**Questionnaire Research Ethics for Review**

**Title of your research project:  
Cartographic Symbolization on high-resolution digital displays, PHASE 1**

**PART 1**

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| **1. Describe your research team (short CV of the principal investigator; institute, research group or professional expertise of the other researchers)** |
| PI:  Dipl.-Ing. Florian Ledermann  Univ.Ass. at FB 120-06 Cartography, Department of Geodesy and Geoinformation  Completed studies: Dipl.-Ing. Informatik, TU Wien, 2004  University assistant at FB Cartography since 2015  https://cartography.tuwien.ac.at/florian-ledermann/  Supervisor:  Prof. Georg Gartner  FB 120-06 Kartographie, Department für Geodäsie und Geoinformation  https://cartography.tuwien.ac.at/georg-gartner/ |

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| **2. Who is financing your study?** |
| This study is undertaken as part of my regular research duties as a university assistant, and as part of my PhD research. |

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| **3. Describe your study: aim, procedure, duration, location, test procedures, institutional framework etc.** |
| **Introduction and aim**  In recent years, the pixel density (sometimes referred to as “display resolution”, which is a more ambiguous term) of commercially available smartphones and monitors has increased significantly. However, it is not entirely clear if and how this increased display fidelity can be put to use for digital cartography and geographic visualization. Cartographic guidelines generally recommend to use larger symbology for screen-based presentation, based on the assumption of a generally low pixel density and therefore low fidelity of reproduction on (conventional) desktop monitors. Scientifically established guidelines for symbol sizes for *printed* maps date back to the 1980’s, and specify absolute minimum dimensions for map labels and symbology (such as e.g. 0,3mm minimum diameter for circle symbols etc.). It is currently unclear whether these guidelines can now be applied unchanged to digital display media with sufficient pixel density, or whether new guidelines for map design for high-resolution displays need to be established.  While the availability of high-resolution displays is a prerequisite for increased fidelity of cartographic depictions, any guidelines for map design must ultimately be grounded in the properties of human visual perception. The marketing term “retina display”, introduced with the iPhone 4, already hints to the fact that modern displays may have reached or surpassed the limits of human visual acuity, so making the symbols as small as possible for a given display may produce maps that are beyond the visual capabilities of humans. While a huge body of psychophysical literature is available on the limits of human visual acuity, it is not entirely clear how this knowledge applies to specific cartographic design elements (such as the symbology used for line or point phenomena, or the labels on a map).  The aim of this overall research project is to verify human perceptual limits as they apply to cartographic design elements, potentially develop new cartographic design techniques that leverage specifically the possibilities of display devices with very high pixel densities, and propose a set of new and updated guidelines for map design in the digital age. **In this first part of the study, the focus lies on a) reproducing relevant well-known findings from the psychophysical literature in the context of near-field viewing of digital displays, and b) establishing fundamental limits of cartographic depictions (e.g. line separation, point symbol size, text label size) for different display resolutions under controlled viewing conditions.**  **Test apparatus**  The study aims to compare the reproduction of cartographic symbols on a range of displays with different pixel densities. Therefore, 4 different mobile phones (covering a range from low to very high pixel densities) will be used to present a set of stimuli to the participant.  Due to the fact that human visual acuity varies with contrast of the stimulus, any systematic empirical investigation of visual acuity needs to take place under controlled lighting and viewing conditions. Furthermore, general guidelines for empirical studies apply, e.g. that the study location should be largely devoid of additional stimuli not related to the studied phenomena. The study will therefore be conducted under controlled conditions (as good as possible) in a separate room at the FB Cartography which will be temporarily adapted for the purposes of the study. To control the lighting conditions, the window of the room will be temporarily blocked with a sheet of plywood, and the ceiling light will be switched on during the experiment. A luxmeter will be used to verify similar lighting conditions for each experiment run. For a controlled viewing position (distance, angle and avoidance of reflections), the mobile phones will be mounted on a vertical plane (a panel of plywood) that is mounted across two standard desks. To prevent the appearance of the different phones to bias the participant, the phones will be covered with a cardboard cover of identical size, revealing only a square area of the display of identical size for each display. The mounted mobile phones establish the 4 stations of the experiment.  The participant will sit on a conventional office chair (with wheels), and can “roll” from one station to the next when requested to change to the next station. To assure an equivalent viewing distance throughout the experiment, a guiding rail will be mounted parallel to the mounting plane of the mobile phones in a way that it can be used by the participant as a chin rest to use at each station.  For participant response, a tablet computer will be provided which the participant takes from station to station to enter their response.  **Test procedure**  At each station, the participant is exposed to an identical sequence of stimulus types, presented on the mobile phone screen (therefore the independent variable being the pixel density). The definitive stimuli types for the experiment haven’t yet been finalized, but a exemplary list would be: Snellen E Orientation, Line Separation, Dashed Line Pattern, Point Symbol Size, Text Size. For each stimulus type, the participant is presented with a “n-Forced-Choice-Task”, i.e. the participant is asked to select the presented type of stimulus from a set of options presented on the response tablet, for each trial. For each stimulus type, a “staircase” procedure is used to incrementally reduce the stimulus size on subsequent trials and to eventually establish the minimum size at which the different stimulus types can be discriminated without error.  After repeating the tasks for all stimulus types at all four stations, the experiment ends. |

