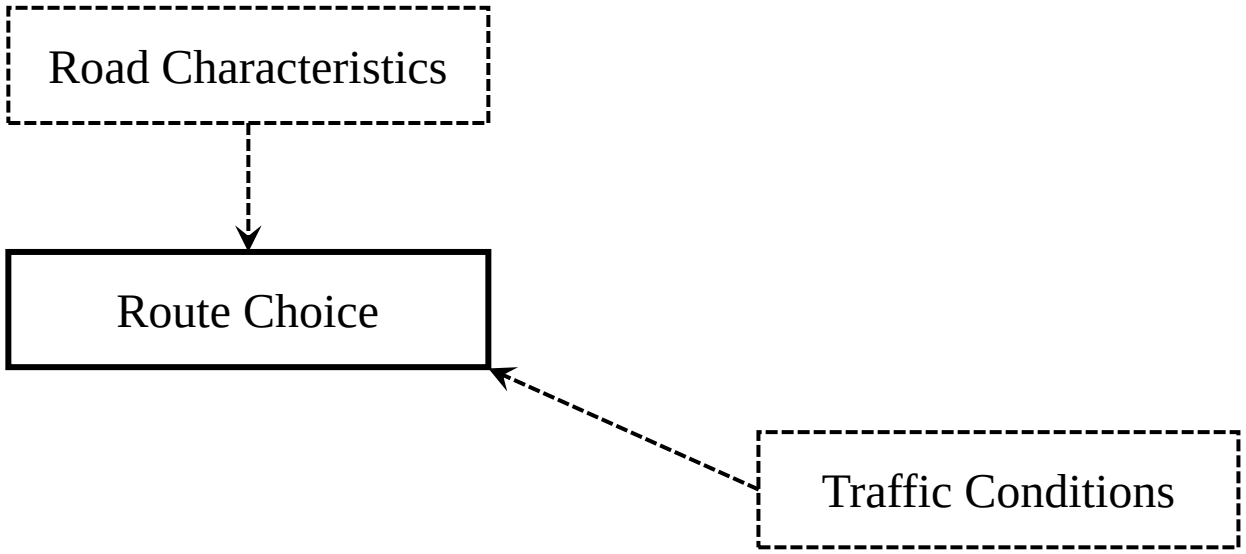
Introduction

- Route choice behavior
  - Individual response
  - Collective response

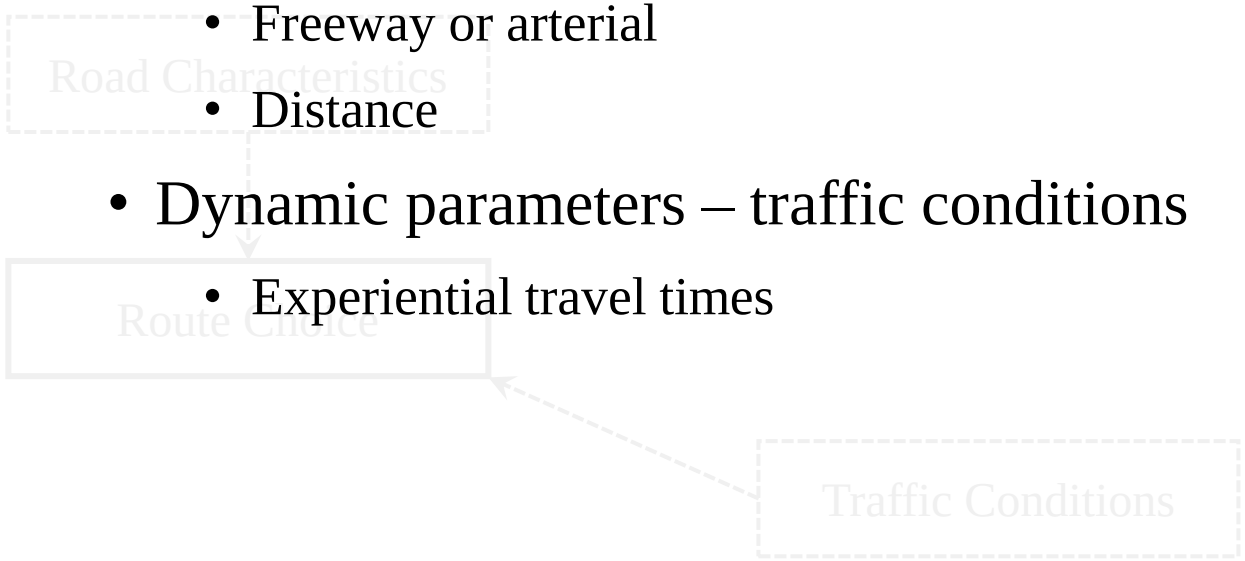
- Individual response
  - Rational choice utility theory
  - Expected utility theory
  - Prospect theory
  - Regret theory, etc.

