

I. Preparation (before each session)

- A. Put on the hygiene equipment (mask, gloves, glasses/face shield) and follow the COVID checklist in the lab. All the documents are in the SpaRe folder in the cupboard on the right side when you come in (next to all the other project folders)
- B. Turn on the devices (body tracker, 2x controller, dongle for body tracker signal)
- C. Ensure that SteamVR is running and that it is running smoothly (no pink lines or significant delays in the performance view tab). To start up steamVR simply click on one of the builds and close the build again after steamVR started up.
- D. Make sure all devices are recognized by SteamVR. Pair the missing devices manually (SteamVR → devices → pair controller).
If the body tracker is not connecting, make sure the corresponding dongle is plugged into a USB 3.0 port. If you get the warning that “controllers are already connected”, disconnect all devices and connect them again, starting with the body tracker.
- E. Make sure that SRanipal ***has permission to run but is NOT updating!!!***
When you open a build for the first time after you start up the PC, SRanipal will ask for permission to run. Give it permission and make sure that it starts working in the background (you see a little robot in the taskbar). If it tries to make an update (update window opens in the background after you gave it permission), it is very important that you “close” the update window quickly, before it is updated. If the build is already opening and going into full-screen mode, simply use “ctrl” + “esc” or “alt” + “TAB” to leave full-screen mode and close the update window. Then, reopen the experiment from the bar at the bottom of the screen.
- F. Plug a fresh sticker onto the VR headset that covers the parts of the HMD that would otherwise touch the face (white cover sticker).
- G. In case you are going to run out of something (covers, gloves, masks etc) please contact me, or the lab manager in advance. Do this if there are less than 20 pieces left, so we have a bit of time to order new hygiene equipment.

II. Picking up the participant

- A. When picking up the participant, ensure that she/he is not suffering from any symptoms that could be related to COVID-19. Only let them enter the building if no symptoms are present; otherwise reschedule
- B. Exchange mask for FFP-2 mask from the lab. It is not allowed for them to wear their own masks. Make sure you always keep a safe distance of min. 1.5 meters.
- C. Let them sign the COVID measurement protocol and other required documents, incl. questionnaires.
- D. Make sure the participant stays in the designated “participant area”. In the mobile lab this is the blue square.
- E. Follow all the other steps as described in the COVID checklist.
- F. **Let the participant fill in the COVID contact sheet / measurement protocol! This is required for each session!**

III. Only for the first Session (Exploration 1)

A. Let them fill in the following questionnaires:

1. FRS / Spatial navigation questionnaire (Fragebogen Räumlicher Strategien; English or German, based on participant's preference)
2. Weekly questionnaire (English or German, based on participant's preference):

IV. Exploration (5 Sessions total; *Points in big brackets: “[“ ”]” only relevant for the first exploration session*)

- A. Make sure all devices are turned on, SteamVR is running and recognizing all devices (2 controllers, 1 body tracker). Otherwise pair the missing devices manually (SteamVR → devices → pair controller).
- B. If it is not displayed already, select **“Display VR view”** in the SteamVR menu and make it full-screen on your second screen. Here, you can see what the participant sees. Also turn on “Display Performance Graph” if it is not turned on already to see that there is no significant delay or connection issue.
- C. Let them put on the feelSpace belt in their size (XS/S/M/L/XL), but ensure that they do not turn it on, yet.
- D. Let them put on the body tracker first, then the HMD, and finally, hand them the controller that they prefer to use (right/left). *Turn off the other controller!*
- E. Before starting any build, **start the SteamVR “room setup”**. Select **“standing only”** → “next” (if the headset is “ready”) → tell the participant to sit still and upright, then press: **“calibrate center”** → press “next” and tell the participant to stay still and upright. **Set the height to 150cm** and press **“calibrate floor”** → press “next” twice.
To check if everything was calibrated successfully, ask the participant to look down. They should be sitting in the center of a grey square (indicates player position). The chair should not be moved and dislocated as well from this point on. Rotating on the chair is allowed.
- F. **[Only first expl. Session:** Introduce the participant to the controls and let them do the *tutorial* for exploration. Therefore, start up the “Exploration_Tutorial” build and: 1. Train the movement (chest/tracker based direction; dynamic movement speed: push the joystick further/less far to the front); 2. explain that the head can be moved independently (boxes that change colors); and 3. let them take a couple of pictures of the statue. As soon as the participant completed this successfully and feels comfortable with the controls, quit the tutorial by pressing “ctrl” + “esc” OR “alt” + “TAB”. Then, right-click on the SpaRe symbol in the task list and select “close”]
- G. **Instruct the participant:**
“In the following, we are going to let you explore the virtual city of Westbrook. A famous group of street artists has recently visited the city and left their mark on some of the buildings. They left a total of 52 pieces of street art (e.g. graffiti, painting, illustrations) on 26 shops and 26 regular buildings in