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| **4. Describe your study participants: Number of participants, age groups, how and where do you recruit them? If potentially vulnerable groups (e.g. children, see also part 2) are involved, explain why. Are there any dependencies that need to be taken into account? (e.g. students are recruited by teachers)** |
| For the Phase 1 study around 30 participants will be needed. Participants may be of a homogeneous age group (since findings will be verified with a broader demographics later), distribution of gender among participants should be roughly equal.  The current plan is to recruit students through the lectures offered by colleagues at the same research group than the PI, to avoid recruiting students through the PI’s own courses. A small number of points will be given to students for signing up to participate in the experiment, or for performing an alternative task (details TBD) of roughly equal duration.  Since among students of the “International Master Cartography” there is usually a roughly 50:50 gender distribution, recruiting enough students from all genders should not be a problem. However, since students usually take multiple courses offered by our research group in one semester, it cannot be ruled out that students of the PI will also participate in the experiment, although not recruited in conjunction with one of his lectures.  Students will be offered an alternative task to perform if they choose not to participate in the study to get an equal number of points. Furthermore, participants will be informed that they can abort the experiment at any time, including before the start of the experiment, without this being recorded in conjunction with their name and without any consequences. |

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| **5. Describe how you plan to obtain informed consent of your study participants.** |
| Participants will be informed both by email before the date of participation, as well as by a written consent form that will also be read to them at the beginning of the study, that participation in the experiment is fully voluntary and that they can abort the experiment at any time without this being recorded in conjunction with their name or ID. This is the full text of the corresponding section of the consent form we are planning to use:  “Your participation in this research is entirely voluntary. It is your choice whether to participate or not. You may change your mind later and stop participating even if you agreed earlier, and you may stop and abort the experiment at any time without negative consequences. The credits for the course (if applicable) are given automatically upon registering for participation, and do not require you to complete the experiment.”  (The full consent form can be found in the attachment) |

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| **6. Describe the form of data collection and recording (interviews, questionnaires, audio/video recording, etc.)** |
| The participants response to the stimuli presented during the experiment are entered on a tablet computer and recorded electronically. At the beginning of the experiment, a short questionnaire is presented to the participants on a monitor, asking 2 questions about demographics (age, gender), 2 questions about their eye sight (corrected/not corrected) and 2 questions about their prior experience with digital maps. The answers to these questions are stored digitally, together with the experiment results, but separate from any personal information. After the main part of the experiment, participants are asked 2 questions about subjective feedback in another questionnaire (difficulty of the tasks, fatigue) and are presented with an opportunity to leave comments.  Personal information is stored in a separate document, solely for the purpose of coordinating appointments for participating in the experiment. All personally identifying information is deleted as soon as the participant showed up for the appointment. |

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| **7. Describe the technologies used. Are these established technologies (off the shelf) or only being developed or modified in the course of the project (prototypes)?** |
| The hardware for stimulus presentation and recording the response is off-the-shelf hardware. Mainly the stimuli will be presented on 4 different mobile phones.  The software for stimulus presentation and recording participants’ responses is custom written for this experiment, because of the unique requirements for presenting stimuli on various devices and the need for pixel-perfect control of the rendering of the stimuli. |