Route Choice Behavior Model

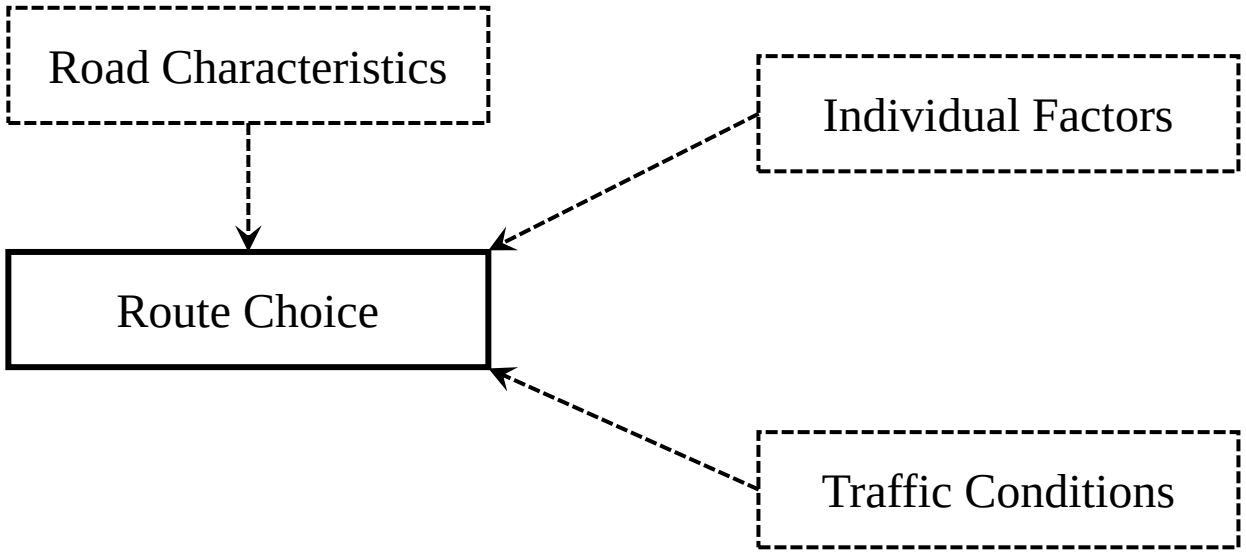


Route Choice Behavior Model

- Early research
  - Static parameters – road/route characteristics
    - Freeway or arterial
    - Distance
  - Dynamic parameters – traffic conditions
    - Experiential travel times



