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Abstract

The report provides information on the current state of research regarding exposure perception of 5G. It also explains how the data of the present qualitative, exploratory study were obtained. The results will be published in a peer-reviewed journal.

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Contents

1   Introduction

5G is the latest mobile communications (MC) standard and emits, like earlier MC standards (2G/GSM, 3G/UMTS, 4G/LTE), electromagnetic fields (EMFs). In order to understand citizens´ reactions to the rollout of the new MC standard 5G, their perceptions of electromagnetic fields exposure need to be explored.

1.1   Objective

The present study aims to assess citizens´ 5G exposure perceptions in situations that are relevant to their daily lives. Relevant topics related to this objective were investigated, namely comparative exposure perception, the affect towards different exposure situations, and base station siting preferences. Besides, the present study aims to find out what citizens already know about 5G, what they would like to know about it, what they associate – besides radiation – with MC exposure situations, and which role 5G plays compared to other potential health risks. The results of this qualitative exploratory study will be further explored in a quantitative study which will take place in several European countries.

1.2   5G deployment

5G rollout is at different stages of progress throughout Europe. The European 5G Observatory, supported by the European Commission, is a platform that provides an overview of the 5G deployment in the European Union and releases quarterly reports. According to the European 5G Observatory (as of March 2023) 72% of the European Union's population can potentially receive 5G. Population coverage of over 90% was reached in Germany (91%), Italy (99,7%), the Netherlands (97%) and Denmark (99,3%). Network coverage of less than 40% of the population is mainly found in Eastern European countries such as Poland (43,2%), Estonia (33,3%), Latvia (0%) and Romania (24,9%).

For Germany, where the data for the present study were collected, the Federal Network Agency (Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen) similarly provides an interactive map that shows which MC standard is implemented in which region. Since 5G coverage is already very high in Germany, only a few rural regions still have no 5G. The map further allows to distinguish between 5G at 3.6 GHz and 5G DSS. The biggest difference between 5G at 3.6 GHz and 5G DSS is that 5G DSS can operate on the same frequencies as 4G, and thus 5G can be received without 5G specific base station hardware components, with the expected restrictions in performance characteristics (such as speed, beamforming, etc.). Nevertheless, the user device has to be able to use the 5G-standard.

The fact that 4G and 5G DSS base stations cannot be distinguished visually is relevant for the present study since visibility is assumed to be a relevant criterion for 5G exposure perception. The same applies to small cells or hidden antennas: for laypeople they can hardly be identified as 5G infrastructure. Unlike the different-looking 3.6 GHz antennas, on the display of their devices the users can only see whether they have 5G reception – regardless of the type (5G at 3.6 GHz or 5G DSS).

2   State of research

Previous research has examined how exposure and risk perceptions relate to each other, which misconceptions laypeople have about mobile communications, and what kind of preferences they have when choosing a new base station site. The current state of research regarding these three fields is reviewed in the following chapter.

2.1   Exposure perception

We define exposure perception as the extent to which a person feels exposed to a hazard in a certain situation. In the case of MC EMF, this can be a global perception (e.g., believing that mobile communications radiation is everywhere) or a differentiated assessment depending on the situation (e.g., feeling more exposed when one is close to a base station).

2.1.1   Exposure perception and risk perception

The concept of exposure perception needs to be distinguished from the concept of risk perception. Risk perception, as it is described in the psychometric paradigm (e.g., Slovic, 1987), is usually assessed globally, e.g., with an item such as "How risky do you think mobile phone radiation is?". This global assessment is unlikely to only depend on situational exposure perception. However, Freudenstein, Wiedemann, and Brown (2015) found a correlation between situational exposure perception ("in your opinion, how strong is the exposure to the person in the above picture?") and situational risk perception ("how dangerous do you consider this situation to be for the person [placeholder describing scenario, e.g., using the laptop]?"). Thus, it is important to distinguish between different assessments of risk perception (situational vs. global risk perception) when relating this concept to exposure perception.

It has been shown that experts and laypeople proceed differently when assessing risks. Cousin and Siegrist (2010b) created mental models of experts' and laypeople's knowledge on MC and found that experts rely on an elaborated model for risk assessment, while laypeople rely much more on their intuitive understanding. For this reason, the intuitive toxicology approach (Kraus et al., 1992) has already been used in the field of MC as an explanation for risk perception (Freudenstein, Wiedemann, & Brown, 2015). The fundamental assumption of the intuitive

toxicology framework is that laypeople (must) rely on their intuitive assessment when evaluating a risk, in contrast to experts who have in-depth knowledge. One of the basic principles of toxicology is the relation between dose and effect, which also plays a role in the assessment of EMF effects. Therefore, Freudenstein, Wiedemann, and Brown (2015) further decomposed exposure perception into its cognitive, moral, and affective components and examined their influences on risk perception. In their study, the cognitive component was found to have the strongest relation to risk perception. The weakest relation was found between the affective component and risk perception.

While risk perception has already been investigated for 5G specifically (Frey, 2021; GIM, Gesellschaft für Innovative Marktforschung, 2022; Koh et al., 2020), the current study is – to our best knowledge – the first to focus on 5G exposure perception.

2.1.2   Exposure perception and exposure knowledge

So far, there are no clear results on how knowledge about exposure characteristics affects the risk perception of MC – or more generally EMF (e.g., emitted by power lines). Freudenstein, Wiedemann, and Varsier (2015) specifically investigated which aspects influence risk perception most. They asked: "What do the potential health risks of electro-magnetic fields from exposure sources like mobile phones, mobile communication masts, or other devices depend on?". The majority of participants assumed that the duration of exposure has the strongest influence on health, followed by the strength of exposure, the distance to the exposure source, the frequency of exposure, and the number of exposure sources. The physical size of the exposure source, and the time of the day of exposure played a minor role in this context.

Therefore, the authors concluded that respondents revealed a rather adequate view about the impact of exposure characteristics like duration or strength of exposure. Further they found that the more adequate the participants' view was, the higher their risk perception regarding cell phones. However, Freudenstein, Wiedemann, and Varsier (2015) did not measure the effect on exposure perception itself, but the effect of the participants' view on exposure characteristics on risk perception.

2.2   Misconceptions

With their mental model approach, Cousin and Siegrist (2010b) also discovered some misconceptions about MC regarding the change of exposure magnitudes, regulation issues, and scientific processes. Their results were quantified in a later study (Cousin & Siegrist, 2010a). Claassen et al. (2016) conducted a similar study and created mental models of experts and laypeople regarding their EMF knowledge, followed by a quantitative confirmatory study. Participants were shown statements and indicated whether they thought they were true or false

or if they did not know the answer. On average only six out of the 17 expert statements were rated correctly by the participants. Therefore, the authors concluded that laypeople have major knowledge gaps regarding EMF from different sources.

The three studies also came to the conclusion that laypeople do not assess the relationship between distance and radiation correctly. Cousin and Siegrist (2010b) found that among laypeople, 14 out of 15 respondents thought that radiation was decreasing linearly, not with the inverse square of the distance from the source. A comparable result was reached by Claassen et al. (2016): 68% of the respondents wrongly assumed that the field strength of power lines only gradually decreases with distance. In all three cases, the exposure from base stations was overestimated, e.g., by 12 out of 15 participants in the study of Cousin and Siegrist (2010b). In addition, Cousin and Siegrist (2010b) found that 14 out of 15 respondents were not aware that the interaction of base station and cell phone causes the radiation emitted from both sources. The quantitative studies by Claassen et al. (2016) and Cousin and Siegrist (2010a) also showed that less than one third of their participants (Claassen et al.: 24%, Cousin and Siegrist: 29%) knew that exposure from the base station depends on how many mobile devices it interacts with simultaneously.

2.3   Base station siting preferences

Cousin and Siegrist (2010a) explored which locations laypeople choose as base station sites, by asking them to compare five scenarios pairwise. In each scenario, a village was pictured, with the base station located in different places. Their siting task revealed that – compared to other possible locations – people preferred the site farthest away from the village. The second most chosen site was in a church steeple, installed out of sight. Visibility is consequently likely to be an important criterion in site selection (Cousin & Siegrist, 2010a). Dohle et al. (2010) also investigated how location, appearance, building, and decision process relate to each other. The authors decided for a conjoint analysis, a multivariate method, to estimate participants' preferences by referring to an overall judgment (utility) about a set of alternatives. In line with Cousin and Siegrist (2010a), Dohle et al. (2010) concluded that location has the greatest influence, and appearance the least on base station siting preferences. Nevertheless, situations in which the base station was camouflaged were preferred. Consequently, there are different results regarding the importance of visibility and appearance of base stations with respect to siting preferences.

In a later, methodologically similar study on base station siting, Cousin et al. (2011) divided participants into three groups, with one of the experimental groups receiving an informative text about MC EMF and another experimental group receiving an emotional text about the

construction of a new base station. Specifically, the informative text provided information about GSM technology and its consequences for radiation exposure, with a special focus on the interaction effects between base stations and cell phones. After receiving the information, participants were asked to compare the six possible base station sites pairwise. Compared to the control group and the second experimental group, the informative text led to a preference for base stations closer to the village, even though the site at the outskirts of the village was still favored by many participants. Overall, the participants were able to transfer the information given in the text to the base station siting task.

3   The present study

Although situational exposure perception and situational risk perception are related, earlier studies focused strongly on risk perception. In case of Freudenstein, Wiedemann, and Varsier (2015), who explicitly investigated the exposure perception of MC, the respondents were given a set of EMF exposure characteristics potential health risk perception could depend on, such as duration or strength. However, other factors not considered by the authors could also influence the exposure perception of MC EMF. The present study moves beyond the approach of Freudenstein, Wiedemann, and Varsier (2015) by asking respondents to rank several MC exposure situations as well as capturing their decision-making process. In this way, dimensions relevant to exposure perception can also be identified without specifically asking respondents about them. Consequently, people´s reasoning is explored rather than imposed.

While previous studies on base station siting preferences drew a scenario where a fictional village was initially tethered to the cellular network, the scenario in our study was an upgrade from 2G to 5G. Consequently, MC already existed in our fictional village. In contrast to Cousin et al. (2011), who demonstrated the value of providing information in an experimental study, the present study examines the impact of information on the same group of people. This study design is relevant to find out how providing information affects a person who has already decided on a location. Moreover, our study allows to examine if there are any new trends regarding siting preferences, as the rollout of MC technology has steadily progressed in recent years.

In sum, the present study is the first, to our knowledge, to investigate exposure perception of 5G (visible through infrastructure or on devices). It addresses three main research aims: first, to find out how people evaluate certain MC exposure situations and how they explain their assessment. Second, to investigate in which situations people feel particularly exposed to EMF emitted by MC infrastructure or devices in general, and 5G in particular. Third, to learn about their preferences for the siting of 5G emitting base stations, and about the reasons for these preferences.

