Cyclists' use of Mobile IT in Sweden – usage and self-reported behavioural compensation

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ABSTRACT

The increasing use of mobile phones while cycling has raised safety concerns. In this paper two studies of mobile phone use by cyclists are presented. The first study was designed to characterize mobile phone use by cyclists in Sweden, while the second studied how mobile phone use affected cyclist behaviour and compensation strategies. Mobile phone use was observed in about 20 percent of all urban bicycle trips. The usage varied with cyclist age with the highest usage among young cyclists. Of those using phones, 90% of the cyclists observed used headphones. In parallel, standardized, interviews 15% of cyclists under 15 years old stated that they always used mobile phones while cycling. Listening to music in headphones was the most frequent self-reported activity. To converse using hand-held phones was also rather common, and was the only mobile phone usage reported by women above 50 years old. In the second study twenty-two young cyclists (age 16-25 years) completed a route in real traffic five times while listening to music, receiving and making calls, receiving and sending text messages, searching for information on the internet and while cycling normally without using the phone. The route and the types of tasks were controlled, but the cyclists could choose rather freely when, where and how to carry out the tasks. When the cyclist returned to the starting point, a short interview was conducted. During the interviews cyclists reported their experiences and the compensation strategies they used while cycling. The results indicate differences between tasks performed and experience of using mobile phone while cycling. The more difficult the task was perceived to be, the more often cyclists compensated by reducing their speed or using multiple strategies. Less experienced cyclists found the tasks more difficult and they compensated primarily by reducing speed, while more experienced cyclists compensated behaviourally by changing their visual scanning. .

Keywords: cyclist, phone, behavioural strategy, compensation, traffic safety.

1 INTRODUCTION

The increasing use of mobile phones while cycling has raised safety concerns. Still, there is limited knowledge about how mobile IT is used among cyclists and how it affects traffic safety.
Mobile IT is defined here as mobile phones, smartphones, iPads, music players, or other portable electronic devices. Most research in the area of mobile phone use among cyclists has been conducted in the Netherlands. Studies from the Netherlands show that about 70% of the Dutch cyclists sometimes use their mobile phone or other portable electronic devices while cycling [1]. One out of six (17%) use mobile devices on every bicycle trip, and listening to music is the most common activity (15%). Compared with older cyclists the frequency of use is twice as

high among cyclists younger than 34 years old. Another study from the Netherlands, in which 2000 cyclists where observed at three different sites, revealed mobile phone use by 2.3% of the cyclists [2]. Results from a Japanese questionnaire survey to secondary school students showed that 65-75% of the students had used mobile phones while cycling during the last month [3]. In Sweden, not much is known about cyclists' use of mobile phones, but it is obvious that Swedish cyclists use their mobile phones while cycling, and it is likely that the use will increase due to the increasing use of smartphones in general.

Studies indicate that, for teenagers and adults, using mobile IT while cycling increases accident risk [1]. The increased risk corresponds to a risk factor of 1.4 which is comparable to having a blood alcohol level of 0.05% while driving. There are studies that show that cyclists compensate with reduced speed while listening to music [2], whereas other studies show that they cycle with unchanged speed [4]. Listening to music in headphones reduces auditory perception of ambient sounds. Operating a mobile phone, both hand held and hands free, also has a negative effect on perception and is a potential threat for safety. Other research shows that the risk of serious injuries and fatalities as a result of mobile phone use while cycling is limited compared to car drivers [5] and the assumption is that cyclists can more easily slow down and stop if necessary. In the study from the Netherlands [2], in which observations as well as questionnaires and experiments were performed, the conclusion was that typing (SMS) had the largest effect on speed (3km/h) and on swaying. However, the observations/questionnaires do not indicate that this increased the accident risk [2].

In the present paper two studies of cyclists' use of mobile phone are reported. The first study was designed to estimate and characterize cyclists' use of mobile phones in Sweden [6], while the second examines cyclist behaviour and compensation strategies while using mobile phones [7].