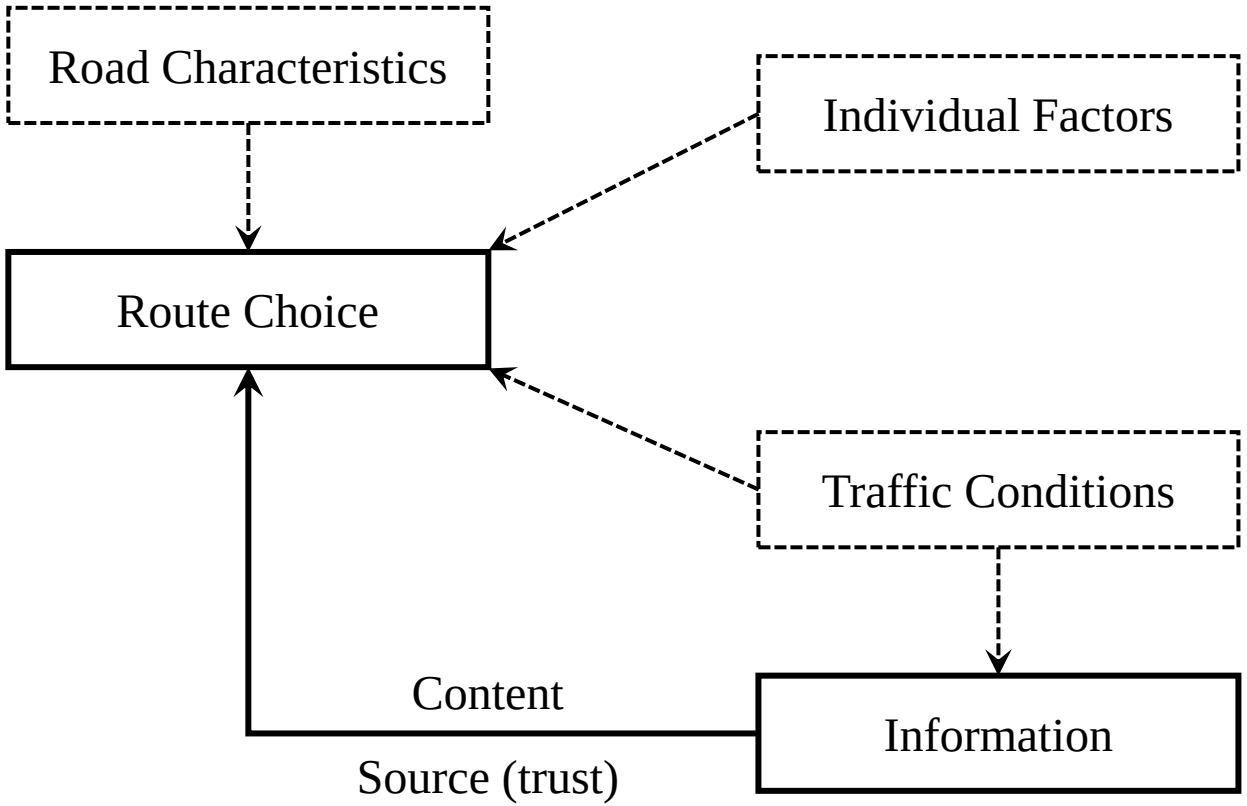
Route Choice Behavior Model



Route Choice Behavior Model

- Individualized parameters – population heterogeneity
  - Route familiarity
    - Experience
  - Individual attributes
    - Sociodemographic characteristics
    - Attitudes and beliefs
  - Trip characteristics
    - Trip purpose