4   Methods

35 individual interviews and six focus groups with the same participants were conducted between December 5-7, 2022. Participants were recruited from six locations in Southern Germany (the cities of Augsburg and Munich, and four specified areas in the countryside surrounding Augsburg). These locations were chosen a) to include participants from both cities and the countryside, and b) to include participants from areas where 5G rollout was at different stages at the time the study was conducted. The current state of 5G rollout was obtained from the mobile communications monitoring map[1] of the German Federal Network Agency. 5G had already been rolled out in Augsburg (Slot 1) and Munich (Slot 2). In the specified areas surrounding Augsburg, 5G was either (a) already available or not yet available (Slot 3, 5, 6), or (b) was about to be rolled out (Slot 4, see table 1).

4.1   Participants

The sample was composed of 18 women and 17 men. On average they were 39 years old (age range 18-67). About 40% owned a 5G-enabled smartphone. While ten participants were still studying or in apprenticeship, 22 participants were full-time employed, part-time employed or self-employed, two participants stayed with their children, and one person was retired. Table 1 shows the sociodemographic information for each focus group.

The recruitment was carried out via a market research company. The company was provided with a screener (see Appendix "Screener") with inclusion criteria and sample requirements, which were defined by the research team. Participants received an individually agreed compensation by the market research company, depending on the distance between their place of residence and the IU-campus, where the interviews took place.

Table 1: Sociodemographic data by group

	Group	Participants (Gender & Age)	5G-enabled phone
Slot 1	City (Augsburg)	4m (20,25,42,56), 2f (24,53)	2
Slot 2	City (Munich)	2m (50,55), 4f (23,23,23,54)	3
Slot 3	Countryside	3m (27,45,61), 3f (34,41,52)	3
Slot 4	Countryside, area shortly before 5G rollout	3m (18,18,48), 3f (35,41,67)	0
Slot 5	Countryside	2m (32,38), 3f (26,47,50)	2
Slot 6	Countryside	3m (22,53,62), 3f (22,39,49)	3

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[1] https://www.bundesnetzagentur.de/GIGA/DE/MobilfunkMonitoring/start.html

4.2   Recruitment

4.2.1   Screener: inclusion criteria

All participants had to meet the following inclusion criteria. Since the interviews were carried out in German, participants were required to have a good knowledge of the German language. Another requirement for participation was the possession of a mobile phone. Furthermore, as we were mainly interested in the perception of average citizens, we did not include people who had been politically active for or against 5G or the further development of MC. For the same reason, people who worked in the mobile communications industry (e.g., for a mobile phone provider) could not participate, as it was to be expected that they would have stronger and more informed opinions on the topic. We included only participants who had not taken part in other studies about the topic "mobile communications" in the past year because we wanted participants to only have their natural knowledge about MC and 5G, without having been influenced by other studies on the topic. Furthermore, it was required that they had not participated in any other market research studies in the past two months.

4.2.2   Screener: sample requirements

In order to have diverse focus groups (regarding age, gender, occupation, and education), quotas were set for some sociodemographic and topic-specific aspects. The quotas were supposed to be met for each of the six groups. However, to deal with the fact that sometimes people who have agreed to participate do not show up, the market research company recruited seven people for every slot, even though only six could participate. If all seven showed up, the last to arrive received compensation and was sent home without participating. In one group, only five participants showed up. Because of this procedure, the targeted quotas for sample composition were not always met in the final groups. Beside diverse sociodemographic aspects three people of each group were supposed to have a 5G-enabled phone. This requirement was met in all groups except one.

4.3   The interviews

The individual interviews and focus group discussions took place at the International University of Applied Science's (IU) campus in Augsburg and were conducted by eight interviewers that were trained in advance. We conducted individual interviews followed by focus groups immediately afterwards with the same individuals (see GIM, Gesellschaft für Innovative Marktforschung, 2022). This approach was used to capture individual perspectives as well as the discussion within the groups. All focus groups were led by the same interviewer. The individual interviews lasted on average 17:50 minutes (min. 10:16 minutes / max. 30:41 minutes), the focus groups took on average 85 minutes (min. 66 minutes / max. 91 minutes).

4.3.1 Individual interviews

After participants were informed about the study and gave written consent to participate (see Appendix "Consent form"), the interview began. Basis for the individual, semi-structured interviews was an interview guide (see Appendix "Guide individual interview"), which was developed and discussed with the work package partners (Aristotle University of Thessaloniki (AUTH), Foundation for Research on Information Technologies in Society (IT'IS), International Agency for Research on Cancer (IARC), Greek Atomic Energy Commission (EEAE), Institute Mines-Telecom (TP-IPP), Federal Office for Radiation Protection (BfS) and National Frequency Agency (ANFR)) before being pre-tested in mock interviews among the project team and with one external test participant. The general goal was to enable participants to answer questions in a meaningful way without asking suggestively or influencing them in any other way. If a question had already been answered when responding to an earlier one, it was skipped and not asked again. Also, the interviewer was supposed to avoid using certain words that could trigger (negative) associations in participants, specifically "risk", "radiation", "danger" and "illness" or anything similar. Generally, interviewers were supposed to pick up and use the same wording as the participant, particularly if they were different terms for the same thing (e.g., "4G" and "LTE").

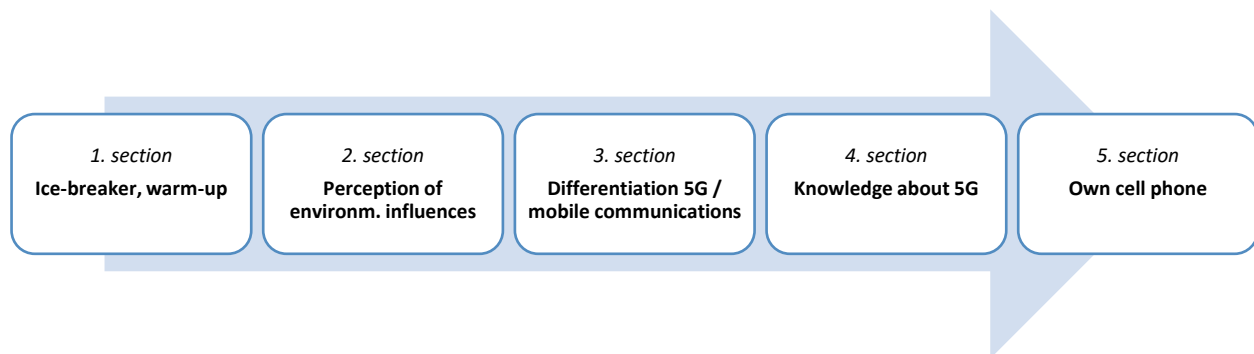| 1. section **Ice-breaker, warm-up**	2. section **Perception of environm. influences**	3. section **Differentiation 5G / mobile communications**	4. section **Knowledge about 5G**	5. section **Own cell phone**

Figure 1: Content of the individual interviews

The interview consisted of five sections (see figure 1), each including questions about different topics. In **the first section**, participants were asked in which situations in their everyday life they encounter technology. Next, interviewers asked which environmental influences participants regard as harmful to their physical and mental health. The mentioned influences (risk factors) were written down and later used in the third task of the focus group.

The second section covered the perception and rating of environmental influences. Participants received a picture (see figure 2) which depicted multiple potential hazards, including for example a highway, a factory, and a 5G base station. They were asked to think aloud while looking at the picture. If not already mentioned, further questions were asked to specifically inquire about their feelings when looking at the picture and whether they found anything worrying or potentially

harmful. Next, they were told to imagine that they live in a particular house (the one with the chimney), asked what this thought triggered in them and if they saw something that could personally harm them. Participants were then asked to rate the aspects (potential hazards) they had mentioned on a scale from 1 (absolutely harmless) to 10 (very dangerous). Finally, they were asked what they generally understood by "risk".
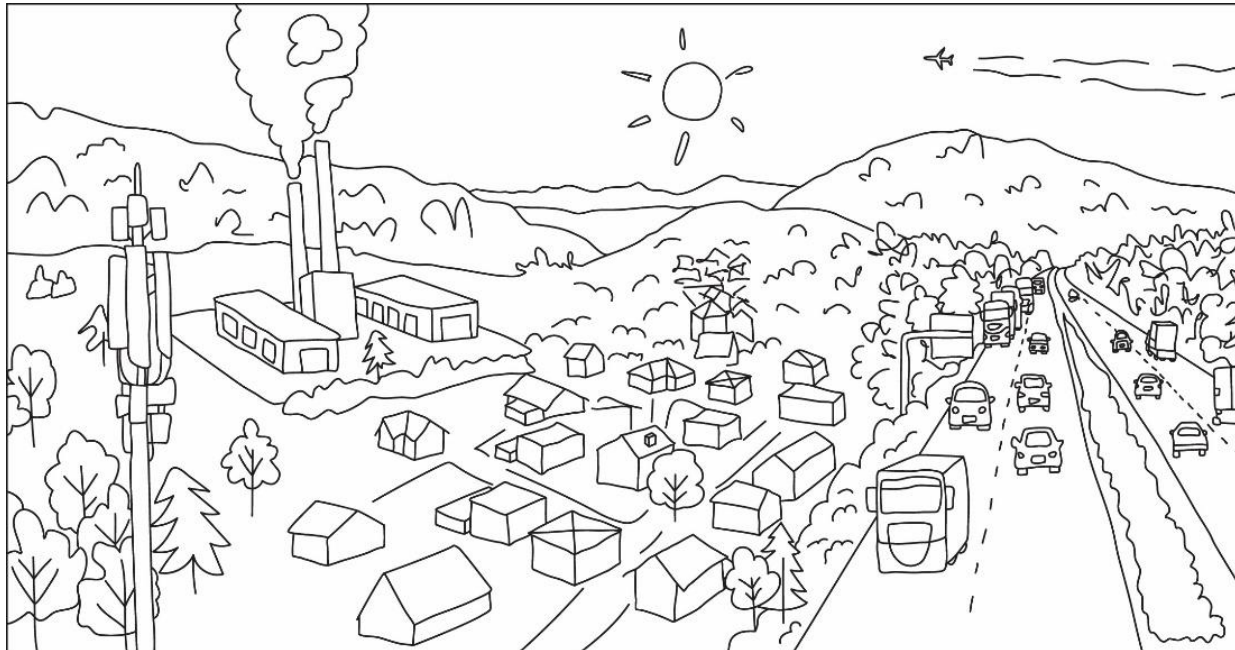

Figure 2: Multi hazard picture used in the individual interviews.

The third and fourth section were about MC and 5G. In **the third section** participants were asked which MC standards they knew about and how they thought these differ from each other. If participants did not know what a "mobile communication standard" was, they were provided with very brief information (e.g., "mobile communication standards are further developments of mobile communications"). Further questions that referred to mobile communication standards or 5G were skipped if the participants knew nothing about this topic. The interviewers also asked how the participants thought mobile communications had evolved over the past 25 years, how they could tell if they were surrounded by different standards (e.g., 2G, 3G, 4G, 5G) and what they thought about the topic of MC and health.

