Interdisziplinäres Zentrum für Verkehrswissenschaften
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Semi-Autonomous Advanced Parking Assistants and their Effects on Surveying the Surrounding Environment in Real Traffic

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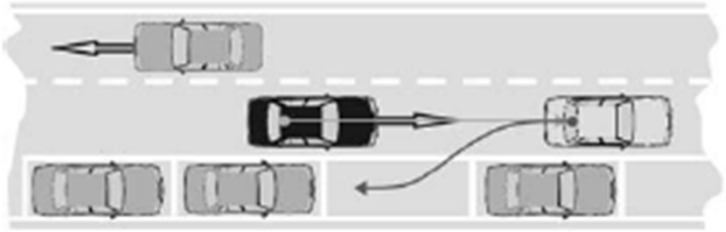
Semi-autonomous Advanced Parking Assist (APA)

Semi-autonomous APA systems



- identify a fitting parking space
- utilize automated steering to reduce the effort of the driver
- do not control speed by accelerating or braking
- work in cooperation with a Front-and-Rear Park-Assistant ("Ultrasonic Parking Assist", UPA) which will give feedback if the vehicle approaches an obstacle

Empirical results (Doisl, 2007; Lee, 2006; Totzke et al., 2010)

- APA systems reduce operational demands for the driver
- APA systems improve parking performance

Visual attention and system's usage

Steering information on its display (Doisl, 2008)**:**

- **Visual attention is held for up to 80 % during parking maneuver**

Semi-autonomous APA system (Totzke, Mühlbacher & Krüger, 2010; Totzke, Jessberger, Mühlbacher & Krüger, 2011)**:**

- **Visual attention is held for up to 22 % during parking maneuver**
- **Display glances predominantly occur at lower speeds**
  - slower than 0.5 km/h: 42% of the first backward motion
  - at a higher speed (from 0.5 km/h): 8% to 15%
- **62 % of all display glances shorter than 1 sec; 3 % longer than 5 sec**
- **Less visual attention is used to monitor the system's display with increasing practice**
- **No systematic learning effects regarding other "areas-of-interest"** (e.g. windshield, windows, backwards, mirrors)

Danger of system's usage

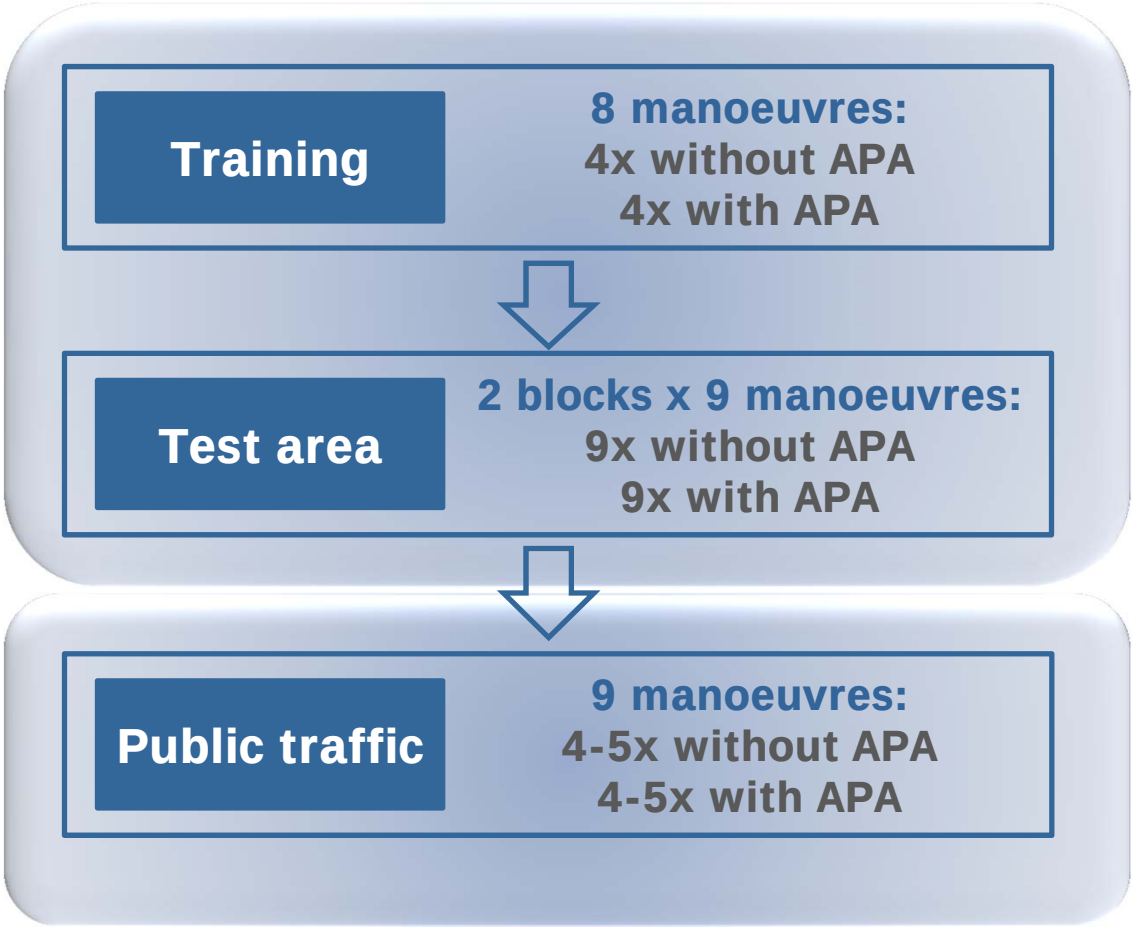
Surrounding environment is not surveyed adequately

