**STREAM-spatial-task - Instructions for experimenter**

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8. **Description of the task**

When you think back to something that happened in the past, what do you remember first? The surroundings, the overall look and feel, or a specific detail? The spatial STREAM task aims to assess the order in which different elements are reinstated when we retrieve a memory. In this task, subjects are asked to make associations between objects and locations around a circle. Later, they are asked to remember the objects when cued with the locations.

The objects come from 4 categories: dogs, birds, cars and aircraft. The subjects are primed to remember 5 elements of the object and answer questions about these 5 elements:

* Living / non-living
* Flying / non-flying
* Photograph / drawing
* Color / Black-white
* The exemplar description (i.e. German shepherd or Dalmatian)

Subjects will have to remember 8 objects (2 dogs, 2 birds, …) per session. The subjects perform 2 sessions, either directly after each other (with a short break) for healthy subjects, or on different (parts of the) day(s) for patients.

There are two versions of the memory task: a behavioural version and a standard version used for electrophysiology and fMRI. The differences are explained in the next section.

The task is mostly self-paced, so it is important to make sure the subjects keep up the pace. At a normal pace, a behavioural session should take about 25-30 minutes, and a standard session 35-40 minutes. For healthy participants, the total study, including instructions and practice (5 min), should take max. 1.5 hours. Subjects get paid 12 pounds (8 pounds per hour) or receive 1.5 credits.

There is also a visual control version of the task, in which subjects answer the same 5 questions about the same 16 objects, but while those objects are on the screen. This task consists of 2 sessions of about 15-20 minutes each. The total task takes max. 45 min and subjects get paid 6 pounds in compensation or 0.7 credits.

1. **Task structure**

The task consists of 4 phases. Below you’ll find a short description of each phase.

* 1. Familiarization

During the familiarization phase, the subject sees all objects multiple times and answer each question at least once for each object. The subjects get feedback on their answers. This way, we want to make sure the subjects know the identifies of all objects and are aware of the questions we are interested in.

There is a slight difference between the behavioural task and the standard task used for electrophysiology/MRI. During the behavioural task, subjects will see the answer alternatives on the screen first and answer the question after the object appears. In the standard task setup, the object is presented first (for 2 seconds), after which the answer alternatives appear.

* 1. Encoding

During the encoding phase, subjects learn each object’s location around the circles. There are two different types of encoding trials. In the first type, subjects are shown the location for a randomized period of time and are then shown the object. The press a button when they are have remembered. In the second trial type, the subjects get to test their knowledge. They are first shown the object, press a button when they remember the location and then navigate to this location. The subjects get feedback and can keep trying until they find the correct location. Each object is shown multiple times, typically around 10 times.

* 1. Distractor

The distractor task is an odd/even number task. It lasts for 60 seconds.

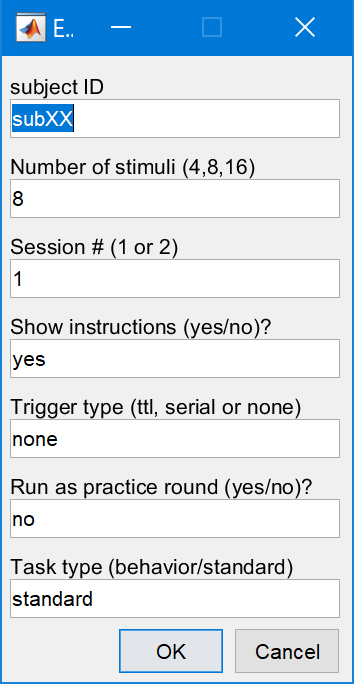
* 1. Retrieval

During the retrieval phase, the subjects are cued with the locations around the circle, and have to remember the object that corresponds to that location. The behavioural task and the standard are slightly different in setup.

In the behavioural version of the task, subjects are shown answer alternatives on the screen first, and are then shown the cue. They are asked to answer the question as soon as they remember the object. In the standard task version, subjects are shown the cue first, press a button when they remember the object and then keep this object in mind for 3 seconds. They are then, on some trials, asked one of the five questions about the object.

1. **Running the task**

*Step 1: Run the script.*In Matlab, navigate to the task folder. You do not have to add anything to the path, the code will take care of that. You do not have to make any changes in the code. All task version (behavioural/standard/visual, and the practice version) are started by running the run\_STREAMspatial.m script.

