

# Young Researchers Seminar 2009

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## Combining Autonomous Vehicles and Controlled Events in Driving Simulator Experiments

Johan Olstam



# Contents

- Driver behavior studies & driving simulators
- Surrounding traffic in driving simulators
- The play preparation problem
- The ideas behind the algorithm
- Test in the VTI Driving simulator
- Conclusions and future research

# Driving behavior experiments

- Used to assess hypothesis
- Studying driver behavior in a specific context
- Follows traditional experimental design
- Limiting confounding variables is difficult

Can be conducted in

- Real world
- Test tracks
- Driving simulators

# Driving Simulators



- Safe and controlled experiments concerning e.g.
- Alcohol, medicines and drugs
  - Driving with disabilities
  - Technical systems (ADAS, IVIS, NOMAD,...)
  - Fatigue
  - Vehicle and road design

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# Two types of surrounding vehicles

## ”Fully controlled”

No own initiatives

“Enslaved”

Detailed instructions

Low driving skills

## ”Fully Autonomous”

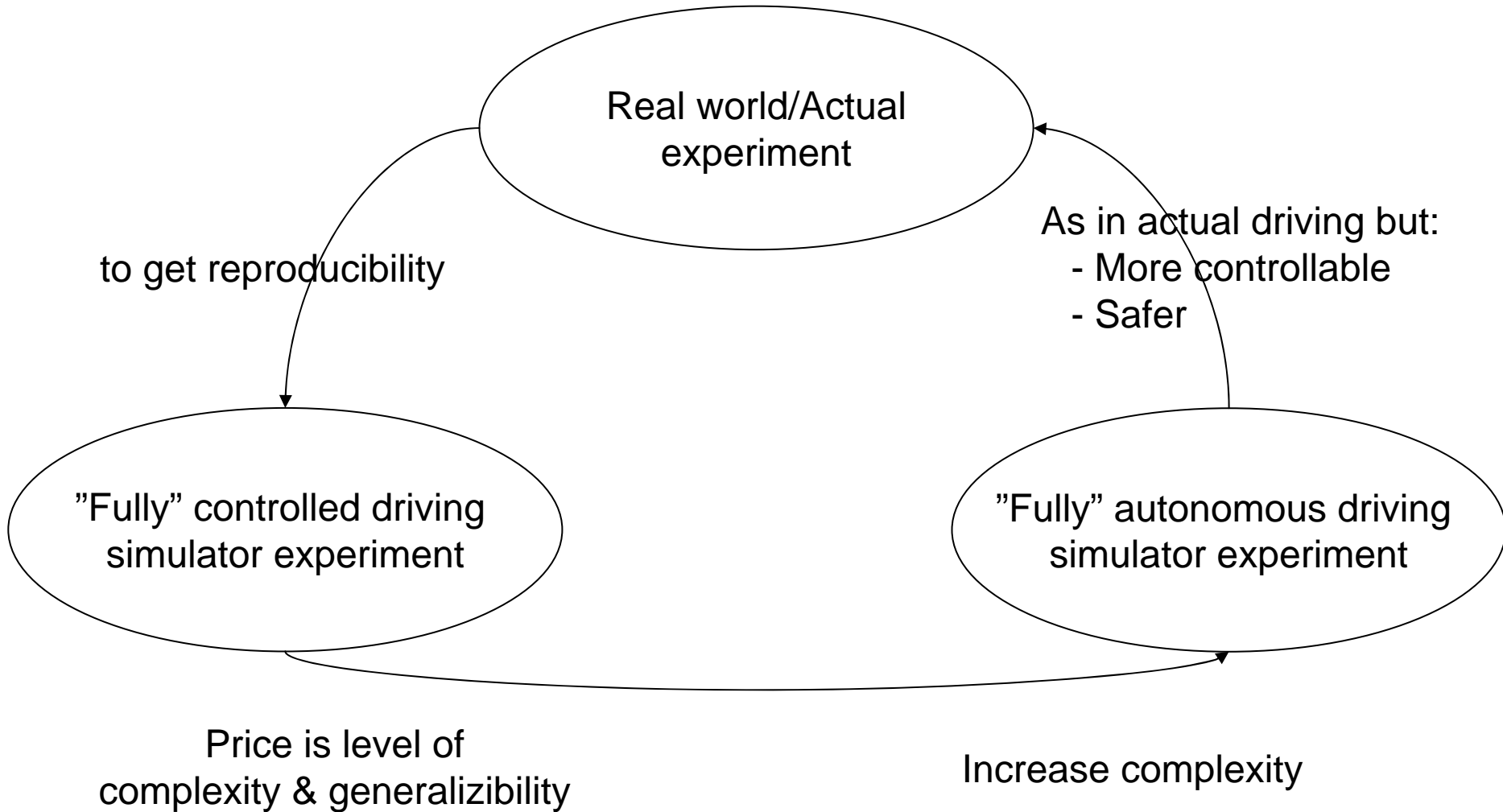
Own initiatives/goals

React on the surroundings

No/few instructions

High driving skills

# Driver behavior experiments



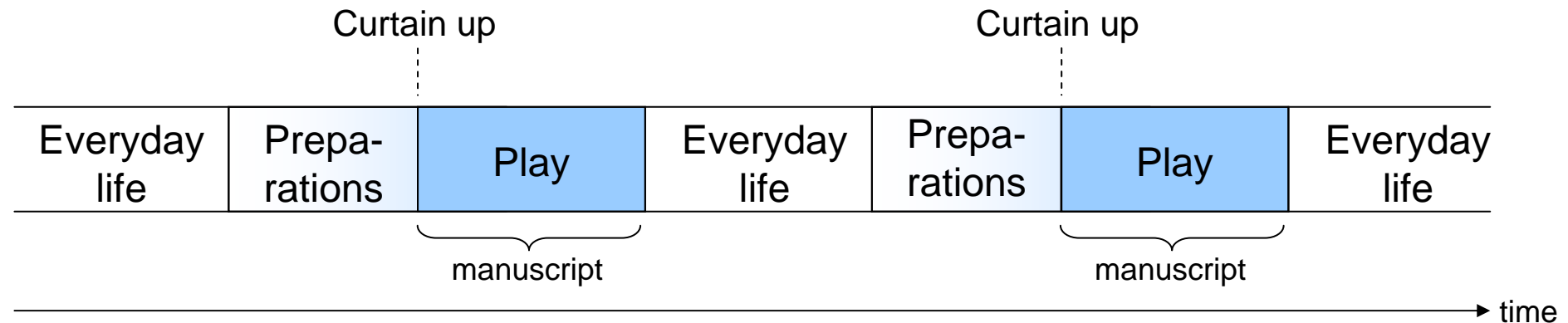
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# The parts of a driving simulator Scenario

- Everyday life driving
- Preparations for directed Plays
- Directed Plays



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# The play preparation problem

Create a pre-specified situation from an unknown traffic situation in a non-conspicuous way

Consists of:

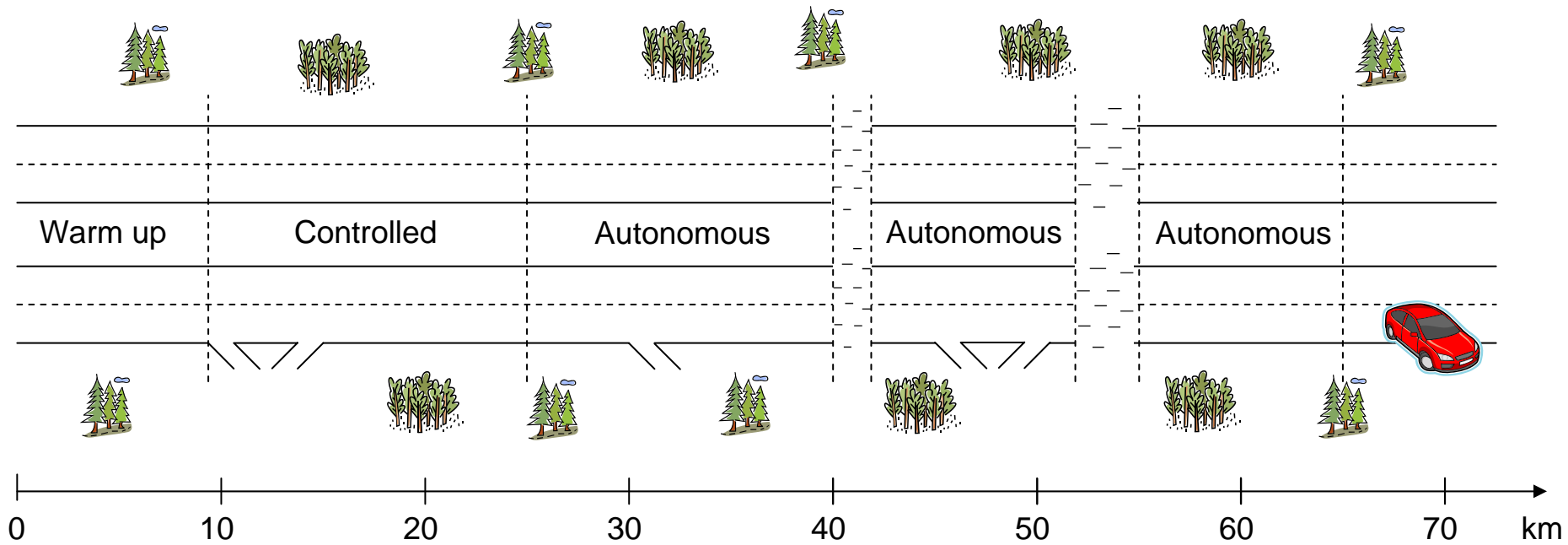
- Casting of roles
- Transportation of actors (with roles) to the stage
- Transportation of actors (without roles) from the stage

# Test in the VTI Driving Simulator

## Aims

- test if the algorithm is able to reconstruct equal play start conditions for each participant in a non conspicuous way
- test if the type of traffic (autonomous or controlled) during the everyday life driving affects the participants' driving behavior and/or experience of the drive.

# Scenario description



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# The participants

- 10 participants, in-house VTI personnel

	Participant number									
	1	2	3	4	5	6	7	8	9	10
Gender	F	M	M	F	F	F	M	M	M	F
Age	36	37	53	50	60	29	43	58	25	32
Years with license	18	20	32	32	41	11	23	32	6	13
Mileage last year	1000	1200	1500	500	1000	3000	1500	1600	300	1000
# of drives in simulator	0	15	3	0	3	0	0	4	1	0
Desired speed	115	125	120	110-120	110-120	120	120	110	120	120

# Analyze method

- Comparing specified and achieved relative speed and position
- Mean free speed analyses
- Questionnaire
- Interviews

# Participant's mean free speed

	Participant number									
	1	2	3	4	5	6	7	8	9	10
Controlled – Warm up	1.22	0.91	2.11	1.64	0.44	0.85	-0.04	0.04	0.09	0.23
Controlled – Autonomous 1	0.80	0.99	2.70	1.66	1.52	1.18	0.84	0.06	0.16	0.27
Controlled – Autonomous 2	1.76	1.48	4.28	1.76	1.36	1.00	2.93	0.05	-0.32	0.61
Controlled – Autonomous 3	1.39	1.72	4.64	2.01	1.24	1.20	0.34	0.40	-0.19	2.28

Controlled – Warm up	$t(9) = 4.01; p = 0.0015$
Controlled – Autonomous 1	$t(9) = 3.24; p = 0.0051$
Controlled – Autonomous 2	$t(9) = 3.50; p = 0.0034$
Controlled – Autonomous 3	$t(9) = 3.52; p = 0.0033$

The participants drive faster during controlled everyday life traffic!

# Participant comments

- No observed conspicuous actions in connection with plays
- Overtaking situations during controlled everyday life traffic was not normal
- The autonomous traffic is driving slow

# Conclusions

- Casting and transportation of active roles works satisfactory.
- Casting and transportation of no-roles do not always work as intended.
- Type of controlled everyday life traffic matters!
- Autonomous everyday life traffic observed as slower than real freeway traffic.

# Future research

- Tests in more dense traffic
- Test in “real” driving simulator experiment
- Algorithm development for other road types (two-lane highways, urban, etc)