- Other vehicles might be overlooked
- Passers-by or obstacles in the pathway of the vehicle might be overlooked

Possible consequences on road safety

- hindering the traffic flow as the lane is blocked and the following vehicles have to reduce their own velocity
- touching other obstacles

Stages in the course of the study and sample



Sample: N = 18 subjects
m = 40.3 years
(sd = 21.9, 19-72)
9 male, 9 female

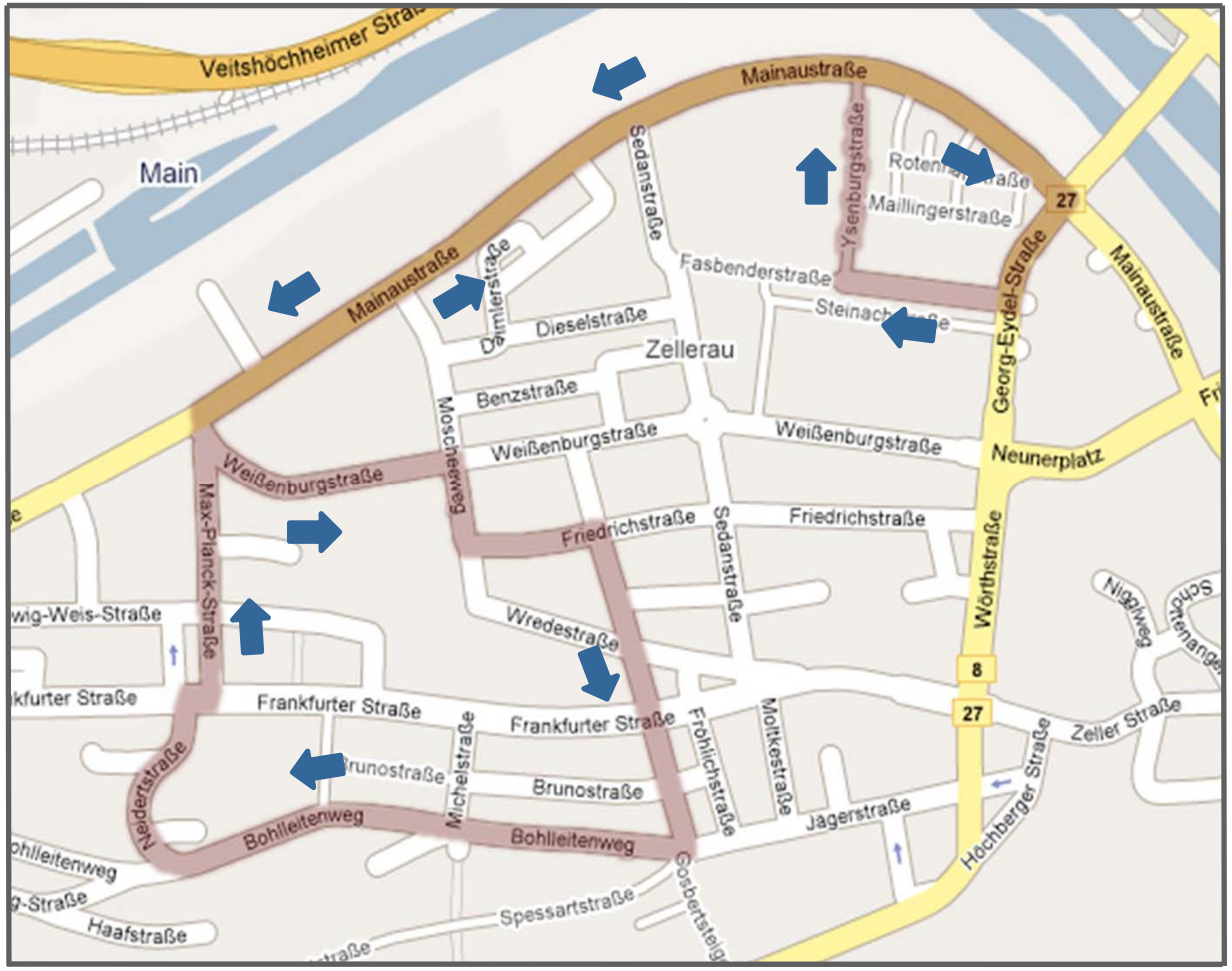
Sample: N = 11 subjects
m = 35.3 years
(sd = 22.8, 19-72)
6 male, 5 female
5 good, 6 bad parker

Public traffic

Test course in residential area of Wuerzburg

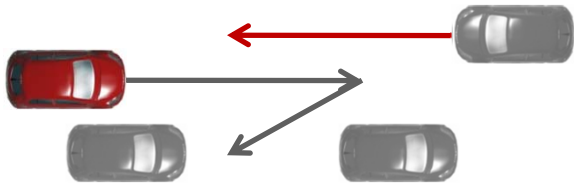
Length: 5.9 km

Duration: 45 min



Oncoming vehicle while parking

Confederated car comes towards while parking



A big orange triangle is fixed in the windshield

After parking maneuver:
“Was there anything that attracted your attention to the oncoming car?”

Analysis of glance behaviour

Measurement device: „Dikablis“ (Lange, Wohlfahrter, & Bubb, 2009)

“Areas-of-Interest” (AOI)

- Backwards
- Windshield
- Mirrors
- Windows
- Display

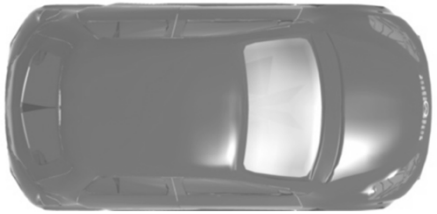
“Points of interest” (POI)

- Overtaking vehicles on same lane
- Oncoming traffic

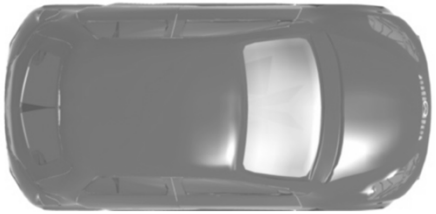
In the following:
glance activity while searching for a parking space and during first backward motion