*Step 2: Subject ID and task settings.*   
The script opens a pop-up box asking for some settings. Once you press the OK button on the pop-up box, the task will start.

The first setting to change is the ‘subject ID’. For healthy subjects, use ‘sub’ followed by your initial and the subject ID, for example ‘subm02’. For patients, use ‘sub’ followed by their BIDS patient code, for example ‘sub1011’. Note down the subject ID, because you’ll need it for the second session.

You do not have to change the ‘Number of stimuli’, the default, 8, is fine for most cases.

The ‘Session #’ is by default set to 1, so you don’t have to change it when running the first session.

The ‘Show instructions (yes/no)?’ switch is there to turn off the instructions in case subjects have seen the instructions already on the previous (practice) session and are comfortable with the task. For patients, it might make sense to repeat the instructions briefly before the second session, if the sessions are far apart in time. Replace ‘yes’ with ‘no’ or ‘n’ to turn the instructions off.

The ‘Trigger type’ is an important setting when running electrophysiology. The default is set to ‘none’, which means no triggers are sent, which is the correct setting for behavioural runs and test sessions. For electrophys, you’ll have to change the trigger type to the desired trigger system. For Neuralynx recordings in Birmingham and Erlangen, change it to ‘ttl’, for macro-only recordings in Erlangen change it to ‘serial’.

If you want to run the task as a practice round (see next section), then you have to change the ‘Run as practice round (yes/no)?’ setting to ‘yes’ or ‘y’. This setting works for both behavioural and standard experiments.

The last setting, ‘Task type (behavioural/standard/visual)’ is maybe most important, as it selects the task version. If you are running a behavioural experiment, change this setting to ‘behavioral’, ‘behavioural’, or simply ‘beh’, for visual type ‘visual’ or ‘vis’.

*Step 3: Run the second session*The script runs one session only and stops when the session is done. To start a second session, again run the run\_STREAMspatial.m script.

In the pop-up box, input the exact same subject ID you used for the previous session. This is important, because the stimuli are balanced between the two sessions, so the second session has to use the data from the first session.

Change the ‘Session # (1 or 2)’ setting to ‘2’. If you forget to change the session number, don’t worry. The code will continue where it left off with session 1 (see Troubleshooting), which is at the last trial of the retrieval phase and it’ll stop automatically. You can then restart the code with the correct session number.

Select the desired task version as described in the previous step. When you are done, press OK. If everything is set up correctly, you will now see the following message in Matlab’s command window: ‘Data found for this participant, but not for this session. Continue with old stimulus-set? (yes/no/quit)’. Type ‘yes’ or ‘y’ and press enter to start the task. If you do not get this question, you probably did not use the exact same subject ID. Stop the task (by pressing the ‘Q’ button any time an input is required, for example, during the instruction pages, or the first trial of the familiarization phase) and try again.

*Step 4: Copy the data*When both sessions are complete, it’s wise to take some time to check and backup the data. Copy all files that contain the subject ID in their file name over to an external flash or hard drive. Make sure you copy files from the following folders: ‘results’, ‘settings’ and ‘sequences’.

1. **Instructions and practice run**

Before the first session, the task has to be explained to the subject verbally, with the use of a series of instruction pages. Scripts for the verbal instructions can be found in sections 4.1 and 4.2. The instruction pages automatically appear on the screen when you run any version of the task. You can move through the instruction pages by pressing SPACE bar, or navigate back and forth by pressing the LEFT and RIGHT response keys.

During the task, each task phase start with a reminder page, reminding the subject of the setup and controls for that task phase.

For the behavioural and electrophys versions, it is good to do a practice run before the first session. To do this, change the ‘Run as practice round (yes/no)?’ in the Setting pop-up box to ‘yes’ or ‘y’. This will select a different stimulus set with only 4 objects and a lower number of trials for each task phase. Otherwise, the task layout is identical to a normal session. The practice round will also start with the instruction pages.

The instruction and reminder pages are saved in the ‘instructions’ folder of the task directory. You can view them as images. If you want to make changes to the pages, you can do so in the ppt file. When you are done, save the slides as .jpg files. Rename the instruction images to ‘instructions\_#.jpg’, with # the number that indicates the order in which the pages appear. Rename the reminder pages to ‘reminder\_taskphase.jpg’, for example ‘reminder\_encoding.jpg’.