In **the fourth section** knowledge about 5G specifically was further addressed. If 5G was known, participants were asked to explain to a fictional friend what they understand by 5G. Afterwards, participants were asked about their information sources regarding MC and 5G, that is where they get their knowledge from (e.g., friends or family, media), which sources they find more or less trustworthy when it comes to 5G, and where they would look for information themselves. To

expand on this, they were asked to formulate a question regarding 5G to a scientist researching MC technology.

In **the fifth section** participants were asked what kind of cell phone they own, if the phone was 5G-enabled and if their mobile phone contract covered 5G. Participants were then thanked and told to wait in the room until the beginning of the focus group.

4.3.2   Focus groups

As for the individual interviews, basis for the focus group discussion was a guide (see Appendix "Guide focus group") which included questions as well as information on the procedure, important notes for the moderator and a time guideline. The contents of the focus group were also discussed with the work package partners and pre-tested in one mock focus group with four external participants. The general questions, targets and materials were predefined, but there was flexibility regarding exact phrasing and further questions that may arise during the discussion. The general goal was to receive answers/opinions from all participants in the group and allow them to have topic-related discussions among each other.

In the beginning of the focus group, the moderator introduced herself and informed the participants once more that the group discussion would be recorded and filmed. She also explained that all participants had done the same individual interview and gave some information about the procedure and discussion culture in the focus group. If there were no more questions, the focus group began. It consisted of five sections (see figure 3), each including tasks or questions about different aspects of MC and 5G.
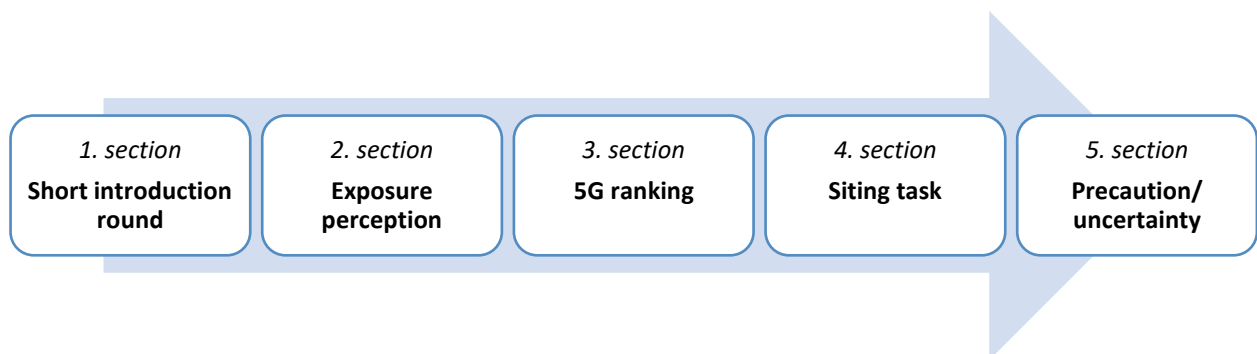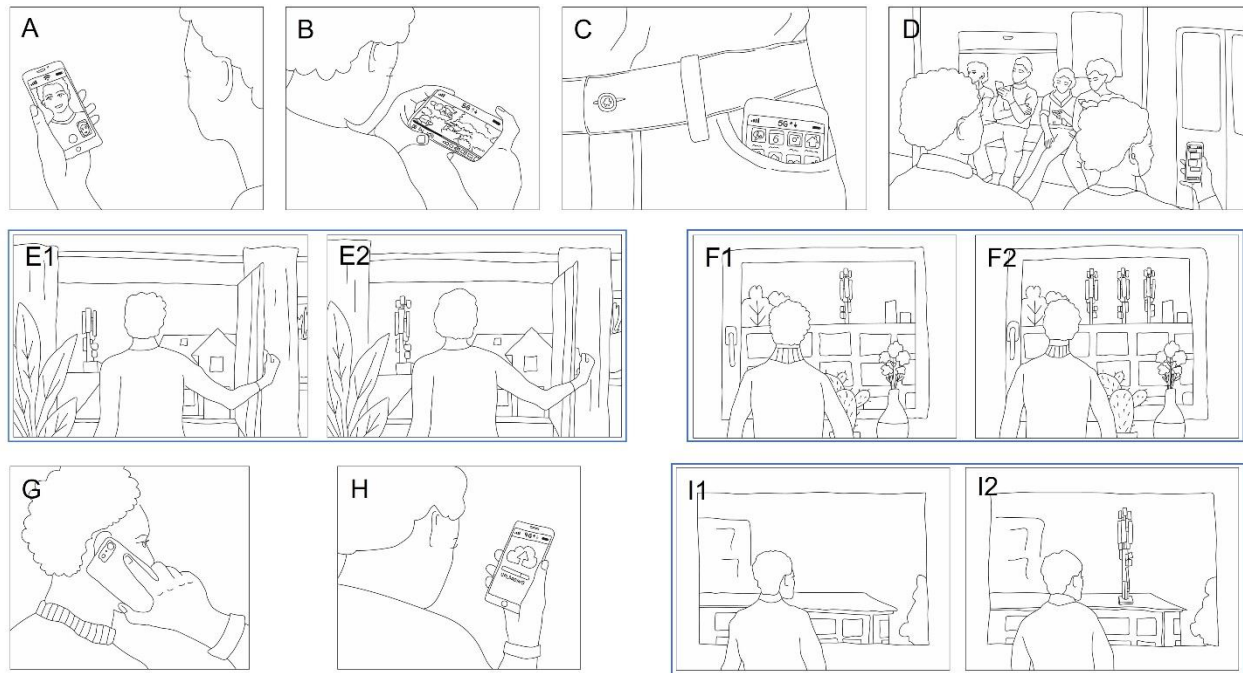
| 1. section
Short introduction round | 2. section
Exposure perception | 3. section
5G ranking | 4. section
Siting task | 5. section
Precaution/ uncertainty |

Figure 3: Content of the focus groups

The first section started with a short introduction round. Participants were asked to introduce themselves briefly (first name, age, profession, and place of residence) and to summarize what they think about 5G. To make sure that all participants had at least an idea of what 5G is and could take part in the discussions, the moderator then presented some facts about 5G.

In **the second section**, participants received pictures showing different situations where someone is exposed to MC or 5G (see figure 4), created for the study in collaboration with a professional illustrator. They were shown the pictures one by one (except for situation E, F, and I, which consisted of two pictures with a before and after comparison). The order of the pictures was the same for every focus group. Those situations were identified by the work package leader in close consultation with the work package partners.

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Figure 4: Exposure situations used for affective evaluation and in the sorting task.

The final selection covered a variety of situations in which 5G/MC infrastructure or devices can be seen by a person or are close to their body. Further, those situations covered several possible dimensions/features (see table 2) that could affect exposure perception. It was not possible to vary every dimension systematically because this would have required much more time and challenged the motivation of the participants.

Table 2: Exposure situations

Picture	Scenario	Features/Dimensions
A	Video call with Wi-fi	Device: Phone Network type: Wi-fi, shown on the display Data transfer: Uplink & downlink, shown on the display
B	Video stream with 5G reception	Device: Phone Network type: 5G, shown on the display Data transfer: Downlink, shown on the display
C	Cell phone in front trouser pocket	Device: Phone Network type: 5G, shown on the display Proximity to particular body parts
D	Tramway drive	Device: Phone Location: In public, indoors Quantity: Of surrounding devices
E1+E2	Comparison: "Normal" site vs. Expanded site	Device: Base station Change: In network type Network type: 5G vs. former types Location: Home, indoors
F1+F2	Comparison one vs. three antennas	Device: Base station Change: In quantity, 1 vs. 3 antennas Network type: 5G Location: Home, indoors
(G)	Phone call with cell phone to ear	Device: Phone Proximity to particular body parts
(H)	Upload with 5G reception	Device: Phone Network type: 4G, shown on the display Data transfer: Uplink, shown on the display
(I1+I2)	Comparison: No antenna vs. one antenna	Device: Base station Change: In quantity, 0 vs. 1 antenna Network type: 5G Location: Home, indoors

A conscious decision was made to introduce "similar" situations (first the cell phone situations, later the base station situations) one after the other to sharpen focus on differences (reception, upload/download). It was also decided to show the change-situations at the same time (instead of one after the other) because time was limited.

Participants were told to put themselves in the situation and judge it as if they were the person in the picture. To capture participants' first impression regarding the situations, everyone received two cards depicting a "plus" and a "minus". They were instructed to reach for the plus if they had a good feeling about a situation and for the minus if they had a bad feeling. As there was no neutral option, they were made aware that these could also be minimal affective tendencies. After everyone had decided for the plus or minus, the moderator initiated a

discussion by asking participants about the reasons for their decision. Situation G, H and I were optional and only shown to participants if time allowed it. Situation G was discussed in four focus groups, situation H and I in two groups. It is important to note that in the second section, the moderator did not ask questions about exposure perception, but general questions about participants' affective reactions to the situations. Exposure was only discussed if participants brought the topic up themselves.

The third section consisted of two sorting tasks. In the first one, participants were asked to sort all situations according to their exposure perception regarding MC in general ("How would you arrange the pictures hierarchically? Please place the picture in which the person in the picture, i.e., you, is, in your opinion, most exposed to mobile communications in general in first place, and the picture in which the person, i.e., you, is least exposed to mobile communications in last place."). All situations (A-I) were included, even if G, H, and I had not been discussed before. The pictures that were part of a before and after comparison (E, F, and I) were to be sorted separately. After finishing, they had time to look at each other's sorting and to discuss their reasons. They were asked if they would change anything if the question was not about MC in general but about 5G ("If we now go from mobile communications in general to 5G in particular: Would your sorting change? If so, how would you rearrange the situations?") and if there were other situations where they feel exposed to 5G.

For the second sorting task, participants received several cards each naming a different environmental influence that could be potentially harmful to health. These potential hazards were chosen based on what participants had said in the individual interviews. The idea behind was that we wanted to include hazards which are relevant to each person's everyday life. If not named, "mobile communications" and "5G" were added by us. Participants were instructed to: "Please arrange the cards so that the most harmful environmental impact for you is at the top and the one with the smallest impact is at the bottom." After finishing, participants had time to look at each other's sorting again and to discuss the reasons for their choices.