First parking motion

Start:
Stopping after passing parking space



End:
Stopping after first parking motion

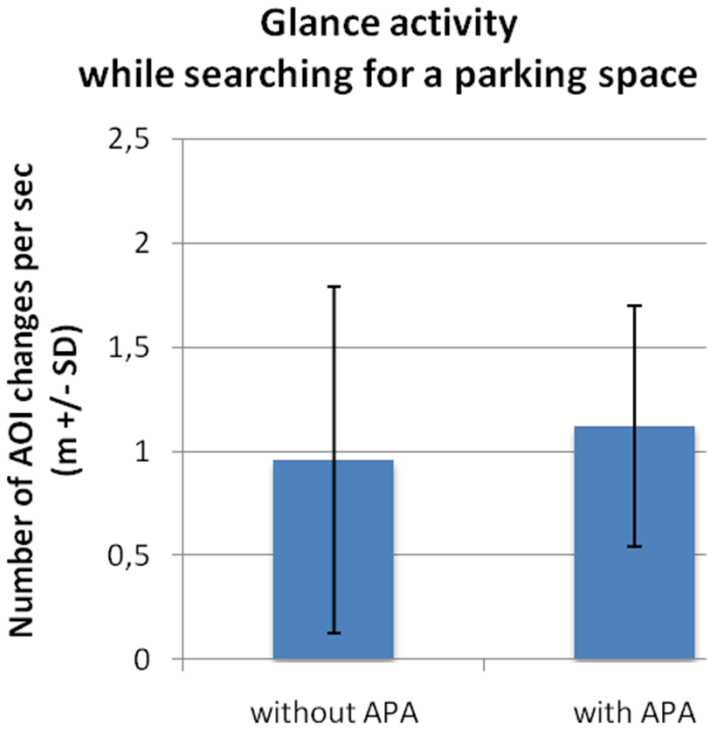


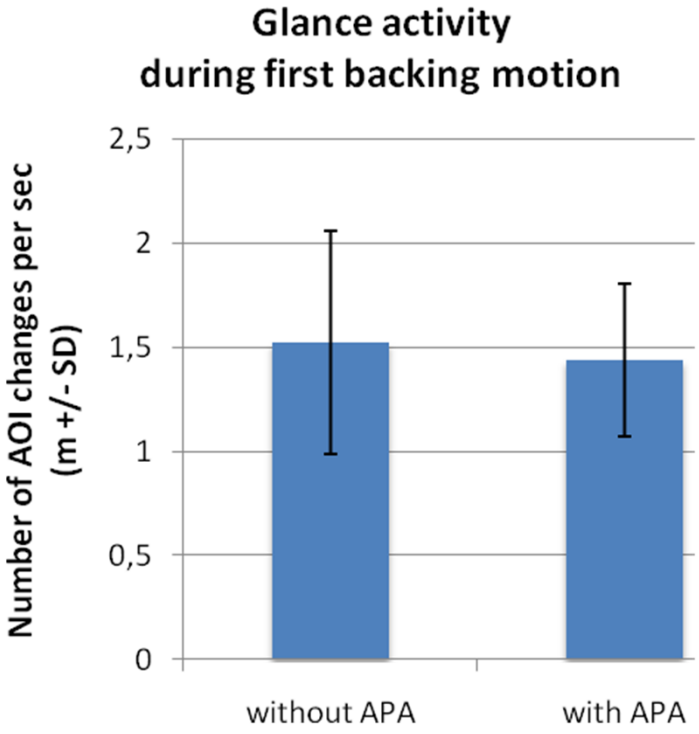
Observations of in-vehicle experimenter

No contact with other vehicles, passers-by, or obstacles occurs in real traffic

- **neither for parking with the APA system**
- **nor for parking without the APA system**

Glance activity





Drivers' glance activity is independent from using the APA system

- While searching for a parking space: t(10) = -0.638, p = .538
- During first backward motion: t(10) = 0.531, p = .607