2 MATERIALS AND METHOD

2.1 Study on cyclists' use of mobile IT in Sweden

2.1.1 Data collection

The data collection aimed at estimating the percentage of cyclists that use mobile IT and to study behaviour at pedestrian and cyclist crossings for cyclists using mobile IT in comparison to cyclists not using mobile IT. It also aimed at increasing the understanding for how cyclists use mobile IT and their experiences. Data collection was carried out during the autumn of 2012.
Observations were carried out during 32 hours on four sites, 8 hours per site, and 336 standardized interviews were carried out during 40 hours. Observations were organized according to:

- 5 minutes of traffic counts of users and non-users among cyclists
- 10+10 minutes of observations of users and non-users among cyclists

2.1.2 Observation sites

Criteria for selection of observation sites were sufficient number of cyclists and signalized and non-signalized crossings. The sites are situated in central Lund (114,000 inhabitants) and Malmö (313,000 inhabitants) in South Sweden. The sites are presented in Figure 1-4.

Figure 1. Lund, Entrégatan/Getingevägen, signalized crossing.

Figure 2. Lund, Trollebergsvägen.

Figure 3. Malmö, Drottninggatan/Kaptensgatan, signalized crossing.

Figure 4. Malmö, Östra Förstadsgatan/Kungsgatan.

2.1.3 Traffic counts of cyclists' use of mobile IT

Traffic counts were made to estimate the percentage of cyclists that use mobile IT. Counts were performed the first 5 minutes of each hour of observation. All cyclists, users and non-users of mobile IT, in both directions were counted manually and the result was registered into a web form via iPad. In total, cyclists were counted for 40 minutes per site.

2.1.4 Observations of cyclists´ behaviour

To study cyclists' behaviour at pedestrian and cyclist crossings, when using/not using mobile IT, behaviour was observed and registered manually into a standardized web form in iPad. Observations were made in periods of 10 minutes for cyclists not using mobile IT and 10 minutes for cyclists using mobile IT, respectively. The sample was randomized by observing the first cyclist, and then the next after ending one observation.

2.1.5 Survey to cyclists

Standardized interviews were carried out to estimate how often and how mobile IT is used while cycling, and to identify critical situations that might happen as a consequence of the use.

The standardized interviews were carried out by means of a web form which means that the questions were adapted to previous answers and that only own experience was reported.

The data collection was carried out in the vicinity to the observation sites during 40 hours, when the respondents filled out the web form into an iPad. The ambition was to collect 40 answers from men and women in four different age groups, in total 320 answers (Table 1).

Table 1. Goal for gender and age distribution in total (and by site).

Age	Male	Female	Total
< 15	40 (10)	40 (10)	80 (20)
15-30	40 (10)	40 (10)	80 (20)
31-50	40 (10)	40 (10)	80 (20)
> 50	40 (10)	40 (10)	80 (20)
Total	160 (40)	160 (40)	320 (80)

Data collection for the youngest category (< 15 years old) was complemented in two schools in Lund and Malmö, since the number of this category was under represented at the sites.

2.1.6 Estimation to Sweden

In order to obtain a picture of the extent of cyclists' use of mobile IT in Sweden an estimation was made based on age and gender distribution among cyclists. Data from observations and counts (Table 2) were used together with data for 2011 on age and gender distribution of bicycle trips in Sweden from the national travel survey (Table 3).

Table 2. Percentage of cyclists that use mobile IT in different age and gender groups (based on observations and counts).

		Age group				
		< 15	15-30	31-50	> 50	Total
Gender	Male	34 %	23 %	26 %	5 %	20 %
	Female	44 %	28 %	13 %	2 %	17 %
	Total	37 %	26 %	21 %	4 %	19 %

Table 3. Distribution of bicycle trips in Sweden 2011 in different age and gender groups (National travel survey 2011).

		Age group				
		< 15	15-30	31-50	> 50	Total
Gender	Male	10 %	12 %	15 %	12 %	49 %
	Female	8 %	10 %	15 %	19 %	51 %

The estimation is based on the assumption that the observed use of mobile IT for a specific age and gender groups is representative for Sweden. This assumption is not possible to control, and it could be both an over and an under estimation, in general or for different groups, due to local factors, but it is the best estimation possible at the moment.

2.2 Study on cyclists' self-reported compensation strategies

2.2.1 Overall method

While cycling a one km predefined route the cyclists were asked to perform four different tasks. It was stressed that the tasks should be performed in the same manner as the cyclist would have done outside of the study, and that it was completely acceptable to stop cycling while attending to the task. The participants could freely choose when and how they performed the task. To create as realistic situation as possible the cyclists used their own bicycles and own mobile phones. Data collection was carried out during the autumn of 2013.

2.2.2 Participants

Altogether 22 cyclists, 11 men and 11 women, participated in the study. One man quit the trial prematurely. Inclusion criteria were an age of 16-25 years old, being used to cycling and to using a smartphone, and also using a smartphone in traffic. These inclusion criteria were chosen since teen and young adult cyclists are more frequent smartphone users while cycling (result from study 1).