In **the fourth section**, participants were given another interactive task, which consisted of placing a base station antenna in a fictional scenario. The siting task was created based on the study by Cousin et al. (2011). In their experiment, Cousin et al. (2011) have investigated how differing information can influence the selection of a fictional base station location. Participants were first asked to choose a base station site without influencing their decision with new information. Then they were provided with information on how the distance between cell phone and base station affects their exposure. Afterwards they were asked to reconsider their choice and were free to change their location.
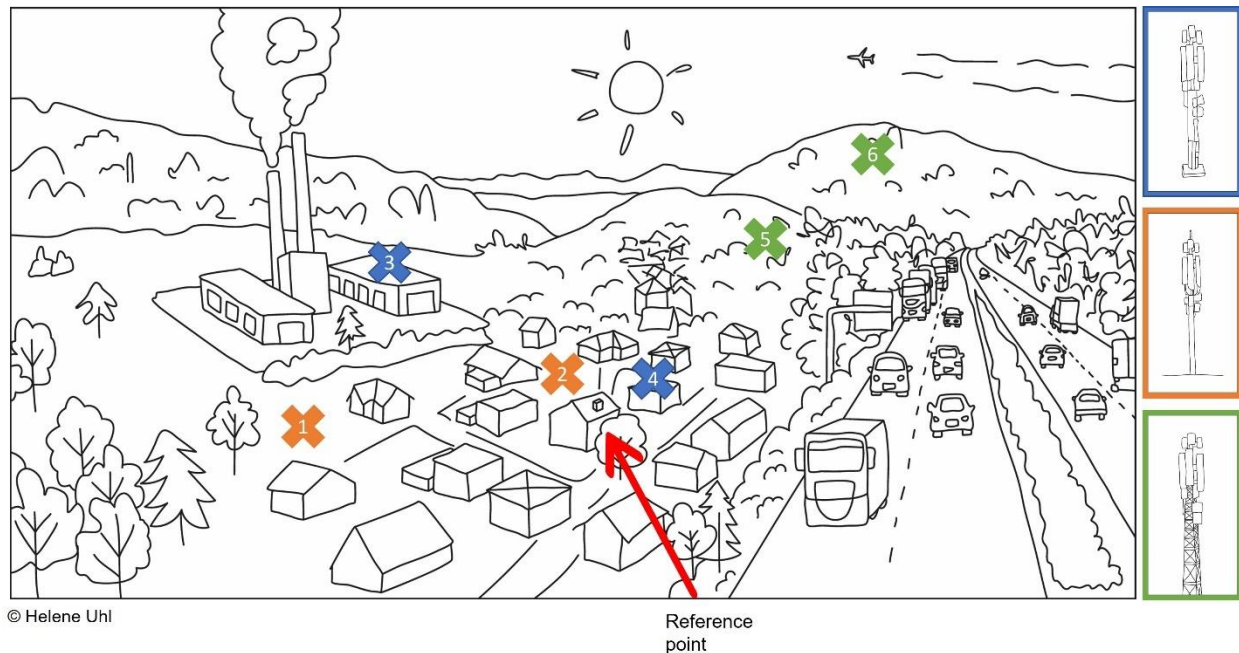
Figure 5: Picture used in the siting task.

Participants received a very similar picture (see figure 5) as in the individual interviews, with the only difference being that there was no base station yet. They were told to imagine that they lived in a particular house (again, the one with the chimney) and until now, there had only been 2G-reception in the village. Now, a new base station antenna which would cover the village with 4G and 5G was supposed to be erected in one of six possible locations (each marked with a crossing in the picture). Depending on the location, the base station antenna would look different. To make the task more vivid, participants were presented with the picture as well as little cut-out base station antennas. After they had decided for a site, participants explained their choices to each other and discussed their decisions. They were then given some basic information on the operation of base stations and cell phones:

"Now I would like to give you some more information about cell phones and base stations. First, the farther away a base station is, the worse your reception will tend to be. Cell phones and base stations interact with each other. Cell phones, like base stations, are transmitters and receivers at the same time. Since the cell phone is generally much closer to you than the base station, regular users of cell phones or smartphones are therefore exposed to higher radiation levels from the personal device than from the base station. In addition, the further away a base station is, the stronger the cell phone has to transmit to reach the station. The radiation exposure for users therefore increases with increasing distance from the mast."

Subsequently they were asked if they would change the location of the base station now.

The implementation of **the fifth section**, which covered the topics of precautions and the perception of scientific uncertainty, was optional and depended on how much time was left. It was discussed in five focus groups. First, participants were asked if they were taking steps to reduce their exposure to 5G or radiation emitted in MC in general and to specify what these steps are. Then, they were given a fictional statement by a supposed scientist: "It is not possible to completely rule out negative health effects from 5G. However, the current state of research does not suggest any risks.". Participants were asked if they believed the statement to be credible and trustworthy and how certain they thought the scientist was about what he is saying.

Finally, participants were asked if their opinion on 5G had changed during the focus group discussion. Then, they were debriefed and informed about the purpose of the study. They received a one-pager with information about the project (see Appendix "Information on 5G") and were given the option to sign a consent form for possible invitations to further studies (see Appendix "Consent form: Contact").

4.4   Data Analysis

The recordings of the individual interviews and the focus groups were transcribed using the software F4 by three members of the project team and two student assistants. A transcription guideline was used, which was based on Dresing and Pehl (2015) and adjusted to our circumstances (see Appendix "Transcription guide"). Afterwards the qualitative data were structured using the software MAXQDA. Guided by our initial research questions, we deductively formed the categories to be coded (see Appendix "Code book"). Moreover, the affective reactions to each exposure situation were counted and the order of the exposure situations resulting from the sorting task was analysed.

5   Results/Discussion

The results will be made available to the public and published in peer-reviewed journals. Once the results are published, we will also provide an updated version of this report including references to the published findings.

6   References

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7   Appendix

7.1   Screener

Set up

	Group / Catchment area*	Date, Time
Slot 1	Augsburg	12/05 2:30 pm
Slot 2	Munich	12/05 5:00 pm
Slot 3	Countryside with 5G	12/06 2:30 pm
Slot 4	Schwabmünchen-Birkach	12/06 5:00 pm
Slot 5	Countryside without 5G	12/07 2:30 pm
Slot 6	Countryside, area shortly before 5G rollout	12/07 5:00 pm

* In general, it doesn't matter which group is in which slot, so for example it could also be Munich in slot 1, and so on.

Each slot is to be filled with six people from the corresponding catchment area. In parallel, six short individual interviews will be conducted (max. 30 minutes), followed by a short break and a group discussion lasting max. 1.5 hours.

Screener

Hello, my name is *[name]* from *[agency]*, we are currently organizing a study on technology and its perception. Are you interested in participating?

( ) yes

( ) no → say thank you and finish

Fine, then I would like you to answer a few questions for me!

Q: <u>Have you participated in a product survey, focus group, interview, etc. in the last year?</u> If yes: <u>On what topic?</u>

- If the person participated in a market research study in the last 2 months → please thank and finish

- If the person participated in the last year on the topic of mobile communications
  → please thank and finish

_____   _____

Topic   Time frame

_____   _____

Topic   Time frame

Q: Do you own a cell phone (cell phone or smartphone)?

( ) yes

( ) no → please thank and finish

Q: What kind of model do you own? (Goal: Use the listing (5G-ebabled devices) to find out if it is a 5G-enabled device).

- If model not known, please note and ask: In which year did you purchase your cell phone? → before 2020 = not 5G-capable

- If multiple cell phones, record all. 5G-enabled trumps not 5G-enabled.

Apple	OnePlus	Huawei
( ) iPhone SE	( ) OnePlus 8 5G	( ) Honor 30 Pro+ 5G
( ) iPhone 12	( ) OnePlus 8 Pro 5G	( ) Honor 50 5G
( ) iPhone 12 Pro	( ) OnePlus 8T 5G	( ) Honor 70 5G
( ) iPhone 12 Mini	( ) OnePlus 9 5G	( ) Honor Magic 4 Pro 5G
( ) iPhone 13	( ) OnePlus 9 Pro 5G	( ) Mate X2 Global Dual SIM 5G
( ) iPhone 13 Pro	( ) OnePlus 10 Pro 5G	( ) Mate 40 5G
( ) iPhone 13 Pro Max	( ) OnePlus Nord 5G	( ) Mate 40 RS 5G
( ) iPhone 13 Mini	( ) OnePlus Nord 2T 5G	( ) Mate 40 Pro 5G
( ) iPhone 14	( ) OnePlus Nord CE 5G	( ) Mate 40 Pro+ 5G
( ) iPhone 14 Plus		( ) P40 Lite 5G