* 1. Instructions script – behavioural – to say to the participant while showing the instructions

Page 1: Familiarization  
Throughout this task, you will be asked to remember the locations of 8 objects: 2 dogs, 2 birds, 2 cars and 2 aircraft. You will also have to answer some questions about these objects. To familiarize yourself with the objects and the questions, we’ll start with a familiarization phase. Each trial will start with the appearance of two possible answers on the screen. After 2 seconds, the object will appear. Choose the answer that matches the object as fast as possible, by pressing the LEFT button for the left answer and the RIGHT button for the right answer. You’ll be asked to answer the following questions: what object is it, is it living or non-living, flying or non-flying, is it a photo or a drawing and is it black-and-white or in color?

Page 2: Encoding 1/2  
Once you have answered all questions for all objects, we will move on to the encoding phase. You are shown a location around the circle first. Then, the corresponding object appears. When you are ready to continue to the next object, press the UP button. You will see every object and location several times, so you don’t have to remember everything the first time. Try to keep up the pace.

Page 3: Encoding 2/2  
Every now and then you’ll asked to do a mini-test. This test is indicated by the text on the top of the screen. After pressing a key, you’ll be shown an object. When you remember the location belonging to the object, you press the UP button, if you’ve forgotten, please press DOWN. You can then navigate to the location by using LEFT and RIGHT and press UP to select. You will then see whether your answer was correct or incorrect.

Page 4: Number task  
After you learn the locations of all objects, we’ll switch gears and do a short number task. You’ll see a number on the screen and will have to indicate whether the number is odd (LEFT) or even (RIGHT). You have 60 seconds to answer for as many numbers as possible.

Page 5: Retrieval  
Then it is time to remember the objects. Like with the familiarization phase, you will be shown two possible answers first. You have 2 seconds to read these. Then one location will be highlighted. You are asked to remember the object that belongs to this location. When you remember the object, pick the description that matches the matches the object by pressing LEFT or RIGHT. If you do not remember the object or do not know the answer to the question, press DOWN.

1. **Troubleshooting**

*I want to stop the task*If for some reason, you have to stop the task, you can do so by pressing the ‘q’ key (for quit), at any moment that the task requires input, so for example, when pressing a button to continue to the next trial, or when answering a catch question or doing the number task. This stops the execution of the code immediately, closes the Psychtoolbox screen and returns you to Matlab. It is safe to stop the task at any point, all data will have been saved already. The code will automatically continue where you left off when you start the code with the same settings at a later point in time.

*I want to continue a stopped session*  
If you want to continue an aborted session, simply run the run\_STREAMspatial.m script again, with the same subject ID, session number and task version as before. You can turn off the instructions, if you want. You should see the following message in the Matlab command window: ‘Existing session found for this participant. Continue with the old session? (yes/no/quit)’. Type ‘yes’ or ‘y’ and press enter to continue the task. If you do not see this message, you probably did not use the exact same subject ID. Stop the task and try again.

The code will continue after the last completed trial. It will always show the reminder page of the trial phase it is starting at (so, whether you start at encoding trial 1, 10 or 100, you will always see the encoding reminder page). If encoding was completed, but not the first trial of the retrieval phase, the script will start with the number task.

*I want to start a completely new stimulus set for an existing participant*If for some reason that I cannot imagine right now, you want to start a completely new experiment with an existing participant, you should, when prompted with either the question ‘Existing session found for this participant. Continue with the old session? (yes/no/quit)’ or the question ‘Data found for this participant, but not for this session. Continue with old stimulus-set? (yes/no/quit)’, answer ‘no’ or ‘n’. This will select a new stimulus set and generate a new sequence. Note that the output will be written to the same log file. Please make a note when you do this and explain why it was necessary.

*I get a message that existing data were found, but the participant is new*   
When you get a message that existing data/an existing session has been found, it means that there already is a file with the exact same subject ID, for example because there was a previous participant with the same initials. If you are sure you are starting with a fresh participant, do not continue running the code. When prompted with the question ‘Existing session found for this participant. Continue with the old session? (yes/no/quit)’ or the question ‘Data found for this participant, but not for this session. Continue with old stimulus-set? (yes/no/quit)’, answer ‘quit’ or ‘q’. Choose a new, unique subject ID and run the script again.