2.2.3 Route

The route was about one kilometre long and located in the peripheries of Linköping city centre (150,000 inhabitants in Linköping municipality). The participants cycled on a separate bike path along a road with moderate traffic flow, crossed the road and turned back on a separate bike path on the other side of the road. Along the route the cyclist had to cross four local street with low traffic flow. The flow of pedestrians and other cyclists on the bike path were sparse, but somewhat higher around lunchtime.

2.2.4 Tasks

During four of the routes the cyclist was given a task to perform with their mobile phone, see Table 4. The order of the tasks were balanced with the help of a Latin Square.

Table 4. Description of the tasks the cyclists were asked to perform during the five routes.

Task	Description
Baseline	The route was cycled without any interaction with mobile IT.
Music	The cyclist listened to self-selected music via in-ear headphones. The music was selected and started before the participant started to cycle.
Conversation	The cyclist was called just before an intersection. Upon answering he or she was asked to call back after having passed the turning point. The cyclist called back. The cyclist was called again just before an intersection.
Text	The cyclist received a sms with a simple question just before an intersection. The cyclist answered the question by replying to the sms. A one-word answer was enough, but this was not explicitly stated in the instructions. The cyclist received another sms just before an intersection.
Internet	The cyclist was asked to check the first headline in one of the main Swedish newspapers (www.dn.se) after having passed the first intersection, and to call the experimenter and name the headline. During the same phone call the cyclist was asked to check the current temperature in Oslo on a known weather site (www.yr.no). The answer should then be texted to the experimenter.

The participant was instructed which condition was coming up, and it was stressed that the task should be executed in the same fashion as the cyclist would have done outside of the study, and that it was completely acceptable to stop cycling while attending to the task.

2.2.4 Interview data

After each round a short interview regarding the participants' experiences, compensation strategies cooperation with other road users, situation awareness and emotional state was conducted. When all rounds and tasks were performed, a somewhat longer interview was conducted, also including ranking of the different tasks according to difficulty and more general questions about traffic safety and pros and cons of using smartphone while cycling. Both open and closed questions were used.

3 RESULTS

3.1 Study on cyclists' use of mobile IT in Sweden

3.1.1 Percentage of cyclists using mobile IT

Approx. 19% of the cyclists observed use mobile IT, both at signalized and non-signalized crossings. The percentage of cyclists using mobile IT was about the same in the signalized crossings studied. However, the percentage differed between the non-signalized crossings, 13% in Lund compared to 25% in Malmö (Figure 5). This might indicate that the layout of non-signalized crossings might affect the use of mobile IT among cyclists.

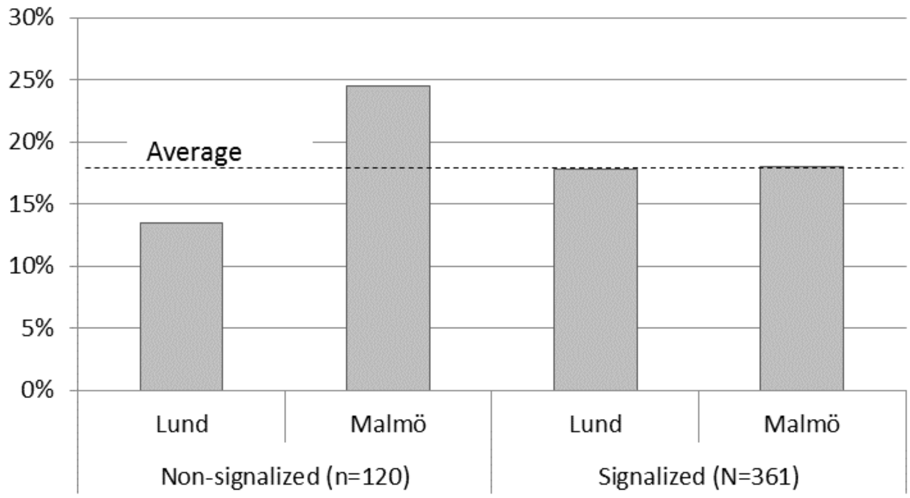

Figure 5. Percentage of cyclist using mobile IT at the different sites.