( ) iPhone 14 Pro

( ) iPhone 14 Pro Max

Xiaomi

( ) Xiaomi Mi 10T

( ) Xiaomi Mi 10T Pro

( ) Xiaomi Mi 10 Lite 5G

( ) Xiaomi Mi 11 5G

( ) Xiaomi Mi 11T 5G

( ) Xiaomi Mi 11T Pro 5G

( ) Xiaomi Mi 11 Ultra 5G

( ) Xiaomi Mi 11i 5G

( ) Xiaomi Mi 12 5G

( ) Xiaomi Mi 12 Pro 5G

( ) Xiaomi Redmi 10 5G

( ) Xiaomi Redmi Note 11 Pro

( ) Xiaomi 11T 5G

( ) Xiaomi 11T Pro 5G

( ) Xiaomi 11 Lite 5G NE

( ) Xiaomi 12 Lite 5G

( ) Xiaomi 12 5G

( ) Xiaomi 12 Pro 5G

( ) Xiaomi 12T

( ) Xiaomi 12T Pro

( ) Xiaomi Black Shark Pro 5G

Samsung

( ) Samsung Galaxy A22 5G

( ) Samsung Galaxy A33 5G

( ) Samsung Galaxy A52s 5G

( ) Samsung Galaxy A53 5G

( ) Samsung Galaxy M52

( ) Samsung Galaxy S10 5G

( ) Samsung Galaxy S20 5G

( ) Samsung Galaxy S20+ 5G

( ) Samsung Galaxy S21 5G

( ) Samsung Galaxy S21 FE 5G

( ) Samsung Galaxy S21 Ultra 5G

( ) Samsung Galaxy S21+ 5G

( ) Samsung Galaxy S22 5G

( ) Samsung Galaxy S22+ 5G

( ) Samsung Galaxy S22 Ultra 5G

( ) Samsung Galaxy Z Fold2

( ) Samsung Galaxy Z Fold3

( ) Samsung Galaxy Z Fold4

( ) Samsung Galaxy Z Flip3

( ) Samsung Galaxy Z Flip4

( ) Samsung Galaxy XCover6 Pro Enterprise

Google

( ) P40 Pro 5G

( ) P40 Pro+ 5G

( ) Nova 7 5G

Realme / Oppo

( ) realme 7 5G

( ) realme 8 5G

( ) realme 9 5G

( ) realme 9 Pro 5G

( ) realme 9 Pro+ 5G

( ) realme 9 Pro 5G

( ) realme GT 5G

( ) realme GT Master Edition

( ) realme GT neo 2

( ) realme GT neo 3

( ) realme GT 2 5G

( ) realme GT2 Pro 5G

( ) realme X50 Pro 5G

( ) Find X2 5G

( ) Find X2 Pro 5G

( ) Find X3 Pro 5G

( ) Find X5 Pro 5G

( ) realme Narzo 50 5G

( ) MOVIL Smartphone realme X50

( ) Reno 7 Z 5G 2022

( ) Xiaomi Poco F2 Pro 5G

( ) Xiaomi Poco F4 GT 5G

( ) Xiaomi Poco X3 GT 5G

Nothing Phone

( ) Nothing Phone (1) 12 GB RAM

( ) Nothing Phone (1) 8 GB RAM

Lenovo

( ) Legion Phone Duel 2 5G

Asus

( ) ROG Phone 3 5G

( ) ROG Phone 5 5G

( ) ROG Phone 5s 5G

( ) ROG Phone 5s Pro 5G

( ) ZenFone 7

( ) ZenFone 7 Pro

( ) ZenFone 8

( ) ZenFone 8 Flip

LG

( ) LG V50 ThinQ

( ) Google Pixel 4a 5G

( ) Google Pixel 5 5G

( ) Google Pixel 5a 5G

( ) Google Pixel 6

( ) Google Pixel 6a

( ) Google Pixel 6 Pro

( ) Google Pixel 7

( ) Google Pixel 7 Pro

Sony

( ) Xperia 1 IV 5G

( ) Xperia Pro-I

( ) Xperia Pro 5G

( ) Xperia 1 II 5G

( ) Xperia 1 III 5G

( ) Xperia 5 II 5G

( ) Xperia 5 III 5G

Microsoft

( ) Surface Duo 2 5G

ZTE

( ) Nubia Red Magic 5G

( ) Nubia Red Magic 5S

( ) Nubia Red Magic 6S Pro 5G

( ) Nubia Red Magic 7S Pro 5G

( ) Nubia Red Magic 7 5G

( ) Nubia Red Magic 7 Pro 5G

( ) Axon 11 5G

( ) Axon 30 5G

( ) Axon 30 Ultra 5G

Motorola

( ) Moto G200

( ) Moto Edge 30 Pro

( ) Moto Edge 20

( ) Moto Edge 20 Lite

( ) Moto g100 Global Dual SIM

Note: Many of the listed devices are also sold without the reference to 5G and only under the model number.

( ) Non 5G-enabled cell phone: _____

Quota (hard): 50% / 50% per focus group. If this is not feasible, 30% / 60% is also fine.

Q: <u>Are you involved in volunteer work? Are you politically active? If yes, where / how?</u>

( ) yes

( ) no

If yes, does person advocate for / against 5G / mobile expansion? (do not ask explicitly!)

( ) yes → please thank and finish

( ) no

Q: <u>What gender do you identify as?</u>

( ) Female

( ) Male

( ) Divers (*joker*)

Quota (hard): Per slot 50% women & 50% men, max 1 person per slot diverse (can take place of a man or a woman).

Q: <u>Please tell me: How old are you?</u>

_____ years (fill in age and assign to groups accordingly).

( ) Under 18 years → thank you and finish

( ) 18-39 years

( ) 40-65 years

( ) Over 65 years

Quota (soft): Per slot: invite 40-50% 18-39 year olds & 40-50% 40-65 year olds, invite max 20% over 65 year olds.

Q: <u>Are there children living in your household?</u>

( ) yes

( ) no

Quota (soft): Per group, persons with and without children

Q: <u>Where do you live?</u>

Please mark with a cross where applicable, otherwise complete the answer in the free field.

<u>City</u>	<u>Surrounding area without 5G</u> (less than 20.000 residents)
( ) Augsburg	( ) Holzburg
( ) München	( ) Asbach
	( ) Eismannsberg
<u>Recent 5G expansion</u>	( ) Haunswies
( ) Schwabmünchen-Birkach	( ) Wiesenbach
	( ) Lechlingszell
<u>Surrounding area with 5G</u> (less than 20.000 residents)	( ) Unterperlmühle
	( ) Oberperlmühle
( ) Diedorf (~10.600 residents)	( ) Holzheim
( ) Aystetten (~ 3.000 residents)	( ) Bergendorf
( ) Derching (~ 1.700 residents)	( ) Todtenheim
( ) Dasing (~ 5.800 residents)	( ) Nördling
( ) Kissing (~ 11.700 residents)	( ) Wächtering
( ) Mering (~ 15.000 residents)	( ) Agathenzell
( ) Bobingen (~ 17.500 residents)	( ) Ebenried
( ) Wehringen (~ 3.000 residents)	( ) Neukirchen
If there are not enough participants in these places, also:	( ) Hölzlam
( ) Gersthofen (~20.800 residents)	( ) Stuben
( ) Neusäß (~22.000 residents)	( ) Affaltern
<u>Surrounding area shortly before 5G rollout</u> (less than 20.000 residents)	
( ) Baar (Schwaben)	

Other location: _____

- Only relevant if city is not listed:

- Please briefly research how many inhabitants the place has.

- Towns with fewer than 20,000 inhabitants are considered rural areas and are relevant for the surrounding area groups. The mobile communications map of the Federal Network Agency (checkmark for 5G) can also be used to identify whether 5G is available in this location or not: https://www.breitband-monitor.de/mobilfunkmonitoring/karte

Q: <u>Are you currently employed or studying / in apprenticeship? If yes, are you: …?</u>

- If more than one category applies, please select the one that is considered your "main job" (e.g., student who is working part-time at the same time)

( ) Employed or self-employed full-time

( ) Employed or self-employed part-time

( ) In apprenticeship

( ) Studying

Q: <u>If no, are you: …?</u>

( ) Looking for a job

( ) On parental leave

( ) Staying at home

( ) Retired

Quota (soft): min. 50% employed, max. 25% not employed (= answer "no"), max. 25% trainees / students

Q: If employed or self-employed full-time / part-time: <u>What is your current occupation?</u>

If job-seeking / on parental leave / staying at home / retired: <u>What was your last professional activity?</u>

If in apprenticeship / studying → Skip question

_____   _____

Exact job title   Industry

Quota (soft): Please recruit as diverse as possible.

Q: <u>At which employer do / did you work?</u>

- If person works / worked for a mobile network operator (Vodafone, Telecom, Telefónica, O2), please thank and end.

Q: <u>What is your highest educational qualification?</u>

( ) No degree

( ) Elementary school

( ) Secondary school

( ) Vocational school

( ) High school diploma

( ) University, University of Applied Sciences

( ) Other degree: _____

Quota (soft): Good mix of educational degrees!

Invitation

We would like to invite you to an individual interview (0.5 h) followed by a group discussion (1.5 h) on *[date]* at *[time]*.

Are you able and willing to participate in this discussion session?

( ) Yes, acceptance

( ) No, cancellation

7.2 Participant information

PARTICIPANT INFORMATION

for the study *Technology and situation-specific perception*

Dear Sir or Madam,

Thank you for your interest in our scientific study! With this **Participant Information** we would like to give you some information about the study.

Please read the following information carefully first and then decide whether or not to participate in this study. Both your participation and non-participation are up to you. If you have any further questions about the study beyond this information, we will be happy to answer them.

Your contacts for this study are Prof. Dr. Christoph Böhmert (christoph.boehmert@iu.org), Sarah Link (sarah.link@iu.org), Dr. Marie Eggeling (marie.eggeling@iu.org) and Ferdinand Abacioglu (ferdinand.abacioglu@iu.org).

Problem definition and aim of the scientific project

The use of technical devices plays an increasingly important role in our everyday lives. On the one hand, technology is constantly evolving, and on the other, new developments are constantly coming onto the market and thus into our lives. In this study, we would like to examine your personal experiences with certain technical innovations. We are primarily interested in your perceptions in certain situations.

Study process

Participation in the study will take a maximum of 120 minutes. As part of the study, you will participate in an individual interview and a group discussion. The interview and the group discussion will be recorded in order to be able to evaluate them afterwards with regard to the research question. The files will be deleted as soon as the anonymized transcripts have been made.

For your participation in the study, you will receive compensation in the amount agreed upon with Sociogramma.

Benefits

Not only does the research benefit from your participation, but you also learn more about technical innovations and gain an insight into current psychological research. For science, your participation in the study means an additional gain in knowledge.

Risks for the participants

There are no risks for you by participating in the study. Participation in the study is voluntary. You can terminate your participation at any time without any disadvantages.

Confidentiality risks (e.g., the possibility of identifying the person concerned) exist whenever data is collected, stored, used and transmitted. These risks cannot be completely excluded and increase when more data can be linked together. The study management assures you that it will do everything possible according to the state of the art to protect your privacy.

Discussion of benefit and risk

Since there are no risks for you by participating in the study and you have the option to terminate participation at any time without disadvantages, the benefits of participation outweigh the risks in the view of the research team. You are, of course, free to come to a different conclusion and decide not to participate – this will also not result in any disadvantages for you.

Obligations of the participants

When participating in the study, you agree to follow the instructions and to answer the questions conscientiously and truthfully.

Requirements for participation in the study

You are at least 18 years old and have a very good knowledge of the German language.

Confidentiality and handling of data

The evaluation and use of the data is anonymized. Of course, your data will be treated confidentially and used only for scientific purposes. This also includes the publication of anonymized quotes in scientific publications and the forwarding of anonymized data to professional colleagues.

Contact data will only be collected for possible renewed contact and only after your explicit consent and will be kept strictly confidential. These will be destroyed at the latest after the end of the project (May 31, 2025).

Voluntariness and anonymity

Participation in the study is voluntary. You may terminate your participation in this study at any time and without giving reasons, without incurring any disadvantages. The data and personal communications collected as part of this study described above will be treated confidentially. Thus, those project staff members who have contact with you or personal data at their disposal

are subject to the duty of confidentiality. Furthermore, the results of the study will be published in anonymous form, i.e., the data cannot be assigned to your person.

Data protection

Personal data (name, age, place of residence, etc.) are collected and processed as part of the study.

The electronic storage and processing of your data takes place anonymously at the IU Internationale Hochschule GmbH (Juri-Gagarin-Ring 152, 99084 Erfurt) using a number without your name. Personal data such as name and contact details remain exclusively in analogous form with the study management (Sarah Link) and are used to assign the statements made to a person. These data will also be destroyed at the end of the project (May 31, 2025 at the latest). The documentation of your data and its archiving is exclusively anonymized in a protected electronic database, to which only authorized employees have access. All employees involved are bound to professional secrecy.

The anonymized data are processed and used in the form of anonymized transcripts on electronic data carriers, usually for a period of 10 years, unless the purpose of the study, e.g., in the case of inclusion in a database and long-term studies, requires a longer storage period. The audio or video recordings made during the interview or group discussion are deleted after transcription, at the latest three months after recording.

The information obtained in the course of this study may also be transferred for scientific purposes to cooperation partners within the scope of the European General Data Protection Regulation (GDPR) or with a comparable level of data protection.

The research results from the study will be published exclusively in anonymized form in professional journals or in scientific databases. Your identity will not be disclosed when the research results are published.

You can request information about your stored data at any time or request a free copy and have the right to have incorrect data corrected. You can also request at any time that your data is being deleted so that a reference to your person can no longer be established. These rights are restricted in accordance with Section 13 of the State Data Protection Adjustment Act and Section 27 of the Federal Data Protection Adjustment Act, respectively, to the extent that these rights are likely to make it impossible or seriously impair the realization of the respective research purposes and the restriction is necessary for the fulfillment of the respective research purposes. Furthermore, the right to information does not exist if the data is required for scientific research purposes and the provision of information would require a disproportionate effort.