Westbrook. Your task is to explore the city for 30 minutes and to take a picture of the buildings that have street art on them. You can take a picture by pressing the trigger button on your controller twice (as shown in the tutorial). Make sure that the entire building is visible on the picture and not just the graffiti. If you are uncertain whether a building has street art on it, or whether you already took a picture of it previously, please take a(nother) picture of it. Your movement is limited to the streets and smaller paths of the city. The areas that you cannot walk on are also fenced off with walls, fences or curbs. Every 10 minutes, we will place you in a neutral (grey) room to check that the eye tracking data is recorded correctly. Therefore, please do not move or touch the VR headset without informing the experimenter. We will now start the experiment by calibrating and validating the eye tracker. You can put on the VR glasses now.”

- H. *[If they are not wearing the headset already: Show them how to put on the headset correctly and how to adjust the fit.]*
- I. Start up the build “SpaRe_Exploration” from the SpaRe folder on the desktop.
- J. Make sure the headset is placed on the head correctly, otherwise help the participant by giving clear instructions. Then, select the participant’s preferred language setting (English/Deutsch) (Again ensure that the VR View is on so you can see the eye tracker calibration procedure.)
- K. **Type in the correct Subject ID and session nr** (“1” for first exploration session, “2” for second exploration session and so on...). You can find these in the ‘participants’ sheet. Make sure that this is done **correctly!** Directly mark on the excel sheet that the participant is doing the session by adding a “1” to the respective line on the excel sheet under the “Sessions - belt” page.
- L. Now you can let them **turn on the feelSpace belt**.
- M. Open the feelSpace “beeline” App on the smartphone in the laboratory. To unlock the smartphone, simply draw the letter “N”. In the app’s menu select “Connect belt” and choose the correct belt from the list. If the connection was established correctly, the menu should now show “disconnect belt”.
- N. Once the connection to the belt is established, you can start the “belt calibration” from the menu. A blue arrow is now displayed on the floor. Instruct the participant to align their body with the arrow, facing the direction of the arrowhead. Now navigate to the compass in the feelSpace “beeline” app. Ensure you have “cardinal directions” enabled (otherwise the signal does not move around the waist).
- O. **Calibrate the belt to the virtual city’s North direction.** Ask the participant to point with their hand/arm to the direction of the belt signal. Adjust the compass needle so that the belt signal and therefore also their pointing direction aligns with their body orientation and the blue arrow on the floor. Once you feel like this is set up correctly, *ask the participant to rotate a little bit to the left and then a little bit to the right side*. Both times, ask them to confirm that the belt signal is still pointing towards the direction of the arrow. If necessary, adjust and finetune the belt signal to the correct direction. Once the belt is calibrated correctly, make sure to lock the screen of the phone to avoid changing the signal again by touching the screen. For the rest of the session, only touch the phone if necessary (e.g. when the participant reports

the belt stopped vibrating or that the signal has changed direction).