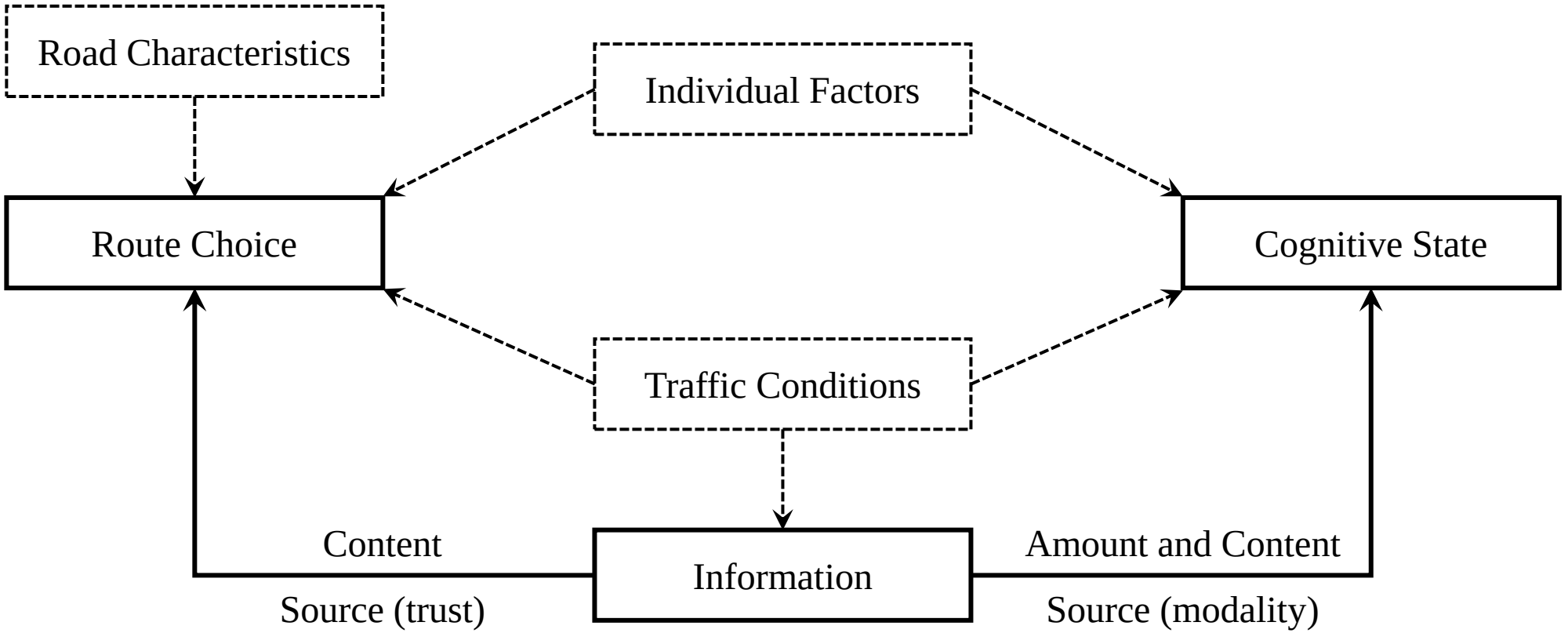
Route Choice Behavior Model



Route Choice Behavior – Information

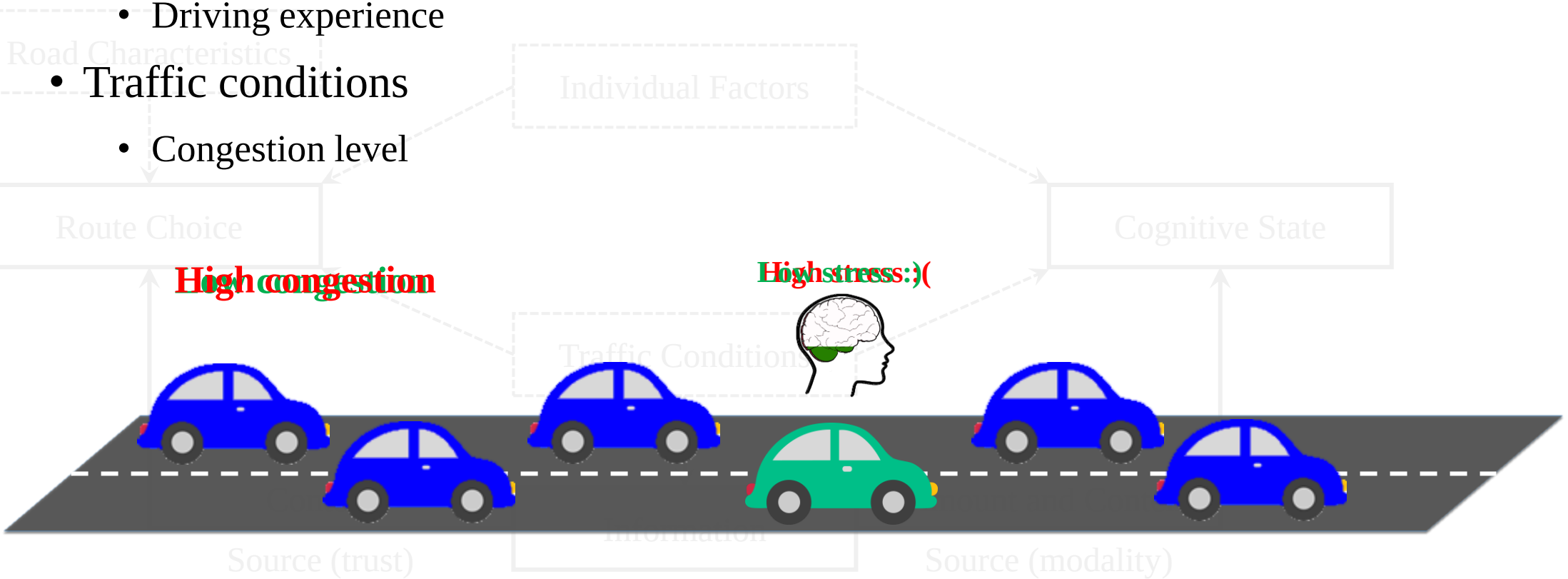
- Advanced Travel Information System (ATIS)
  - Provides real-time travel information related to traveler's situation
  - Leverages new technologies to deliver information
- Information characteristics
  - Content
    - Descriptive
    - Prescriptive
  - Source (trust)
    - Public infrastructure (e.g. variable message sign)
    - Personal device (e.g. smartphone using Google maps)