The percentage of men using mobile IT was slightly higher than among female cyclists observed, 20% compared to 17 %. The usage varied much more with cyclist age (Figure 6) with the highest usage among cyclists 15 years old or younger. In this group one of three cyclists were observed using mobile IT, whereas the lowest usage (4%) was among cyclists over 50 years old.

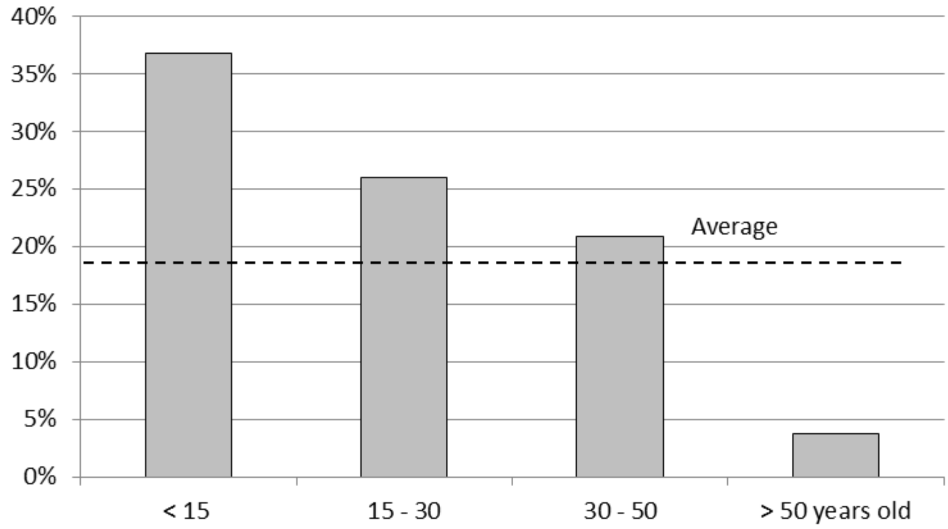

Figure 6. Percentage of cyclists using mobile IT for different age groups (observations adjusted by counts).

3.1.2 How often is mobile IT used by cyclists?

According to the standardized interviews, self-reported use of mobile IT is generally higher, the younger the age group. The age group with the most frequent use of mobile IT is cyclists under 15 years old, where more than 15% state that they always use mobile phone while cycling. The high usage among younger groups is in line with the observation results. To speak in hand-held phone was also rather common, and was the only mobile phone usage reported by women above 50 years old.

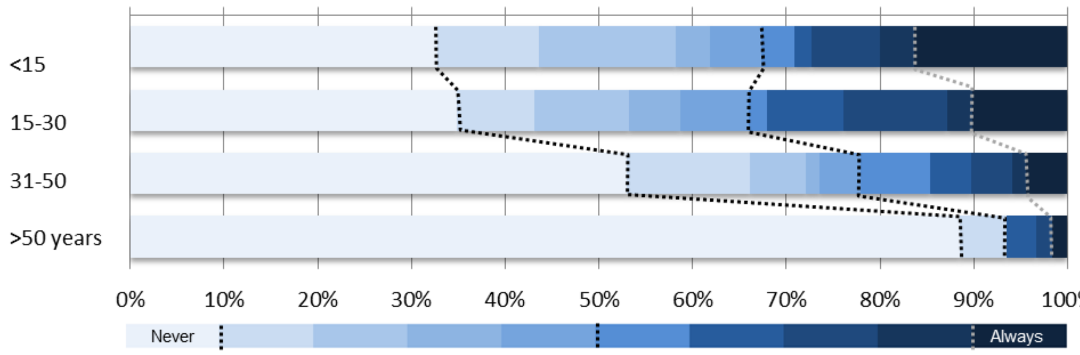

Figure 7. How often mobile IT is used by cyclists in traffic, self-reported frequency for different age groups ($n_{(<15)}$=55, $n_{(15-30)}$=109, $n_{(31-50)}$=68, $n_{(>50)}$=61).

Cycling experience also seems to affect how often the cyclist use mobile IT while cycling (Chi2 < 0.05). Generally, experienced cyclists use mobile IT more frequently than less experienced (Figure 8).