- P. Manually start the “**calibration & validation**” on the computer display. Simultaneously, inspect the “*VR view*” *display from SteamVR* (SteamVR menu → select “display VR view”) to see whether calibration and validation are successful. IF calibration of the eye tracker failed, this will be displayed in red letters ONLY on the VR view. It cannot be seen on the other display! If the validation failed, repeat it until both calibration and validation are displayed as “successful”
- Q. **Instruct the participant that now the experiment/exploration will start.** Ask if there are any **remaining questions**. Then, **press: “Start experiment”/ Start Exploration** in the menu.
- R. (If the participant asks for a break, or if you see that they move the VR glasses, you can “pause” the experiment from the menu screen by pressing the “pause” button or pressing space. Do not incentivise them to have a break though. Before pressing “resume” after the break, restart “calibration & Validation” (s. Point “P”). After calibration & validation has been completed successfully, instruct the participant that the experiment will continue, and press “resume”.)
- S. Every 10 minutes, the exploration pauses automatically. If the participant did not touch the VR glasses and keeps them on, select “**error check**” and instruct the participant to focus on the dot. If the error check / validation was successful, you can **resume the experiment**. If the error check fails or if the participant touches / takes off the glasses, repeat step “P” until both calibration and validation are ‘successful’ / ‘erfolgreich’. Then, resume the experiment.
- T. After the second part (10mins), repeat step “S”, and if necessary step “P” again.
- U. Every now and then, you can update the participant on how much time is left.
- V. During the entire exploration: **monitor the walking and viewing behavior of the participant** to ensure the participant’s attention is on the task that we gave him/her. If this is not the case, do not hesitate to repeat the task instructions many times. If a participant disobeys your instructions, report their Subject ID to me and we will exclude them. Nevertheless, let them finish the session.

V. **Experiment** (6th session)

- A. Make sure all devices are turned on, SteamVR is running and recognizing all devices (2 controllers, 1 body tracker). Otherwise pair the missing devices manually (SteamVR → devices → pair controller).
- B. **Instruct the participant:**
“In the following, we are going to test your spatial knowledge of the virtual city of Westbrook. Previously, you have already explored the city 5 times, searching for 52 graffiti that were placed on 26 shops and 26 regular buildings in Westbrook. Now, we will place you in front of these graffiti buildings and let you perform 3 different tasks. We will start with two pointing tasks: the

pointing to North task, where you have to indicate by pointing with your controller in which direction the North is located (or where you think the North *could* be located); and then *pointing towards a target building* task, in which a picture of a target building is displayed on your screen and you have to point towards the displayed target building from your current location. Both tasks consist of 56 trials and you have 30 seconds to answer for each pointing trial. In the last 10 seconds, a time will appear in the bottom center of the screen. Make sure that you answer before the time runs out. If you are uncertain where to point, just stick to your intuition. *Do not let the timer run out without providing an answer!*

After each task block, we will place you in a neutral (grey) room to check that the eye tracking data is recorded correctly. Therefore, please do not move or touch the VR headset without informing the experimenter. We will now start the experiment by calibrating and validating the eye tracker. You can put on the VR glasses now."

- C. Let them put on the feelSpace belt in their size (XS/S/M/L/XL), but ensure that they do not turn it on, yet.
- D. Let the participant put on the body tracker and the HMD. Finally, hand them the **two controllers** (*here, we need both*).
- E. Before starting any build, **start the SteamVR "room setup"**. Select **"standing only"** → "next" (if the headset is "ready") → tell the participant to sit still and upright, then press: **"calibrate center"** → press "next" and tell the participant to stay still and upright. **Set the height to 150cm** and press **"calibrate floor"** → press "next" twice.
To check if everything was calibrated successfully, ask the participant to look down. They should be sitting within a grey square (indicates player position).
- F. Start up the build "SpaRe_Experiment_FINAL".
- G. Make sure the headset is placed on the head correctly, otherwise help the participant by giving clear instructions.
- H. **Type in the correct Subject ID!**
- I. Start the tutorial for the first task.
- J. **Explain to the participant** that they can point by moving their right controller into the intended pointing direction, which is indicated by the green beam. They can select their pointing direction by pressing the trigger button on the right controller and then, they can either confirm their choice or select another pointing direction by pressing the "A" button on the right controller. (For the pointing towards a target building task, also explain that the target building is displayed in the middle of the screen. By pressing the trigger button on the left controller, they can bring the picture of the target building into the middle of the screen to have a closer look at it. Releasing the left trigger button brings the picture back into the top center of the display.) Finally, repeat that they have 30 seconds per trial to select an answer and that in the last 10 seconds a countdown will be displayed on the bottom of the screen. When a trial is completed, they will receive an acoustic feedback in the form of a 'beep' sound.
- K. Start the second tutorial. (For the pointing towards a target building task, also explain that the target building is displayed in the middle of the screen. By

pressing the trigger button on the left controller, they can bring the picture of the target building into the middle of the screen to have a closer look at it. Releasing the left trigger button brings the picture back into the top center of the display.)