Route Choice Behavior Model



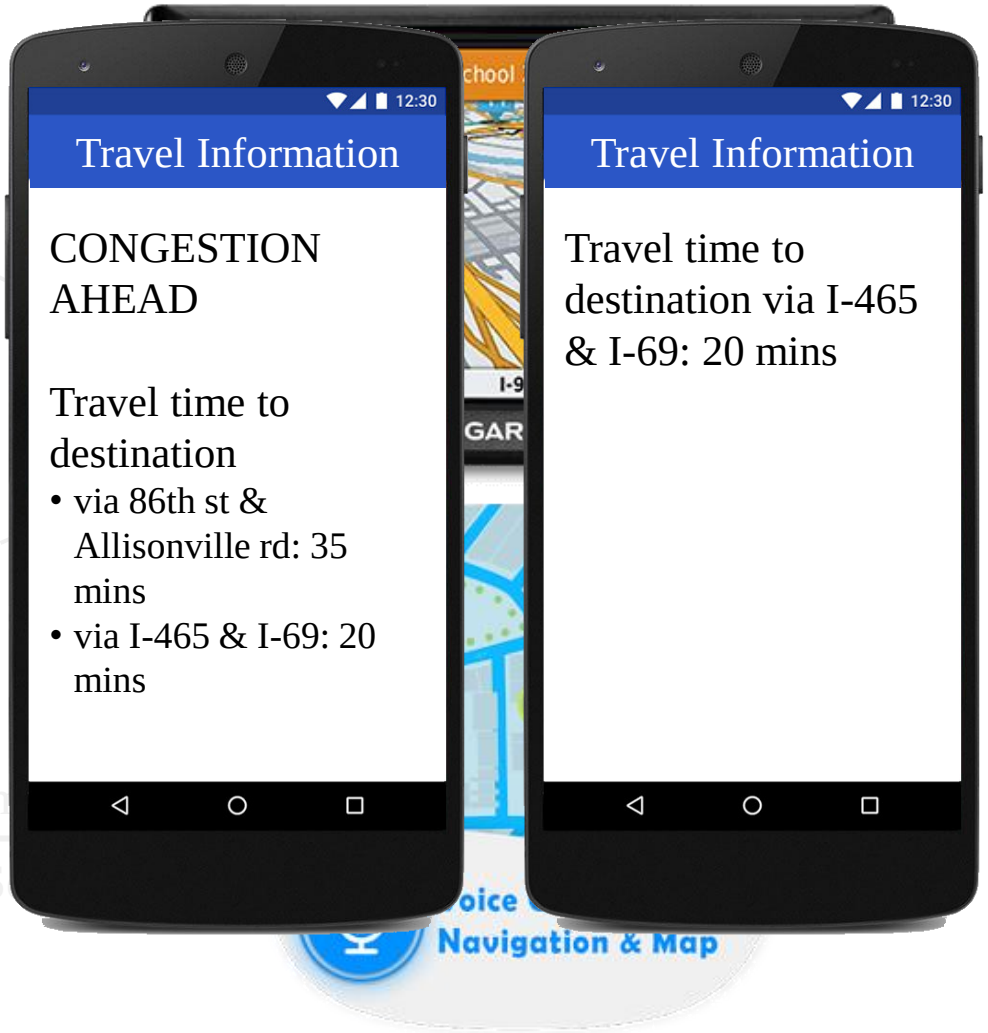
Route Choice Behavior – Driver Cognition

- Determining impacts on driver cognition/psychology
  - Individual factors
    - Driving experience
  - Traffic conditions
    - Congestion level