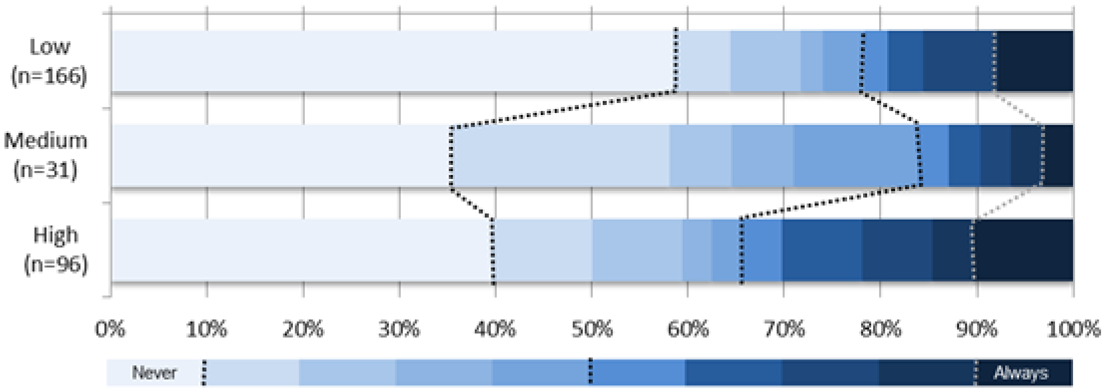

Figure 8. How often mobile IT is used by cyclists in traffic, self-reported frequency for cyclists by cycling experience (low= 0-2 times last week, medium= 3-4 times last week, high=5-7 times last week).

There is also an association between helmet use and use of mobile IT (Figure 9). Cyclists wearing bicycle helmet more seldom use mobile IT than cyclists not using helmet (Chi2 < 0.05).

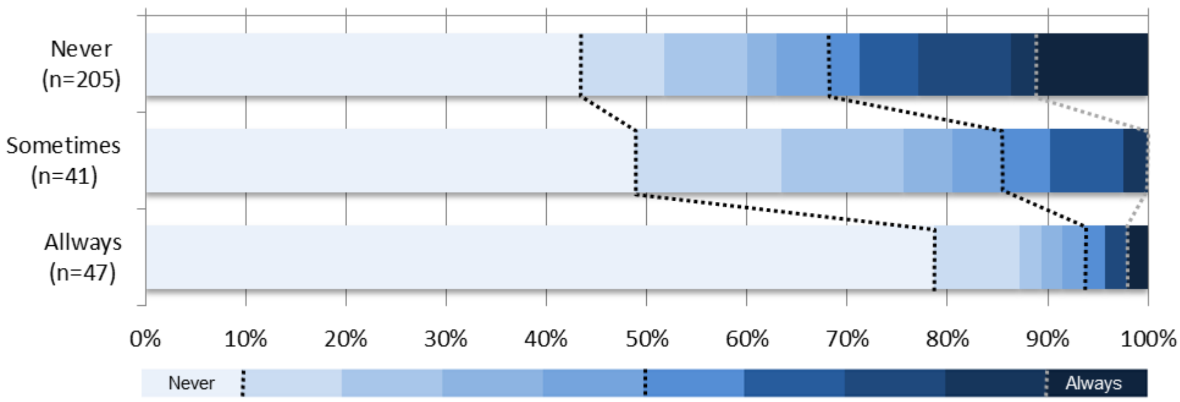

Figure 9. How often mobile IT is used by cyclists in traffic, self-reported frequency for cyclists by helmet use.

Both wearing a helmet and not using mobile IT while cycling might be an expression for an underlying safety awareness.

3.1.2 What do cyclists do with their mobile IT while cycling?

The observations show that using headphones is most common while cycling, almost 90% of cyclists categorised as using mobile IT have headphones/hands free in their ears. More than 10% hold the mobile device to their ear and only 3% interacted with their mobile device (e.g. read or write). Some persons observed made more than one of these task, which explains why the sum exceeds 100%.

The high use of headphones corresponds to the self-reported activity. Listening to music in headphones was the most frequent form of using mobile IT for cyclists, except for women over 30 years old (Figure 10). Even so, listening to music in headphones was a common form of using mobile IT for women between 31 and 50 years old.