Let them get comfortable with the controls and tell them that the blocks in the experiment will follow the same task order as the instructions!

- L. *{Information: The order of the experimental tasks follows the same (initially randomized) order as the tutorials. E.g. if they get the pointing towards a target building (PtB) tutorial first, they will also start with this task, followed by pointing to North (PtN) and the repetition of PtB, again followed by the repetition of PtN}*
- M. If the experiment starts with PtN, you can skip steps N-Q for now, and return to them after PtN is completed. Continue with R.
If the experiment starts with PtB, follow the steps N-Q below.
- N. Now you can let them **turn on the feelSpace belt**.
- O. Open the feelSpace “beeline” App on the smartphone in the laboratory. To unlock the smartphone, simply draw the letter “N”. In the app’s menu select “Connect belt” and choose the correct belt from the list. If the connection was established correctly, the menu should now show “disconnect belt”.
- P. Once the connection to the belt is established, you can start the **“belt calibration”** from the menu. A blue arrow is now displayed on the floor. Instruct the participant to align their body with the arrow, facing the direction of the arrowhead. Now navigate to the compass in the feelSpace “beeline” app. Ensure you have “cardinal directions” enabled (otherwise the signal does not move around the waist).
- Q. **Calibrate the belt to the virtual city’s North direction.** Ask the participant to point with their hand/arm to the direction of the belt signal. Adjust the compass needle so that the belt signal and therefore also their pointing direction aligns with their body orientation and the blue arrow on the floor. Once you feel like this is set up correctly, *ask the participant to rotate a little bit to the left and then a little bit to the right side*. Both times, ask them to confirm that the belt signal is still pointing towards the direction of the arrow. If necessary, adjust and finetune the belt signal to the correct direction. Once the belt is calibrated correctly, make sure to lock the screen of the phone to avoid changing the signal again by touching the screen. For the rest of the session, only touch the phone if necessary (e.g. when the participant reports the belt stopped vibrating or that the signal has changed direction).
- R. Manually **start the “calibration & validation”** on the computer display. Simultaneously, inspect the “VR view” *display from SteamVR* (SteamVR menu → select “display VR view”) to see whether calibration and validation are successful. IF validation of the eye tracker failed, this will be displayed in red letters on the VR view. It cannot be seen on the other display! If the process failed, repeat it until both calibration and validation are displayed as “successful”

- S. Ensure again that the controls and the procedure are understood correctly and instruct the participant that now the experiment will start and press: "Start experiment" in the menu. Inform the participant that they will receive the pointing tasks in the same order as they received the tutorials and repeat which task will be measured first. Emphasize again that "in case you are uncertain where to point, simply go with your intuition."
- T. **Start the first task.** Whenever the participant is ready, they can start by pressing the trigger button on their right controller.
- U. If the next task is PtN, let the participant turn off the belt.
If the next task is PtB, calibrate the belt by following the steps N-Q as described above
- V. If the participants did not move/take off the HMD, select "**error check**" in the menu and instruct the participant to focus on the dot. If the error check / validation was successful, you can resume the experiment. If the error check fails or the participant moves/takes off the HMD, repeat step "R" until both calibration and validation are 'successful / erfolgreich'. Emphasize that "in case you are uncertain where to point, simply go with your intuition."
- W. (If the participant asks for a break, or if you see that they move the VR glasses, you can "pause" the experiment from the menu screen by pressing the "pause" button. They have to complete the current trial and the experiment will pause. Do not incentivise them to have a break though. Before pressing "resume" after the break, restart "calibration & Validation" (s. Point "R"). After calibration & validation has been completed successfully, instruct the participant that the experiment will continue, and press "resume".)
- X. Repeat the name of the second task and **start the second task**. Emphasize again that "in case you are uncertain where to point, simply go with your intuition."
- Y. Every now and then, you can update the participant on how many trials are left.
- Z. After the second task, again, follow point "U" (turn off belt if PtN is the next task, turn it on and make sure it's calibrated correctly if PtB is the next task)
- AA. Repeat step "V", and if necessary step "R" again.
- BB. Inform the participant that we are now repeating both tasks. Start the **repetition of task 1** when the participant is ready.
- CC. After the repetition of the first task, again, follow point "U" (turn off belt if PtN is the next task, turn it on and make sure it's calibrated correctly if PtB is the next task)
- DD. Repeat step "V", and if necessary step "R" again.
- EE. Start the **repetition of the second task**.
- FF. **After the second task has been repeated, participants can have a break if they need/want to.** If they have not had any breaks yet, tell them to have a break now. Let them take off the glasses. You can offer them a cookie and/or a lemon water from the lab.
They can *turn off the feelSpace belt for the break*.

