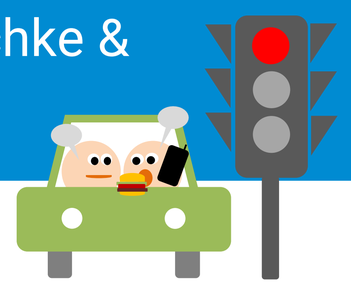
TECHNISCHE UNIVERSITÄT CHEMNITZ

Does intersection complexity matter?

Investigating the prevalence of driver distraction when waiting at a red light in a German city

Tina Morgenstern, Sarah Anders, Julia Dostmann, Lisa Jahn, Rahel Zeschke & Franziska Bocklisch



Background

- There is evidence of different observational studies in the United States [1, 2] and Europe [3, 4, 5] that drivers are especially willing to engage in secondary tasks in low demanding driving contexts, such as when stopped at a red light.
- However, so far, it is unclear if intersection complexity (e.g., the number of lanes in each direction) affects secondary task prevalence when waiting at a red light.
- Aim of the present study was to assess drivers' secondary task engagement when stopped at a low vs. high complex signalized intersection by conducting a roadside observational study.
- It was assumed that drivers engage more often in secondary tasks when stopped at the low compared to the high complex signalized intersection due to the increased driving task demand at a high complex intersection (e.g., more other road users that should be noticed to maintain situational awareness).

Method

SITE SELECTION AND TIMING OF OBSERVATIONS

- Observation of the 2nd and 3rd driver waiting in the right lane at a red light in Chemnitz (Germany)
- Observation at two sites: Low vs. high complex signalized intersection (see Fig. 1)
- Intersection characterics:
  - Located in a distance of 1.1 km to each other
  - Speed limit of 50 km/h
  - Stable traffic flow
- Intersections differ in their complexity (one vs. four traffic lanes, crossing tram lines)

Fig. 1: Low (left) vs. high (right) complex intersection

- Observations were conducted in two-person teams in the spring of 2018 in clear weather for 60 min sessions between 4 pm and 6 pm on Thursday; each site was observed twice

OBSERVED VARIABLES

AGE & GENDER

AGE
- < 30 years
- 30 – 50 years
- > 50 years

GENDER
- Male
- Female

SECONDARY TASKS
- Cell phone – Conversation
- Cell phone – Visual-manual interaction
- Smoking
- Eating/ drinking
- Adjusting controls/ radio
- Passenger interaction
- Other (e.g., personal grooming)

Results

- *N* = 217 observed drivers (male: 114, female: 103; < 30 years: 36, 30 – 50 years: 115, > 50 years: 46; low complex intersection: 125, high complex intersection: 92)
- 54% of the drivers engaged in at least one secondary task (see Table 1)
- Passenger interaction was most frequently observed (23%), followed by other tasks (14%) and adjusting controls/ radio (11%)

AGE

- Significant differences in overall secondary task engagement ($\chi^2(2) = 7.16$, $p = .023$)

→ Younger drivers (< 50 years) engaged more often in secondary tasks

- Older drivers (> 50 years) engaged less often in visual-manual cell phone interactions ($\chi^2(2) = 8.17$, $p = .018$)
- Middle-aged drivers (30 – 50 years) engaged more often in other secondary tasks ($\chi^2(2) = 6.71$, $p = .035$)

GENDER

- No significant differences in overall secondary task engagement ($\chi^2(1) = 0.70$, $p = .417$)
- Male drivers engaged significantly more often in passenger interactions ($\chi^2(1) = 4.72$, $p = .036$)

INTERSECTION COMPLEXITY

- No significant differences in overall secondary task engagement ($\chi^2(1) = 0.12$, $p = .426$)
- Drivers waiting at the low complex intersection engaged significantly more often in visual-manual cell phone interactions ($\chi^2(1) = 3.68$, $p = .048$)
- Drivers waiting at the high complex intersection engaged significantly more often in smoking ($\chi^2(1) = 5.31$, $p = .020$) and passenger interactions ($\chi^2(1) = 4.09$, $p = .030$)

Table 1: Number (percentage) of observed secondary tasks depending on age, gender and intersection complexity

		Overall secondary task engagement	Only driving	Cell phone – Conversation	Cell phone – Visual-manual interaction	Smoking	Eating/ drinking	Adjusting controls/ radio	Passenger interaction	Other
Age	< 30 years	38 (17.5)	18 (8.3)	3 (1.4)	9 (4.1)	3 (1.4)	4 (1.8)	7 (3.2)	13 (6.0)	9 (4.1)
	30 – 50 years	59 (27.2)	56 (25.8)	3 (1.4)	10 (4.6)	4 (1.8)	3 (1.4)	15 (6.9)	21 (9.7)	20 (9.2)
	> 50 years	19 (8.8)	27 (12.4)	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)	16(7.4)	1 (0.5)
Gender	Male	64 (29.5)	50 (23.0)	2 (0.9)	7 (3.2)	3 (1.4)	4 (1.8)	15 (6.9)	33 (15.2)	17 (7.8)
	Female	52 (24.0)	51 (23.5)	5 (2.3)	12 (5.5)	4 (1.8)	3 (1.4)	8 (3.7)	17 (7.8)	13 (6.0)
Intersection complexity	Low	68 (31.3)	57 (26.3)	2 (0.9)	7 (3.2)	7 (3.2)	4 (1.8)	14 (6.5)	35 (16.1)	19 (8.8)
	High	48 (22.1)	44 (20.3)	5 (2.3)	12 (5.5)	0 (0.0)	3 (1.4)	9 (4.1)	15 (6.9)	11 (5.1)
Total		**116 (53.5)**	**101 (46.5)**	**7 (3.2)**	**19 (8.7)**	**7 (3.2)**	**7 (3.2)**	**23 (10.6)**	**50 (23.0)**	**30 (13.8)**

Conclusion

- The present findings indicate that drivers adapt their secondary task engagement depending on driving task demand at least to some degree.
  - Simple secondary tasks such as smoking were observed more often at low complex intersections.
  - Demanding secondary tasks such as visual-manual cell phone interactions were observed less often at high complex intersections.

→ Secondary task engagement while waiting at a red light can impair situational awareness, especially at high complex intersections. Here, unexpected events are more likely to occur (e.g., another driver who suddenly changes the lane). Hence, avoiding demanding secondary tasks at such intersections might present a form of self-regulatory behavior adaptation.

- However, the sample size of the present roadside observational study was relatively small which limits the generalizability of the results.

CONTACT

M. SC. PSYCH. TINA MORGENSTERN

☎ +49-371-531-34832

✉ tina.morgenstern@psychologie.tu-chemnitz.de

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