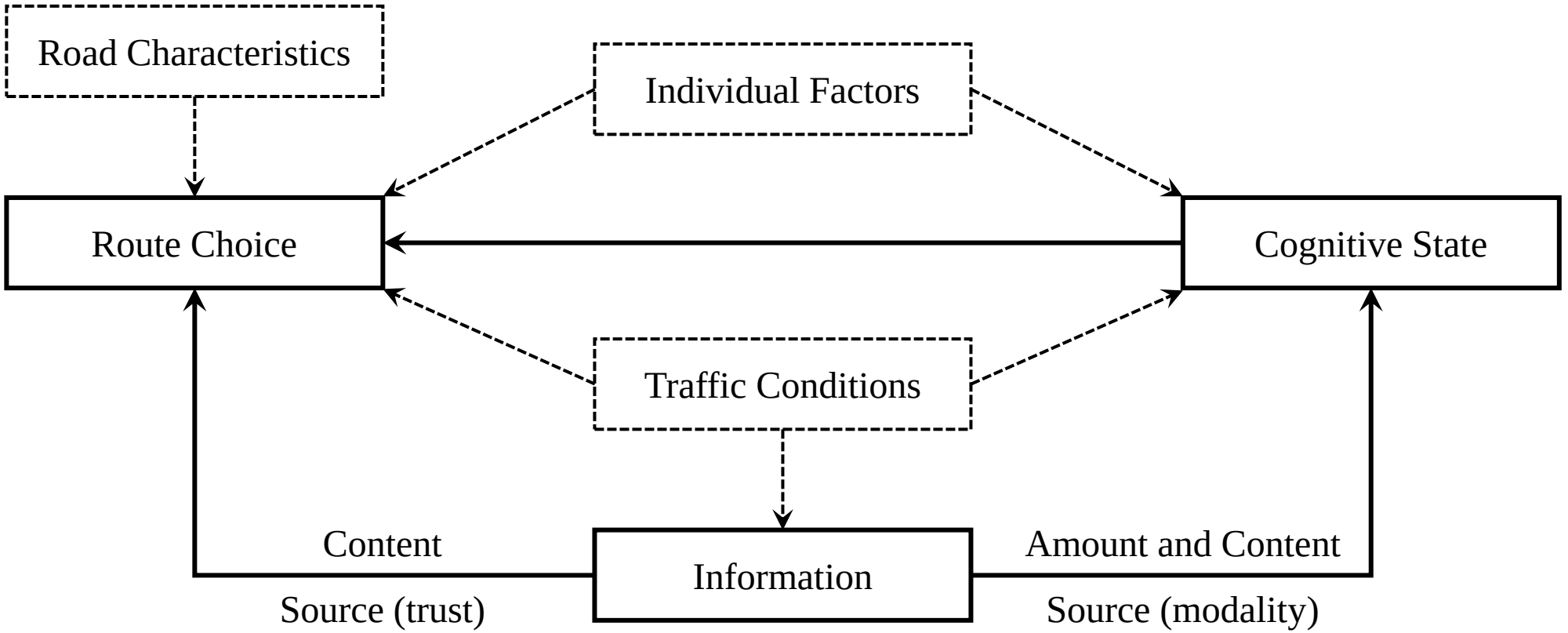


Route Choice Behavior – Driver Cognition

- Determining impacts on driver cognition/psychology
  - Individual factors
    - Driving experience
  - Traffic conditions
    - Congestion level
  - Information characteristics
    - Amount and Content
    - Source (modality)



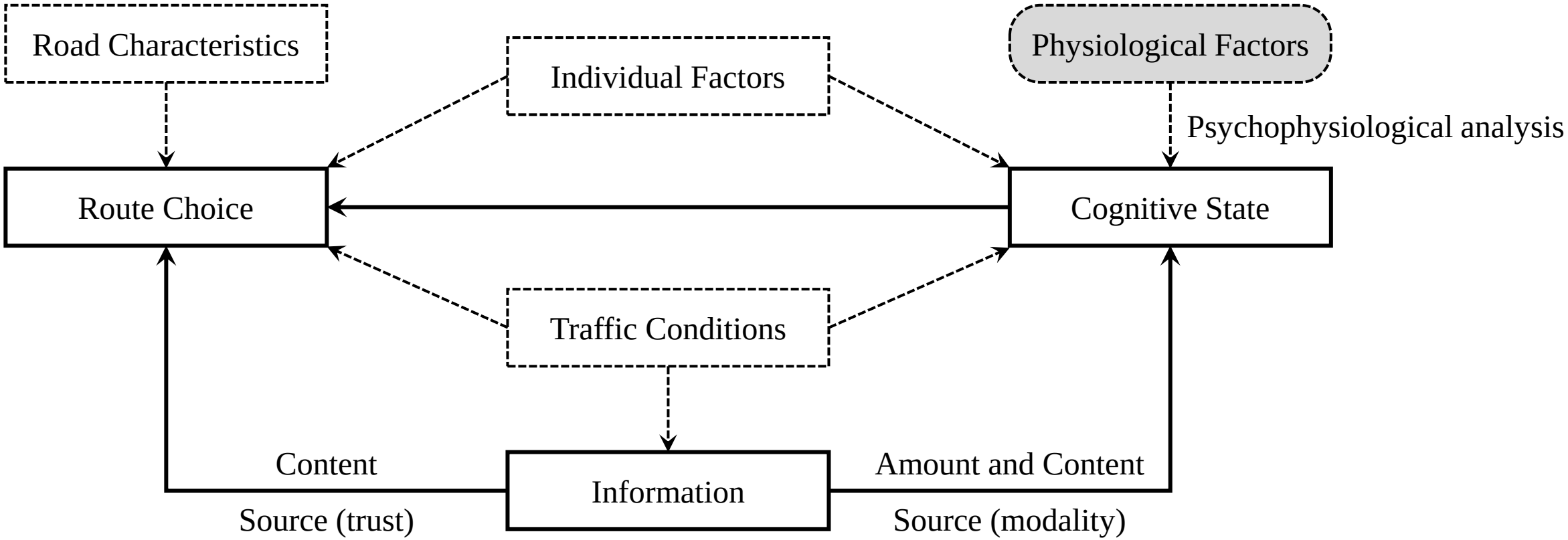
Route Choice Behavior Model



Route Choice Behavior – Cognitive Effects

- Impacts of driver cognitive state on route choice behavior under real-time travel information
  - Increasing amount of information from multiple sources
    - Consumes driver's cognitive resources
    - Affects driving performance and route choice decisions
  - Sparse research
    - Hybrid route choice models using latent variables approach
  - Challenges
    - Driver cognitive/psychological state is not observable
    - Self-reported survey based metrics are biased