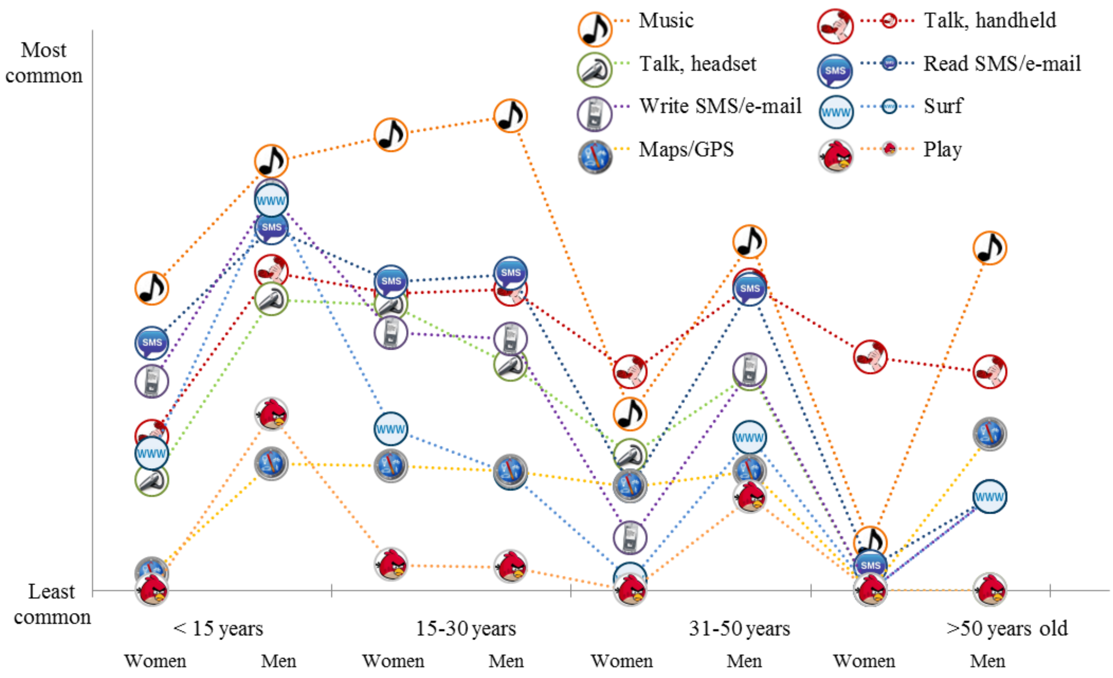

Figure 10. How cyclists use mobile IT, self-reported activity. $n_{(<15)}$=34, $n_{(15\text{-}30)}$=69, $n_{(31\text{-}50)}$=31, $n_{(>50)}$=7).

To speak in a handheld mobile phone (device to the ear) is also a relatively common activity according to self-reported information, and it was the only mobile IT usage reported by women above 50 years old. Compared to the observed behaviour, the interviewed cyclists report a higher frequency of holding the device to the ear than was observed.

To read and write sms/e-mails are also common activities (operating/interacting), especially among younger groups. It is less common to surf, use maps/gps and play games, with exception for the youngest men that play games to a larger extent than other groups.

The least common activity is playing games while cycling, even if it occurs among young males. The way the mobile device is used in not affected by how often the cyclist use the bike.

The self-reported behaviour indicate above all a higher degree of operating/interacting with the phone than what was observed. The discrepancy could be due to the observation sites, since the observations are depending on the sites, whereas the self-reported activities are for cycling in general. It could also be due to how cyclists perceive, and remember, their behaviour.

3.2 Study on cyclists' self-reported compensation strategies

3.2.1 Cyclists' self-reported compensation strategies

After each task (except baseline=normal cycling) the cyclists were asked whether they consciously had compensated in any way to be able to perform the task (in the way the cyclist chose to perform the task) and if so how they compensated to be able to perform the task (open question). The answers were categorised and grouped into six themes:

- **Reduced speed** (incl. slow down, stop, stop to initiate a task, walk alongside the bike)
- **Enhanced vision** (incl. many quick focus shifts between phone and road/traffic, look extra carefully, scan a larger road/traffic area)
- **Enhanced hearing** (incl. more focus on audial information, use only one earphone)
- **Enhanced balance** (incl. firmer grip on the handlebar)

- **Choice of location** (incl. more advance planning, wait to initiate the task until after the intersection, choose a location with good visibility to perform the task, pause the execution of the task in intersection)
- **Increased alertness** (incl. prompt oneself to stay alert, extra attention to other road users)

Many of the cyclists used one strategy for the majority of the tasks, while other chose different compensation strategies depending on type of task. Reduced speed was the main strategy (regardless of type of task) for eight cyclists, enhanced vision for three. Seven of the cyclists used different types of compensation strategy depending on type of task. Three of the cyclist did not report any compensation strategy, for any of the tasks.