The study management is responsible for data processing and compliance with legal data protection regulations. If your data is processed on the basis of your consent, you can revoke this declaration of consent at any time with effect for the future.

For the collection, storage, use and disclosure of your data, your express consent is required by signing the data protection consent form.

Your personal data will be processed by IU Internationale Hochschule GmbH, Juri-Gagarin-Ring 152, 99084 Erfurt. IU has appointed Dr. Annette Demmel, SPB DPO Services GmbH, Unter den Linden 21, 10117 Berlin, annette.demmel@spb-dpo-services.com, as its external data protection officer. In case of complaints, you can contact this office.

To assert your rights, please contact the specified office in writing. In addition, you have the right to lodge a complaint with the data protection supervisory authority in accordance with Art. 77 SDGVO.

7.3   Consent form

CONSENT FORM

Declaration of consent to participate in the scientific study

„Technology and situation-specific perception"

Study management:
Prof. Dr. Christoph Böhmert, christoph.boehmert@iu.org
Sarah Link, sarah.link@iu.org

Respondent data

_____

(Surname, first name)

I have read and understood the participant information for the above study. I have been given a copy of the information and the consent form. I have been informed about the significance and scope of the study, in particular its objectives, duration, procedure, benefits, risks and side effects of participation in the study. In addition, I had sufficient opportunity to ask questions (e.g., about the content, aim, course and risks).

I understand that if I have any questions or problems, I can contact the study supervisor at any time using the contact information provided above.

I agree to participate in the study. My participation is voluntary.

I affirm that I am at least 18 years old.

I know that I have the possibility to terminate my participation in this study at any time and without giving reasons, without any disadvantages for me.

_____   _____

Place, date   Signature

7.4   Guide individual interview

Information for the interviewer

Time limit: 20-25 minutes

The study participants were already "checked-in" at the reception desk. This means that their identity was already checked, and the consent form was handed out and signed.

Please fill in the header for assignability.

Please avoid the following words unless they were introduced by the study participant him/herself:

Risk (not before definition of risk), radiation, danger, illness

Explanation of the guide:

- Italic means „Instruction for action" and is not read aloud

- The pen (✎) means that the interviewer has to write down the answer(s) for the further process. These will be handed over to the focus group leader.

- Otherwise, empty boxed represent space for optional conversation notes.

- The arrow (→) indicates that the further course depends on the response of the study participant

- Sentences after bullet points that have not been formulated should be freely formulated by the interviewer. Otherwise, please stick to the chosen words as far as possible.

General information (3 min.)

In own words:

- Short introduction (with name and function)

- Informing participants about recording, data protection and anonymization

- Ask for short introduction by study participant (first name, age, profession, own children/children in household, age of the children)

- "Please switch off cell phone"

- "Please answer honestly and unfiltered, speak your thoughts out loud, also talk about feelings"

- Brief information on the procedure:

Several individual interviews are being conducted in parallel, after which you will meet the other study participants in order to continue the conversation in a group discussion. We will talk about everyday situations, and I am most interested in how you perceive them.

- Ask if there are any questions

1. Ice-breaker / warm-up (3 min.)

If you think about your everyday life, in which situations do you encounter technology?

Only if cell phone not mentioned: Do you also use a cell phone? When do you use it?

Our physical and mental well-being can be influenced by various factors. Which environmental influences do you consider (especially) harmful to your health?

- *If asked, please paraphrase first, if still unclear, give example:* An example would be contaminated drinking water.

✎ *Note which factors are mentioned. We will come back to this later.*

2. Perception of environmental influences (5 min.)

Present picture depicting multiple potential hazards, including mobile communications/5G. Lead directly:

I am going to show you a picture in a moment and would like to ask you to speak your thoughts out loud. *Briefly give time to share thoughts.*

When you look at this picture, what does it trigger in you?

If necessary, ask: Why is that? Why does xy trigger these feelings in you?

Do you think something here could harm you? Does something here worry you?

Imagine that you live in the house with the chimney that you see in the picture (*point to it, if necessary*). What does this thought trigger in you?

Do you see something that could harm you personally here?

Now we have talked extensively about the picture and your view. How do you rate the various aspects [such as car fumes, noise, mobile communications, …] on a scale from 1 to 10, where 1 means absolutely harmless and 10 very dangerous? Again, please assume that you live in the house with the chimney.

✎ *Please only ask what was also named by the interviewed person (please mark with a cross), or name unlisted factors under "other factors":*

[ ] Fumes (motorway): ___   Other factors:

[ ] Noise (motorway): ___   _____: ___

[ ] Pollutants / Fumes (factory): ___   _____: ___

[ ] Mobile communications: ___   _____: ___

[ ] 5G: ___   _____: ___

[ ] UV-radiation (sun): ___

Now we can put the picture aside for the moment. What do you yourself understand by risk in general?

3. Differentiation 5G / mobile communications (4 min.)

If base station antenna mentioned: You have already identified a mobile communications base station in the picture.

Which mobile communication standards do you know (in addition)?

- *If necessary, explain:* Mobile communication standards are further developments of mobile communications

  → *If 5G is mentioned:* What does 5G mean to you?
  → *If no standards are known, skip next questions*

How do you think mobile communication standards differ from each other?

→ *If no answer here, then skip first question in block 4*

How do you think mobile communications have evolved over the past 25 years? What has changed?

How can you tell that you are surrounded by 2G (GSM) / 3G (UMTS) / 4G (LTE) / 5G (NR)? *(if necessary, assist: Visibility of the technology, feeling/sense, …)*

I would also like to know what you think about the topic of mobile communications and health.

4. Knowledge about 5G (5 min.)

→ *1st question is only asked if 5G/mobile communication standards are known:*

[   ] *yes, 5G is known*

[   ] *no → skip question*

Let's now talk more about the 5G mobile communications standard. You have already told me what you know about 5G. Now I would be interested to know how you would explain to a friend what you understand by 5G.

How do you know what you know about mobile communications/5G? *(What are your sources of information?)*

- *If necessary, ask – if not mentioned:* What about other sources?
    - Have you already talked about 5G to people you know?
    - Have you already heard or read about 5G in the media?
    - Have you actively searched for information about 5G yourself?

Who or which institutions do you consider to be trustworthy sources of information when it comes to 5G? Who wouldn't you trust in this case?

If necessary, specify: If you were looking for information yourself, where or with whom would that be?

If you had the opportunity to ask a scientist researching mobile communications technology something about 5G, what would your question be?

5. Own cell phone (1 min.)

Back to you. What kind of cell phone do you own?

Is your cell phone 5G-enabled?

If 5G-enabled: What does your cell phone contract say? Does it cover 5G?

Bridging to focus group (1 min.)

Thank you so far. After a short break, we will then continue with the focus group discussion at around XX o'clock. Please feel free to take some time to have a drink or go to the restroom. I will pick you up here in time.

7.5   Guide focus group

General notes (3 min.)

- Welcoming words

- Short introduction by the moderator

- Information that all have already done the same interview

- Informing participants about recording, data protection and anonymization

- Information on the discussion culture and the process and purpose of a focus group

    o   Please answer honestly and unfiltered, also talk about feelings

    o   Let each other finish talking, talk to each other and respond to each other → we are interested in your conversations

    o   Please switch off your cell phone, if not already done

- Ask if there are any questions

1. Short introduction round (7 min. / 10 min.)

Please introduce yourself briefly with your first name, age, profession, and place of residence.

Please briefly summarize what you think about 5G.

- *Clarify what 5G „actually" is*

Thank you very much for your assessments! For the further course of the group discussion, I would like to provide you with some information on 5G:

- *Show bullet points on screen and read information aloud*

Mobile communications technology has continued to evolve in recent years. The latest standard "5G" is the successor to 4G (also known as LTE) and refers to the 5th generation of mobile communications. The 5G standard enables up to 10 times faster data transmission than its predecessor. This is made possible by technical innovations in base stations, cell phones as well as in data transmission. 5G is already available in most German cities.

2. Exposure perception (30 min. / 40 min.)

In the individual interviews, you have already seen a picture that you were asked to evaluate. I am primarily interested in whether the pictures I will show you later trigger a positive or a negative feeling in you.

To do this, please put yourself in the place of the person depicted in the picture. So, imagine that you are that person. Then please reach for the plus as quickly as possible if you have a good feeling. If you have a bad feeling, please reach for the minus.

Please remember that there are no right or wrong answers or feelings. They can also be minimal affective tendencies.

Afterwards, I would like you to explain to each other why the situation shown triggers this feeling in you.

Show pictures in fixed order

If necessary, ask: Does this make you feel comfortable/uncomfortable?

Picture 1: Video calling with Wi-fi

> Here you can see the first picture. Please imagine that you are the person in the picture. What does this trigger in you?

Picture 2: Video stream with 5G reception

> Here you have the next picture. What does this one trigger in you?

Picture 3: Cell phone in trouser pocket

> Even if you only see an excerpt in this picture, please imagine that you are the person carrying the cell phone in your front pants pocket. What does that trigger in you?

Picture 4: Tramway drive

> In this picture you see a person sitting in the tram. Please imagine you are the person on the front left of the picture. What does this trigger in you?

Picture 5: Expanded site

> Now I have two pictures for you, which present a before and after situation. Please imagine again that you are the person in the picture and have not been home for three days. The view from your living room window has changed during this time. What does this trigger in you?

Picture 6: Comparison one/three antennas

> Lastly, I have another pair of pictures for you. Again, this is a before and after situation. Again, please imagine that you are the person in the picture and have not been home for three days. The view from your living room window has changed during this time. What does this trigger in you?

Optional:

Picture 7: Phone call with cell phone to ear

Please imagine you are the person in the picture. What does this trigger in you?

Picture 8: Upload with 5G reception

Here you have the next picture. What does this one trigger in you?

3. Ranking 5G (15 min. / 65 min.)

Now you have seen several situations where people are surrounded by mobile communications / 5G. Before we start with the next task, I would like to present to you more pictures. Two of them again represent a before and after situation, the other two are to be considered individually.

Hand out pictures and allow a short time for viewing.

Now I would like to know: How would you arrange the pictures hierarchically? Please place the picture in which the person in the picture, i.e., you, are in your opinion most exposed to mobile communications in general in first place, and the picture in which the person, i.e., you, are least exposed to mobile communications in last place.

→ *give approx. 2 minutes for sorting*
→ *give another 2 minutes to look at how the others have arranged the pictures*

Instruction for assistant: Record the order of the pictures

Please explain and discuss your sorting with each other afterwards.

- What did you notice? Did anything about the sorting of the others surprise you?

- Which picture is on top for you and why? What do the others think about this?

If we now go from mobile communications in general to 5G in particular: Would your sorting change? If so, how would you rearrange the situations?

- Why did you make this change?

- Are there additional situations where you feel like you are exposed to 5G (more than to other mobile communication standards)?