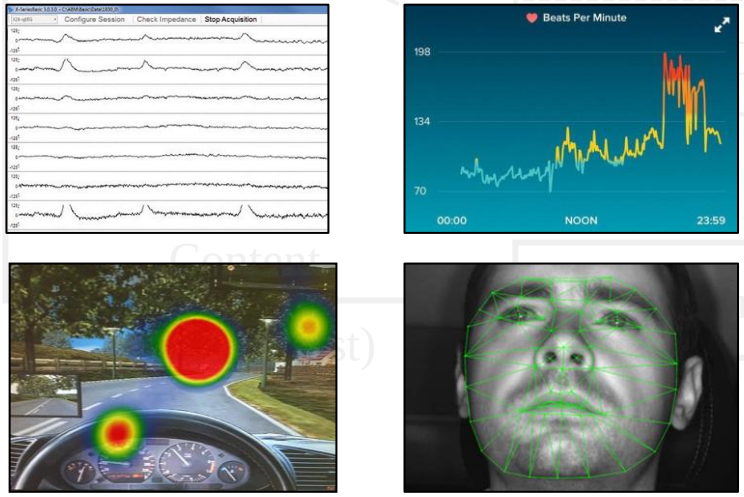
Route Choice Behavior Model



Route Choice Behavior – Psychophysiological Analysis

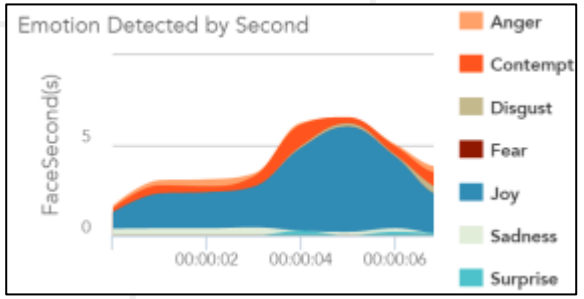
- Measure driver cognitive state under real-time information provision in a tangible manner
  - Collect physiological data using biosensors
    - Brain electrical activity, heart rate, eye movements, facial expressions, etc.
  - Estimate cognitive state using psychophysiological analysis
    - Mental workload, task engagement, etc.