3.2.2 Task difficulty and habit of using smartphone while cycling

After all five routes (including baseline) the participants were asked to rank how easy/hard the different tasks were. The results show that the baseline (without smartphone usage) was considered to be easiest, quite closely followed by listening to music, see Figure 11. Having a phone conservation and texting while cycling are considered to be equal hard/easy. The hardest task to perform was, according to the participants, the internet-task.

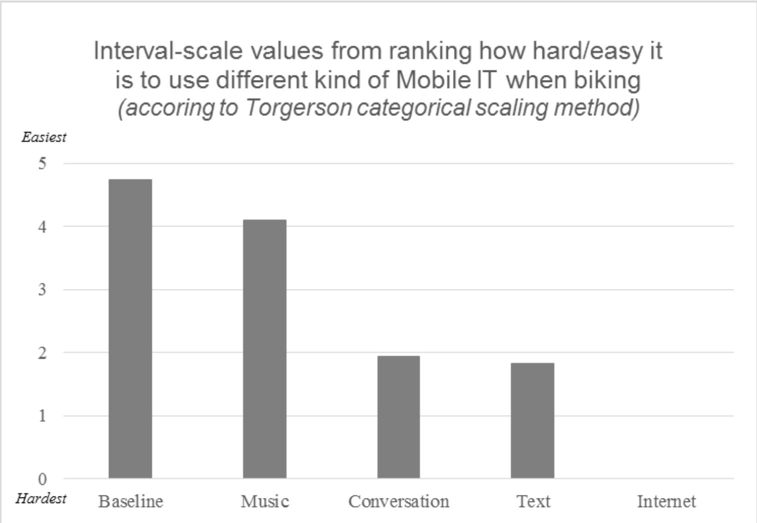

Figure 11. How easy/hard the different tasks were perceived by the participants.

Many of the participants were quite used to using a smartphone while cycling. The most common activity was listening to music, while the least common activity was playing games. This is consistent in both study 1 and study 2, see Figure 12.

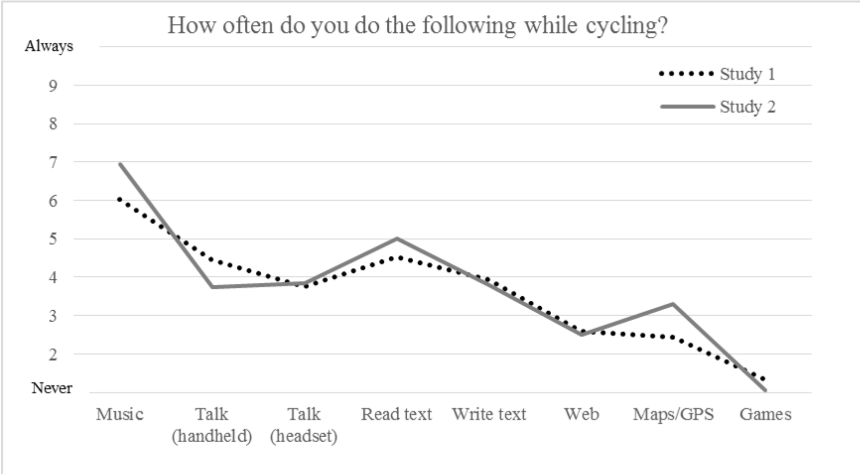

Figure 12. The habit of using smartphone while cycling. Age study 1: 17-25 years old, study 2: 16-25 years old.

3.2.3 Compensation strategy by task

Looking at which compensation strategies that were used for the four different tasks reveals trends in choice of compensation strategy for different type of tasks, see Table 5. Reduced speed tend to be a more common strategy when the difficulty in the tasks increase, as are the approach to combine different strategies e.g. reduced speed and enhanced vision. Not reporting any use of compensation strategy tend to be more common with easier tasks compared to harder.

Table 5. Reported strategies per type of task.

Type of task	Reduced speed	Enhanced vision	Enhanced hearing	Enhanced balance	Choice of location	Increased alertness	No reported strategy	Combining more strategies
Music	2	8	1	0	1	1	9	1
Conversation	9	6	0	1	3	0	6	4
Text	11	6	0	1	4	1	4	5
Internet	17	4	2	0	2	0	3	6
Sum	39	24	3	2	10	2	22	16

3.2.4 Compensation strategy by experience

The type of compensation strategy also depend on the cyclist's familiarity with the task. Cyclist that are custom to e.g. texting while cycling (answering 7-10 on a 10-graded scale of how often they text while cycling where 1 is never and 10 is always) tend to use other compensation strategies compared to cyclists that are unfamiliar with texting while cycling (answering 1-3 on the 10-graded scale).