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| **8. Does the study take place in a controlled environment (lab conditions) or are there study conditions that cannot be controlled (field research, real-life testing)?** |
| The study takes place in a controlled environment, in a room that will be temporarily adapted as a lab for the duration of the study (due to space constraints, a permanent lab is not currently available in our research group).  The following measures will be taken to control the environment, particularly the lighting situation: The window of the lab room will be temporarily covered with a sheet of plywood to block incoming light. The light in the room will be switched on. All display devices will be calibrated with a display calibration device for identical brightness. The light level in the room will be measured with a lux-meter to verify similar lighting conditions across experiment runs. The area of the institute in and next door to the lab room will be closed for institute staff during experiments. Any decoration on the walls of the lab room will be removed.  After each participant, the lab will be ventilated for 10 minutes and all surfaces that were potentially touched by participants are disinfected – particularly to comply with COVID-19 protection measures. (Please find the COVID-protection concept for the experiment attached) |

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| **9. What unintended, incidental, or unexpected study results could occur (findings that are outside the scope of the study)?** |
| The only thing imaginable would be that the study could fail to replicate well-known findings from the psychophysical literature (e.g. well-known limits of human visual acuity), in which case the methodology of the study would be checked and a confirmatory experiment would be run to replicate these results.  Other than that, results of the experiment will be used to confirm/reject hypotheses about the stimuli and variation of map symbol legibility with display resolution, which will inform subsequent experiments undertaken as part of the overall research project. |

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| **10. What measures do you have in place to protect the identity of your participants (e.g. anonymization, pseudonymization)?** |
| Personal information connected to the identity of the participants will only be used to coordinate the appointments for participating in the study. The record for each participant will only be used to email instructions (for getting to the experiment location, advance information about voluntary participation etc.) and will be deleted once they show up for the appointment. The data collected during the study will assign a number to each participant, and will not include any personally identifying information. |

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| **11. How do you store and transfer the data of your participants? Who has access to the collected data? Can unauthorized persons gain access to this data? (e.g. research data on a cell phone)** |
| Data will be stored locally on the main PC located in the lab room. Only the PI has access to that data. The network of the institute is protected by a firewall from outside traffic. Furthermore, no personally identifying information will be stored with the experiment data, as described above. |

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| **12. How do you ensure compliance with the General Data Protection Regulation? (e.g. analysis of research data, storage of personal data of research participants that are not analyzed in your research)** |
| As explained above, personal data will be deleted before the start of the experiment, therefore the GDPR does not apply. |

**PART 2**

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| **13. Does your study involve potentially vulnerable individuals? (e.g. children, persons unable to consent, minorities, marginalized groups, migrants, refugees, victims of abuse or violence)** |  | **no** |  |

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| **14. Does your study involve participants without their consent or knowledge? Are you planning to conduct a deception study? (e.g., covert observation of people in non-public places, experiments without thorough debriefing).** |  | **no** |  |

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| **15. Does your research project raise other specific ethical concerns? (e.g., will political opinions, religious or philosophical beliefs, union membership, sexual life, or sexual orientation disclosed? Will health data or data on the sexual life or sexual orientation of a natural person collected? Is it end of life research?)** |  | **no** |  |

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| **16. Is there a physical risk of injury for the study participants? Could the study cause psychological stress or anxiety, humiliation, harm, or other negative consequences to participants beyond the risks they face in everyday life?** |  | **no** |  |
| *The study requires ~45 minutes of concentrated looking at different screens. At most, this may cause temporary eye strain. Participants are informed that they may pause or abort the experiment at any time when they feel uncomfortable or strained.* | | | |

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| **17. Are there any other ethical concerns related to your research project that have not been addressed in this questionnaire?** |  | **no** |  |

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| **18. Would you like to have support and/or supervision concerning ethical questions that may emerge during the research process?** |  | **no** |  |

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| **Attached documents (e.g., research plan, documentation on informed consent if available, ...).** |
| * **Informed Consent Form** “Consent\_Form\_LEDERMANN.docx” * **COVID-19 prevention concept** (in German)  “Schutzmassnahmen\_Experiment\_LEDERMANN.docx” |