- GG. Ensure that the devices are still connected properly and shown in the SteamVR window. Ensure that the glasses are worn correctly.
- HH. Before starting the *Ghost house placement (GHP) tutorial* **explain that:** “In each trial, one of the buildings has disappeared from the city and you have to place it back to its original location. You can place the building by adjusting its direction (pointing with the left controller), the distance of the building (pull/push the left joystick forwards or backwards), and even the orientation of the building (push the right joystick to the left or to the right). By clicking the trigger button on your right controller, you can select to place the building and subsequently, you can either press the trigger button again to confirm the placement, or the “A” button to cancel the placement.” Let them play around with this for a while. Then, let them turn towards the blue squares on the right side. Explain that they “can place a building behind other objects and that those other objects disappear when they are hit by the blue beam. Only the wireframes of the objects remain as visual indicators.” Now let them place buildings behind / through the blue boxes.
- II. Whenever the participant feels comfortable with the controls, finish the tutorial and **introduce the procedure of the task:** “You will be placed in front of a building with street art on it. From each location, you will place 4 houses. The house that you are placing has disappeared from the city and your task is to place it at its original location. You have 1 ½ minutes to place a building. In the last 20 seconds, a timer will appear on the display to warn you that you are running out of time. In case you are uncertain where to place a building, simply go with your intuition.” Ask for remaining questions.
- JJ. After the tutorial and instructions, again, let them **turn on** and **calibrate the feelSpace belt** as described in steps N-K (only adjust the signal direction if necessary - in theory it should still match, but please make sure this is the case!)
- KK. **Repeat step “R”** (calibration & validation).
- LL. **Start the task.** Whenever they are ready, they can press the trigger button to start the experiment. Only pause if necessary (if you pause, remember to recalibrate and revalidate the eye tracking).
- MM. After the GHP task, wait for the “Thank you for your participation” screen. Then, “Quit” the experiment and instruct the participant to take off the glasses. They are done. Nevertheless, wait for the data to be saved (SpaRe window in “VR view”). Then, thank them for their participation.
- NN. **During the entire experiment:** monitor the pointing and viewing behavior of the participant to ensure the participant’s attention is on the task that we gave him/her. If this is not the case, do not hesitate to repeat the task instructions many times. If a participant disobeys your instructions, write down what happened and report their Subject ID to me. Most likely, we will exclude them. Nevertheless, finish the experiment.

VI. After each Session

- A. **Let them fill in and sign the VP hour / payment sheet!**

- B. **Charge all devices (controllers & body tracker)**, as well as the **phone** (charger next to the 2x6 screen) and the **belt** (disconnect battery and charge it)
- C. Disinfect all the surfaces, all devices that have been used (HMD, controllers, body tracker, pens etc), and the laboratory (doorhandles, chair etc). Basically everything that has been, or could have been touched, including your own hands.
- D. Air the room. Open all windows that can be opened and the entrance door for air circulation.
- E. Follow all the other steps as described in the COVID checklist
- F. Remove the hygiene cover sticker from the glasses.