Now I have another sorting task for you: In the individual interviews, my colleagues and I have already asked you about environmental influences that could affect your health. The following were mentioned … *[read out cards and hand them out].*

Instruction assistant: Record the order of the risks

Where would you sort mobile communications in general? Where 5G? What is more risky, what is less risky? Please arrange the cards so that the most harmful environmental impact for you is at the top and the one with the smallest impact is at the bottom.

→ *give approx. 2 minutes for sorting*
→ *give another 2 minutes to look at how the others have arranged the cards*

How did you sort the influences? And what did you notice with the others?

4. Siting task (10 min. / 75 min.)

Now I have one last interactive task for you. To do this, please put yourself once again in a scenario that you already know from the individual interview.

Hand out pictures and base station antennas.

As you can see, there is no base station antenna here in the picture, you can imagine that it is a different locality. Now imagine that in this scenario you also live in the house with the chimney. Until now, there was only 2G reception at your place of residence, which means you could write text messages, for example, but otherwise had very limited use of the internet via mobile data. A new base station antenna is now to be erected that will cover the locality with 4G and 5G. So far, however, it is unclear where the base station antenna will be erected.

For this purpose, six possible locations have been identified, which are drawn and numbered on the map. Depending on your choice, the appearance of the base station antenna differs. The six possible locations are marked with an X in the drawing.

Which location would you prefer? Why?

Let participants discuss.

Now I would like to give you some more information about cell phones and base stations. First, the farther away a base station is, the worse your reception will tend to be. Cell phones and base stations interact with each other. Cell phones, like base stations, are transmitters and receivers at the same time. Since the cell phone is generally much closer to you than the base station, regular users of cell phones or smartphones are therefore exposed to higher radiation levels from the personal device than from the base station. In addition, the further away a base station is, the stronger the cell phone has to transmit to reach the station. The radiation exposure for users therefore increases with increasing distance from the mast.

Now back to the task: If the base station antenna is placed at one of the orange or blue locations, you will receive 5G in full performance. If the base station antenna is placed at one of

the green locations, which are further away from the site, you will receive 5G in limited performance, which means that your data will be transmitted more slowly.

What location would you choose now that you know? And why?

Let participants discuss.

5. Precaution / uncertainty *(5 min. / 80 min.)*

Optional, if there is enough time

Are you taking steps to reduce your exposure to 5G or mobile communications radiation in general? If yes, what are they?

How do you rate the following statement by the scientist "Thomas Mayr" *[fictional character]*: "It is not possible to completely rule out negative health effects from 5G. However, the current state of research does not suggest any risks."

- *If necessary, ask*: Is the statement credible? Would you trust Thomas Mayr?

- How certain is Thomas Mayr?

Recap (6 min. / 86 min.)

Finally, I would like to ask you again: Has your opinion on 5G changed as a result of today's exchange?

Closing (4 min. / 90 min.)

→ *Inform about the background of the study*

We have now reached the end of the group discussion. I would therefore like to inform you briefly about the background of today's discussion. Researchers at the IU International University of Applied Sciences in Germany are currently investigating situations in which citizens feel particularly exposed to the 5G mobile communication standard. This is part of an EU project.

→ *Show bullet points on screen and summarize information*

- Electromagnetic radiation leads primarily to heating of the tissue

- How much energy is absorbed by the tissue depends on: intensity, frequency, structure of the tissue

- Further research is being conducted to determine whether there are other, non-thermal effects

- Below the threshold values, studies could not confirm any health-relevant effects
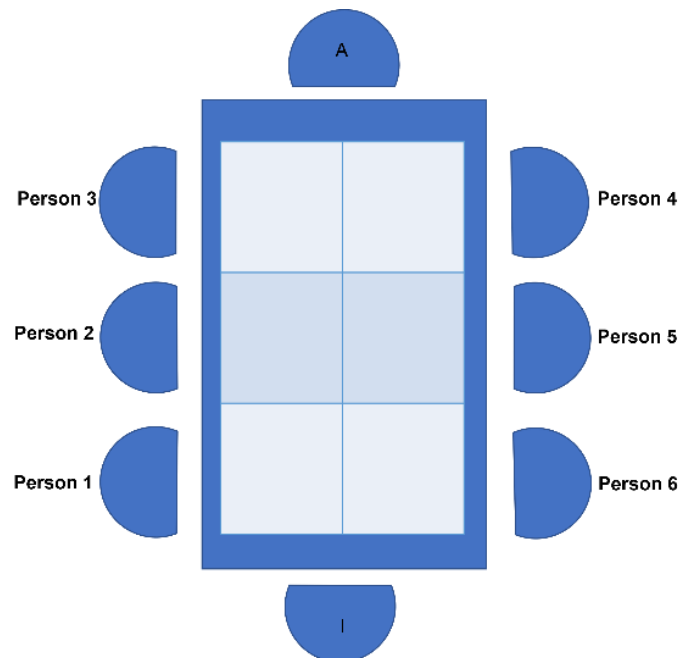
- Long-term effects are still being researched

If you are interested in further information on the project or 5G, you can find the relevant information here.

→ *Hand out one-pager with information about the IU / SEAWave / 5G.*

→ *Hand out consent form for further contact.*

- Thank for participation and say goodbye

7.6 Focus group arrangement

Participants were seated on the long sides of the table, with the moderator seated in front (with a large screen behind her) and the assistant seated across from the moderator. While the moderator led the focus group, the assistant documented the results of the discussion and distributed the materials.

7.7 Information on 5G

Information 5G

About the project

First of all, we would like to take this opportunity to thank you once again for your participation in the study. This study is part of a Europe-wide study on the new 5G mobile communication standard and future developments in mobile communications technology. In addition to the

technical and health aspects, the project also investigates social issues. The working group "Risk Communication" is therefore researching how 5G is perceived by the general public.

In today's sub-study, we were particularly interested in how you evaluate certain situations in which 5G plays a role. Both the individual interviews and the group discussions are part of this study. It was designed and conducted by researchers from IU International University of Applied Sciences under the direction of Prof. Dr. Christoph Böhmert and Sarah Link.

Would you like to learn more about the project?

- You can find further information about the EU-project „SEAWave" here: www.seawave-project.eu/

- Specific information on the Risk Communication working group can be found here: www.iu.de/forschung/projekte/seawave.

If you have any questions, suggestions or criticism regarding the study, please contact Sarah Link at: sarah.link@iu.org.

Official Information

In Germany, the following institutions provide information about 5G:

- The Federal Ministry of Digital Affairs and Transport (BMDV): www.bmvi.de/DE/Themen/Digitales/Frequenzen-Mobilfunk-und-Digitalradio/5G/5g

- The Federal Network Agency (BNetzA): www.bundesnetzagentur.de/DE/Fachthemen/Telekommunikation/start

- The Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV): www.bmuv.de/themen/atomenergie-strahlenschutz/strahlenschutz/nichtionisierende-strahlung

- The Federal Office for Radiation Protection (BfS): www.bfs.de/DE/themen/emf/mobilfunk/basiswissen/5g/5g_node

These authorities have also jointly founded the dialog initiative "Germany talks about 5G" (in German: "Deutschland spricht über 5G"). You can find information and exchange ideas about 5G on the associated website: www.deutschland-spricht-ueber-5g.de.

7.8   Consent form: Contact

Consent form: Contacting

~ please return at the reception ~

If you wish to be informed about the results of the study you participated in today, please leave us your contact details and tick the appropriate option. Should we also be allowed to contact you again for a potential survey based on this study, please (also) check the second box. In both cases we need your contact details.

There will be no disadvantages for you if you do not wish to be contacted by us again. In this case, please simply return the blank sheet.

Please mark with a cross:

[   ] I would like to be informed about the further progress of the study.

[   ] I hereby consent to the study team contacting me again for a possible follow-up study.

Contact information*

Name: _____

E-mail-address: _____

* Your data will be stored exclusively in analog form and for the purpose of contacting you until the project is completed. You can object to the storage of your data at any time.

7.9   Transcription guide

Transcription rules according to Dresing & Pehl

- The transcription is verbatim and not phonetic. Dialects are translated into standard German as best as possible. If it is not possible to translate the dialect, it is retained.

- Word breaks and stuttering are not taken into account. If words are spoken twice, they are disregarded unless they are used as a stylistic device to emphasize something in particular. For example, "This is very, very important to me."

- Sentence breaks are marked by a slash.

- Word slurs are not transcribed. Rather, they are approximated to written German. Thus, "so'n Buch" (German) becomes "so ein Buch" (German, in English "such a book") or "hamma" (German) becomes "haben wir" (German, in English "we have"). Even if the sentence structure is incorrect, it is adopted as spoken. For example: "I to the department store went".

- Punctuation is placed in such a way that it is easy to read. If the speaker lowers his voice or expresses an ambiguous emphasis, a period is preferred. Basically, the goal is to maintain the units of meaning. Word distortions can be smoothed out, but basically it is a matter of transcribing verbatim.

- Pauses are indicated by three ellipsis points in parentheses (...). Noticeably long pauses by (longer pause).

- Comprehension signals such as "mhm", "aha", "yes" etc. are not transcribed unless it is the only answer or statement. In this case, the closer meaning is given in parentheses. For example: "mhm (affirmative)" or "mhm (negative)".

- Capitalization is used to indicate particularly emphasized words and statements.

- A separate paragraph is used for each speaker contribution. The interviewer is marked with "I", the interviewee with the person code. In the case of group discussions, short interjections by the speakers are also transcribed separately. A time marker is inserted at the end of each paragraph.

- Laughter, sighing, or other emotional, nonverbal expressions are noted in parentheses. This is to support or clarify the statement.

- Unintelligible passages are marked with (unv.) and the time marker. If the unintelligible passage lasts longer, the cause is also indicated, for example, cell phone noise, microphone static, etc. Words that are not clearly recognizable, or word sounds that one is unsure of, are put in parentheses with a question mark at the end. It is important to insert a time marker at all incomprehensible text passages.

- Notes that serve the understanding are listed in parentheses (Note: ...).

- The storage format for the simple transcription according to Dresing and Pehl is the Rich Text Format .rtf. The storage name always corresponds to the name of the audio file.

- Furthermore, speaker overlaps are marked with //. Within these characters, the simultaneously spoken text is indicated. Non-speech processes and parallel actions are written in parentheses.

- Time marks are placed at the end.

7.10 Code book

Part 1: Codes based on the individual interview

Sample description:

- Personal code: as specified

- Gender: 0 = male, 1 = female

- Age: in years

- Age group: 1 = 18-39, 2 = 40-65, 3 = 65+

- Children in household: 0 = no, 1 = yes

- Occupation: 1 = employed, 2 = studying / in apprenticeship, 3 = retired, 4 = staying at home, 5 = looking for work

- 5G-enabled phone: 0 = no, 1 = yes, -99 = n/a.
  Note: In this case, it is important whether the cell phone is actually 5G-enabled. The assessment by the participant does not have to be correct.