Glance behaviour and inquiry

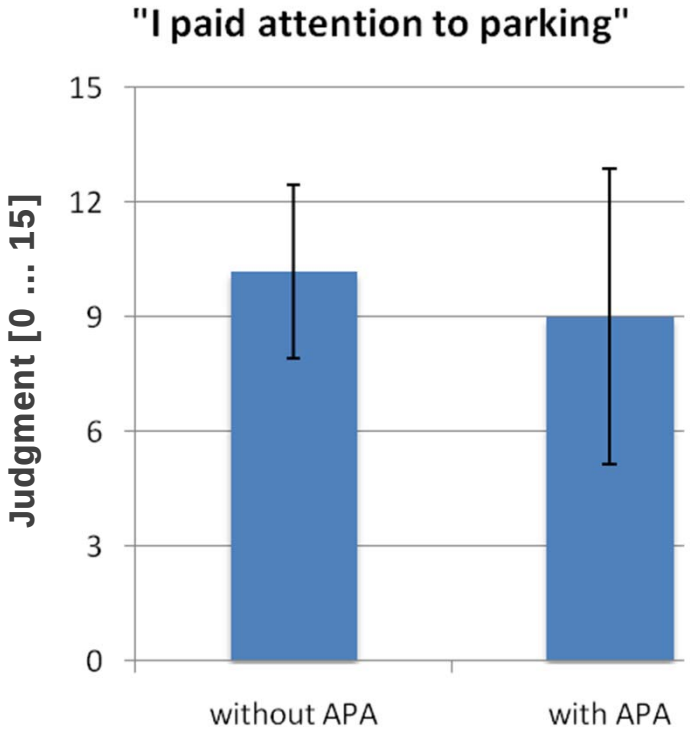
Relative number of maneuvers in real traffic in which

	Without APA	With APA	
… drivers look **backwards at least once** while searching for a parking space	100%	82%	McNemar-Test, N = 11, p = .500
… drivers **fixate oncoming vehicle** while searching for a parking space or making the first backward motion if present	60%	33%	Chi2-test, Chi2(1) = 0.933, p = .334
… drivers **fixate overtaking vehicle** while searching for a parking space or making the first backward motion if present	75%	29%	Chi2-test, Chi2(1) = 2.213, p = .137

Judgments after each maneuver

According to the drivers' judgments they paid as much attention to parking with the APA system as without the APA system.

t-Test for dependent samples,
$t(10) = 1.485$, $p = .168$



Summary

No significant detrimental effects of the APA system on surveying other relevant "points-of-interest" when searching for and entering a parking space

(1) Glance activity is not affected

(2) Drivers look in as many maneuvers backwards at least once while parking

(3) If oncoming or overtaking vehicles appear, drivers seem to fixate on the relevant vehicle less often when parking with the APA system (but: not significant!)

Drivers report to have paid as much attention to parking with the APA system as without the APA system

After the staged situation the drivers with APA are able to name as many features of the vehicle (i.e. color/type of the vehicle, triangle fixed in windshield) **as the drivers without APA**

Limitations I

(1) Parking maneuvers are solely realized within a natural setting

- High external validity, what about internal validity?
- Similar results for handling the APA system in staged situations on a test area (toy coupe, sudden post; Totzke et al., 2010)

(2) Results can only be generalized to parking maneuvers in which the APA system was used with experienced drivers

- Prior to parking in real traffic all drivers gained excessive experience with handling the test vehicle and the APA system in the test area (26 maneuvers)

(3) Drivers had to wear a glance behavior measurement device throughout most of the session

- Reactivity effects? Annoying for the participants?

Limitations II

(4) Only a small sample size is analyzed so that only descriptive tendencies can be seen

- N = 18 subjects participated in this study
- Due to technical problems with the APA system (e.g. system did not detect available parking space), complete data are only available for n = 11 subjects
- Analysis of drivers' glance behavior partly depends on the presence of other vehicles in the near environment of the test vehicle
- Therefore, the absolute number of parking maneuvers with overtaking or oncoming vehicles are rather small

Thank you for your attention!

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