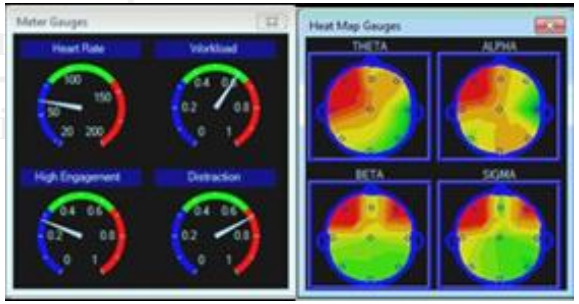
Physiological data



Psychophysiological Analysis

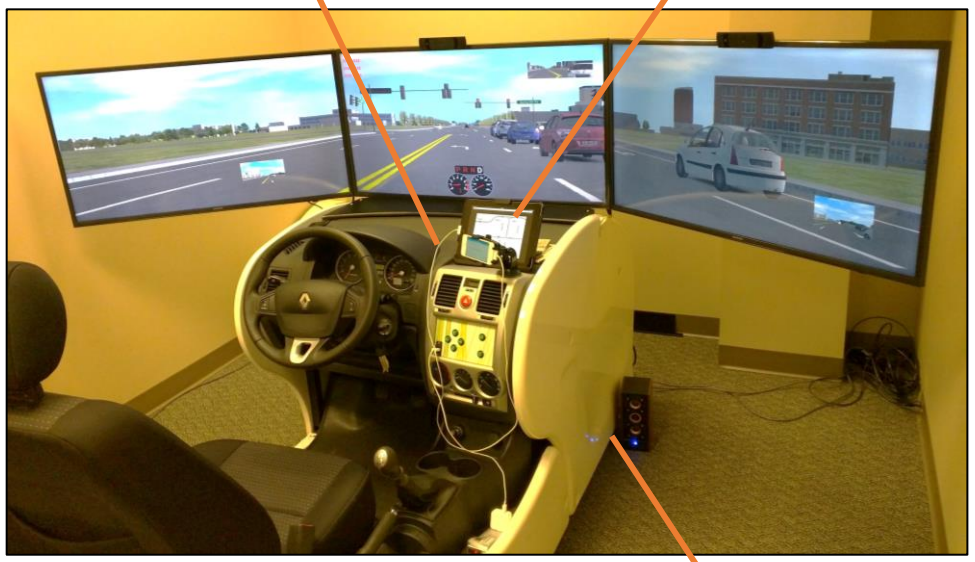
Cognitive state

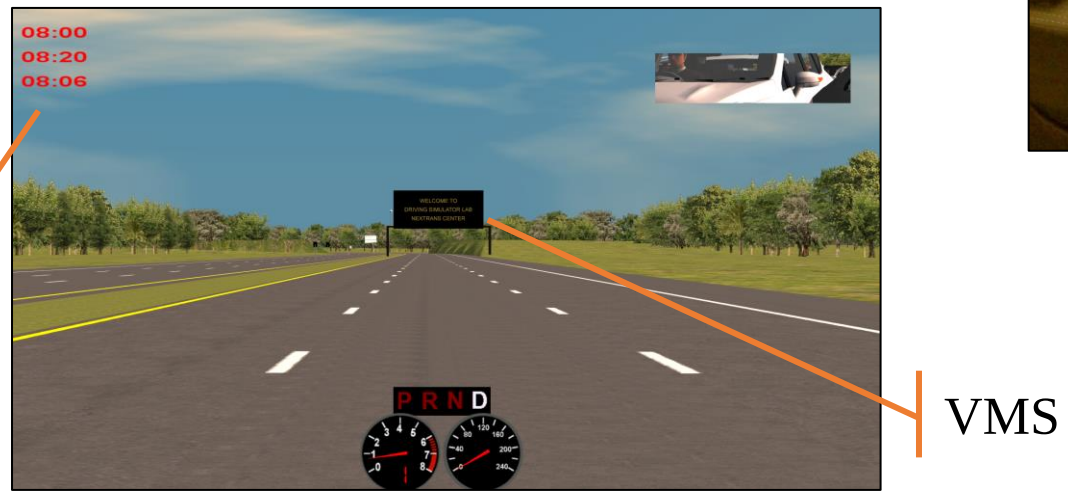




Driving Simulator Experiments (Ongoing)

- Real-world road network (Northern Indianapolis)
- Dynamic and responsive ambient traffic
- Multiple information sources





Measuring Driver Cognitive State

- EEG (electroencephalogram) records electric signals from brain
  - Compute workload and engagement level
    - Workload: related to working memory and problem solving
    - Engagement: related to sensory engagement
- ECG (electrocardiogram) records electrical activity of heart
  - Compute stress using average heart rate and its variability
- Eye tracker
  - Tracks eye gaze, blink rate, pupil size
  - Provides statistics about eye movements in area-of-interest
    - Area-of-interests can be VMS, traffic signals and signs, smartphone, GPS, dashboard, etc.

Integrated Analysis of EEG and Eye Tracker Data

- EEG data can be used to estimate driver cognitive state (i.e. workload or sensory engagement), but not its cause
  - Driver can be thinking about an important meeting
- Eye tracker data (along with driving and traffic data) can be used to infer the cause of driver's cognitive state
  - Model eye gazing pattern and cognitive state to determine the potential cause
- Segregate driver cognitive state caused by driving and non-driving activities
  - Improved understanding of role of real-time information on driver cognition

PURDUE UNIVERSITY

DRIVING SIMULATOR EXPERIMENT

Nextrans

To Understand Driver Response towards Real-time Travel Information

with EEG

& Eye tracker

Interested?

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YOU ARE INVITED TO PARTICIPATE IN THIS STUDY, IF:

- ✓ You are 18 years or older
- ✓ You do not have motion sickness, or any mental or physical impairment, or you are not on regular medication
- ✓ You do not wear corrective glasses. *Contact lenses are allowed*

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You need to:

- ✓ Complete an online survey
- ✓ Schedule a visit for the experiment
- ✓ Participate in the experiment at our lab

For more details. Please visit: www.purdue.edu/drivingsimulator

IRB Protocol #1304013546

Principal investigator: Dr. Srinivas Peeta