The more familiarity the cyclists have with the task, the less often reduced speed is reported as a compensation strategy. Cyclists with low familiarity with the task seem to be using visual compensation less often and cyclist with high familiarity of the task more often reports that they don't uses any compensation strategy, see Table 6.

Table 6. Reported strategies per familiarity with the task.

Familiarity	Reduced speed	Enhanced vision	Enhanced hearing	Enhanced balance	Choice of location	Increased alertness	No reported strategy	Combining more strategies
Low	75 %	14 %	7 %	0 %	11 %	0 %	14 %	21 %
Medium	50 %	42 %	4 %	4 %	19 %	4 %	8 %	27 %
High	19 %	30 %	0 %	4 %	7 %	4 %	48 %	11 %

4 DISCUSSION AND CONCLUSIONS

The use of mobile phones while cycling is common in Sweden today. The best estimate is that mobile phones are used in about 20 percent of all cycle trips, or in about half a million trips per day in Sweden. Larger studies are, however, needed to confirm this.

The use of mobile phones while cycling is most frequent in age groups below 30 years old. The lowest use is found in age groups above 50 years old. The usage is likely to increase in the population as the mobile IT users age.

The most common activity when using mobile IT on a bicycle is to listen to music and/or radio, but reading and writing text messages and talking using hand-held phones are common activities.

Different ways of using mobile IT results in different levels of complexity. Listening to music does not normally interfere with physical performance, although it might produce a cognitive workload and mask ambient sounds. Having a conversation using a headset is similar to listening to music, however the cognitive workload is usually higher. Using a hand held device may also limit physical movement when looking for traffic in e.g. an intersection. Using mobile IT to read or write messages results in many of the same problems, but also requires visual focus.

Considering the above, it is logical that cyclists adapt their behaviour in order to use mobile IT comfortably while cycling. Speed reduction is a common reported compensation strategy, but choosing an appropriate location (e.g. with good view, or avoiding intersections) to perform the mobile IT task is also quite common.

The choice of compensation strategy seems to be related to the difficulty of the task and the familiarity of the task. Speed reduction is less frequently used for simple tasks (e.g. listening to music) and by cyclists that are very familiar with the task. When dealing with a more complex task, there is a tendency to combine strategies (e.g. lower speed and choice of location).

The difficulty of the task and the familiarity with the task could possibly be two sides of the same thing, as being more familiar with the task makes it easier and, if the task is perceived to be easy while cycling, you will do it more often. The conclusion would, in that case, be that new and difficult tasks are more often compensated by speed reduction and/or multiple strategies while for habitual or easy tasks no reported compensation strategies would be more common. The fact that the cyclists doesn't report any compensatory behaviour does not necessarily mean that they don't compensate, they may simply not be aware of how their behaviour is affected.

The frequent compensation among the cyclists using mobile IT is likely to reduce the risk of accidents and may explain why, in Sweden, there has been no increase in accidents related to the increase mobile IT usage while cycling.

During study 2 it also became obvious that the placement of the phone and the connection time also interfere with cycling. Less favourable phone placement makes it more difficult to interact with the phone, adding complexity. Furthermore, if the phone requires a long time to make a connection this may not be foreseen by the cyclists and they may fail to complete their task before, for example, entering an intersection.

Based on the results some recommendations can be made to simplify the use of mobile IT while cycling:

Technical improvements:

- Apps facilitating one-hand usage, even while wearing gloves
- More tactile interfaces reduce the need for visual attention while typing numbers/messages.
- Bicycle phone holders make the phones easy to reach and read
- Short connection times
- Homepages/apps optimised for a quick download and/or rapid transfer of information

For the cyclist:

- Use common sense – if you are looking at the phone you risk overlooking changes in the traffic.
- Only use phones in locations with a good view and calm traffic
- Stop using the phone or, stop cycling, if you don't feel you are in control.
- Don't answer the phone when you are in a complex situation, e.g. cycling through an intersection.
- When listening to music etc. only use one ear-plug
- Call back. You are more in control over the situation when you decide when to initiate a task. You don't need to answer right away, you can always call back when the timing is right.
- Don't trust your fellow road users to save the day. They might also be using mobile IT, or daydreaming.
- Place the phone in an "easy to reach" place or mute it if you don't want to be disturbed.

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