Ice-breaker / warm-up:

- Cell phone proactively mentioned?: 0 = no, 1 = yes

- Environmental influences → list, keep order

Perception of environmental influences:

- Base station identified: 0 = no, 1 = yes
  Note: It is also coded "yes" if the mast has been identified as any type of transmission mast

- Evaluation of risk factors: 1 = absolutely harmless, 10 = very dangerous, -99 = n/a.

  o Evaluation of fumes (road)

  o Evaluation of noise (road)

  o Evaluation of pollutants / fumes (factory)

  o Evaluation of mobile communications

  o Evaluation of 5G

  o Evaluation of UV radiation (sun)

- Listing of other risk factors: Free field

- Evaluation matching the order: 0 = no, 1 = yes, + free field
  Note: In the free field it is recorded how the evaluation differs from the free mentioning.

Differentiation 5G / mobile communications:

- Awareness of standards: 0 = not known / named, 1 = known
  Note: The standard must have been actively named without having been previously introduced by the interviewer.

  - 5G / NR

  - 4G / LTE

  - 3G / UMTS

  - 2G / GSM

- Electrosensitive (if reception is noticeable, not "only" visible on cell phone, or recognizable on the basis of infrastructure): 0 = no, 1 = yes

Knowledge about 5G:

- List information sources → keep order

- List trusted sources → keep order

- List untrustworthy sources → keep order

Overall impression:

- Attitude towards 5G: 1 = negative, 2 = rather negative, 3 = neutral, 4 = rather positive, 5 = positive (subjective rating)
  Note: "neutral" can also be assigned if the person does not have a distinct opinion on the topic, e.g., due to lack of knowledge

Part 2: Coding based on exploratory analysis
→ structuring and exploratory codes

Code „Sociodemographics"

- This code is used to mark passages in which a person provides sociodemographic information about him/herself, or statements that are relevant for the evaluation and description of the sample. These include age, occupation, place of residence, children

Code „Change of acceptance"

- This code is assigned when the person refers to previous thoughts or attitudes regarding mobile communications / 5G that have changed in the meantime

Code „Social change"

- Used when a person addresses the changing use of the cell phone in society, e.g., differences in use between young and old, different socialization, but also new patterns of use in familiar situations

Code „ Technology in everyday life"

- This code refers to the naming (free association) of situations in which a person encounters technology on an everyday basis

Sub-Code „Cell phone use"

- Here, we capture how and in which situations the person uses his or her cell phone. This can be done by explicit request as well as by naming the situation independently

Code „ Ubiquitous risks"

- The aim here is to record the environmental influences that are considered to be a burden on one's own health. The entire passage is coded, the individual mentions are recorded separately in an Excel document.

Sub-Code „Sorting ubiquitous risks"

- This code marks the point in the focus group where the previously named everyday risks, along with mobile communications and 5G, are ranked in order of importance

Code „Risks picture"

- The code is assigned to all passages in which a person, after presentation of the picture, refers to (possible) harmful sources. Attention: Here it is not about the mere description of what is seen, but about the evaluation of it as harmful / dangerous / etc.

Code „Definition risk"

- The individual risk definition of the person is coded, as it is asked in the individual interview

Code „Differentiation mobile communications standards"

- This code is assigned when the person either makes an explicit distinction between different standards, e.g., "5G is faster than 4G," or when the person does not differentiate between 5G and other mobile standards

Sub-Code „Data consumption"

- This code captures ideas about how / that mobile communications / 5G traffic is changing

Sub-Code „Understanding of 5G"

- Here it is recorded, also independently of the explicit question, what the person understands by 5G. This may include conceptual thoughts of the person

Sub-Code „Explanation of 5G"

- What is coded is the definition, i.e., the cumulative knowledge about 5G that the person gives when asked in the individual interview (How would you explain 5G?)

Code „Health & mobile communications"

- The code is always assigned when a connection is made between mobile communications / 5G and health. This also includes statements such as "I do not think that mobile communications are harmful to me"

Code „Prior knowledge"

- This code is assigned when the person reveals knowledge about 5G before any information is given by the interviewer

Sub-Code „Prior knowledge public debate"

- This sub-code is assigned when the person is aware of and refers to existing controversies or activism

Code „Information sources"

- Passages are coded in which a reference is made to information sources on mobile communications / 5G. This also includes the evaluation of the information sources. A list of the information sources mentioned is kept in parallel in an Excel document

Code „Question for scientist"

- Here it is recorded what (or if at all) the person would like to know about 5G

Code „Attitude towards 5G"

- In order to compare the influence of the engagement with the topic of 5G / mobile communications on the respondents, the passage in which they share what they think about 5G is coded at the beginning of the focus group

Sub-Code „Attitude towards 5G post"

- At the end of the focus group, participants were asked whether their opinion of 5G had changed as a result of the discussion. This passage is coded as "Attitude towards 5G post"

Code „Evaluation of situations "

- This code is <u>only</u> used to structure the following codes, which refer to the situations that the respondents should assess. All situation codes can refer to technical as well as social aspects, etc.

Sub-Code „Video calling"

- Coded are passages that relate to the use and assessment of video calls

Sub-Code „Video streaming"

- Statements are coded that relate to (various aspects of) video streaming

Sub-Code „Cell phone in trouser pocket"

- All passages are coded that relate to the situation "cell phone in trouser pocket". This can refer to: own use, convenience aspects, health concerns, etc.

Sub-Code „Public transport"

- This code is used for all statements that refer to different aspects of cell phone use in public spaces – even if this was not stimulated by the picture

Sub-Code „Upgrade location"

- This code is used for passages that deal with the expansion of an existing site

Sub-Code „Additional masts"

- This code is used to mark if statements are made about additional masts at an existing site

Sub-Code „Phone call"

- Here, statements are recorded that refer to the classic phone call with the cell phone to the ear

Sub-Code „Upload"

- This code is assigned when statements are made about uploading in general, or also about the distinction between uploading and downloading

Sub-Code „New location"

- Coded are statements that relate to the opening up of a new site

Code „Justification affect negative"

- This code is assigned when the person makes a negative evaluation of a situation. Those statements / passages are coded which list reasons for this affective (basic) attitude

Code „Justification affect positive"

- This code is assigned when the person makes a positive evaluation of a situation. Those statements / passages are coded which list reasons for this affective (basic) attitude

Code "Exposure perception"

- This code is assigned when a person discusses in which situations he or she is exposed to mobile communications / 5G and to what extent. This can include hierarchical judgments (X emits more radiation than Y), as well as associated feelings (I can't do anything about it anyway)

Code "Siting task"

- Here, it is recorded why the person would choose a certain location for the erection of a base station antenna, so the focus is on the justification

Sub-Code "Siting task after information"

- This records whether – and if so, why – the person chooses the same or a different location after being given information

Code "Precaution"

- The precaution code is assigned whenever a person names measures that he/she uses or has already heard of to reduce his/her exposure to mobile phone radiation

Code „Comparison (with other technologies)"

- This code is used to identify comparisons with other technologies, e.g., "the car should work first and foremost. How it works doesn't matter. It's the same with mobile communications"

Code „NIMBY"

- NIMBY stands for "not in my backyard" and is assigned as a code if the person is in favor of the expansion of mobile communications / 5G, but does not want to have a base station in the immediate vicinity

Sub-Code „NIMBY comparison"

- This code is used to provide NIMBY passages in which comparisons are also made, for example to other technologies

Sub-Code „NIMBY others"

- This code is assigned when the person makes NIMBY comparisons, but these do not refer to mobile communications, but are rather to be understood as a character trait

Code „Thoughts of the future"

- The thought-of-the-future code is assigned when speculations are made about the further development of mobile communications, or also about associated consequences

Code „Narrative"

- Parent code, used for structuring sub-codes

Sub-Code „ Necessary evil"

- This code is assigned when a person opposes infrastructure development but is a willing beneficiary of the technology

Sub-Code „Powerlessness"

- This code is assigned when a person expresses concerns about being able to change or influence something themselves, or feels at the mercy of mobile phone expansion

Sub-Code „Defacement"

- This code is used when primarily aesthetic concerns are expressed in connection with the 5G rollout, which mainly concern the landscape. Landscape is also understood to mean urban space, or obstructed views

Sub-Code „Dangerous / unexplored"

- This code marks statements that focus on mobile communications / 5G as being too unexplored and (potentially) dangerous

Sub-Code „No personal benefit"

- This code is assigned when a person sees no personal benefit in the further expansion of mobile communications, e.g., "where does it end"? "LTE is perfectly adequate", etc.

Code „Pro technological progress"

- This code is used to mark passages that are positive about technological progress

Code „Societal concerns"

- This code is assigned when negative social effects are feared as a result of mobile communications expansion. This includes statements that refer, for example, to a lack of humanity, social withdrawal, or other social structures changing as a result of the development of mobile communications technology

Code „Relevance"

- This code is primarily used to structure the following codes and is only used if none of the other relevance codes seem to be suitable

Sub-Code „Personal relevance"

- Personal relevance can refer to both the benefits and the subjective perception of how important (or unimportant) 5G rollout or 5G in general is in certain areas

Sub-Code „Alternatives"

- Code refers to mobile communications alternatives, e.g., landline, LAN, ...

Sub-Code „EMF / radiation"

- The code is always assigned if the person makes an explicit reference to mobile phone radiation/EMF and includes this in the formation of his/her opinion

Code „Information needs"

- This code is assigned when the person explicitly refers to the fact that he/she knows (too) little, would like to know more, or would explicitly not want to know more, e.g., because for him or her it is only relevant that the technology works, but not how it works. This can also be expressed in the fact that more information would be necessary in order to make well-founded statements

Code „Statement Thomas Mayr"

- This includes all statements made in connection with the 5G quote that cannot be assigned to any of the following sub-codes

Sub-Code „Certainty"

- The code marks passages in which the person refers to how certain Thomas Mayr is about his statement: How is scientific uncertainty perceived?

Sub-Code „Science in general"

- This code is used for passages in which people make statements about what they know (or don't know) about the genesis of scientific knowledge in general, or what they think about the scientificity of Thomas Mayr's statement

Sub-Code „Trustworthiness"

- This code is assigned when statements are made that relate to the trustworthiness of Thomas Mayr. This can refer to his person, the wording or similar

Pencil-Codes

Code „Highlighter"

- This code (pen) is used only to highlight important passages or even individual words within the texts

Code „Intention recognized"

- This code (pen) is used to mark passages in which the person perceives different reception modes (Wi-fi, 5G, ...) or other intended properties in the stimuli as we intended

Code „Important quotes (without assignment)"

- This code (pen) is used for quotations that cannot be assigned to any of the other codes but are powerful (e.g., sharply or summarily worded) or depict an interesting train of thought

Code „Social evaluation"

- This code (pen) is used when the focus is not on the technical aspects of a situation / technology, but on the social aspects, e.g., today everyone is only on their cell phone and loses sight of their fellow human beings. The code is also used for anecdotal descriptions of one's own experiences