*Help, the task is frozen*Oops, that’s not good and it should not happen. Press the Windows key on the keyboard, move the mouse over the Matlab icon in the toolbar, and when the active panels appear, move the mouse to the empty panel (this is the Psychtoolbox screen) and close it by clicking on the appearing cross. You should now be able to return to Matlab and start the script again. Please let me know when this happened, and whether something else was going on (pop-ups from Windows, etc.).

*I get the error ‘Empty results file found, delete this file and start again’*  
This error is thrown when a logfile with this subject ID already exists, but it is empty, because the task crashed or was aborted before the first trial was completed. Navigate to the results folder, you should find the file there. Check whether the file is indeed empty and if so, delete it and start the task again. If you want to keep the file, then you should choose a different subject ID or rename the old file.

1. **Settings**

Most task settings (except the ones set by you in the popup box) are set in a separate file named settings\_STREAM\_[taskversion].m file, found in the settings folder. Settings range from the number of trials in each task phase, to timing parameters (how long is the object shown on the screen etc), position of the catch answer alternatives and color of the background and feedback. Most settings have some form of description in the settings file. If anything is unclear, let me know, so I can improve the documentation.

There is a separate settings file for each of the task versions. You can make changes to these files, but do this with caution. Be aware that each file only affects one task version, if you want your change to apply to more than one version, you’ll have to change the other files as well.

All settings (including the ones set by the popup box) are stored each time the code is run. This allows us to trace back exactly what each subject did. The settings files are stored, with the task version, the subject ID and date/time in the name, in the settings folder.

1. **Logfile**

Every time a trial is completed, the data for that trial are written to a logfile as a new line. The log file is stored in the results folder as a text file. The text file carries the subject ID in the file name, so subject IDs have to be unique. Data in logfiles are never removed or overwritten and new trials are always added to the end, no matter how often you restart the task.

The logfile contains the following columns for every trial. Note that some will remain empty for some of the task phases:

subID: subject ID

sessionID: the current session, 1 or 2

block\_state: familiarization, encoding or retrieval

trial\_id: counter of the number of trials completed in the task phase

trial\_type: for familiarization and retrieval, this is indicated the catch question type (1-5) or no catch question (0); for encoding 0 = a normal trial and 1 = drag-and-drop

cue\_id: number of the location used for this trial (not for fam.)

cue\_xcoord: x-coordinate of the cue location (pixels) (not for fam.)

cue\_ycoord: y-coordinate of the cue location (pixels) (not for fam.)

stim\_label: e.g. german shepherd (see stimuli\_info.txt)

stim\_id: stimulus number (see stimuli\_info.txt)

stim\_filename: xxx.jpg (see stimuli\_info.txt)

stim\_counter: counter of repetitions for each stimulus

stim\_cat: 1 = dog; 2 = bird; 3 = car; 4 = aircraft (see stimuli\_info.txt)

stim\_perc1: 1 = photograph; 2 = drawing (see stimuli\_info.txt)

stim\_perc2: 1 = left-facing; 2 = right-facing (see stimuli\_info.txt)

stim\_sem1: 1 = animate; 2 = inanimate (see stimuli\_info.txt)

stim\_sem2: 1 = flying; 2 = non-flying (see stimuli\_info.txt)

RT\_encoding: time between stimulus onset and encoding button press (s)

DaD\_resp: reinstatement button press of subject (stimulus shown, location asked) on encoding drag-and-drop trials. 0 = forgotten; 1 = remembered

RT\_DaD\_reinst: time between stimulus onset and reinstatement button press on encoding drag-and drop trials (s)

DaD\_numb\_attempts: number of attempts needed to reach correct location on dad trials

RT\_DaD\_loc: time between onset of location selection and selection of the correct location (s)

ret\_reinst\_resp: reinstatement response of the subject on retrieval trials (location shown, stimulus asked) 0 = forgotten; 1 = remembered

RT\_ret\_reinst: time between location onset and reinstatement button press on retrieval trials

catch\_type: catch question asked (perc1, perc2, sem1, sem2, exemplar) (familiarization and retrieval)

RT\_catch: for standard task: time between onset of the catch question and the response of the subject (s); for behavioural task: time between onset of the stimulus (encoding) / cue (retrieval) and the response

catch\_resp: 0 = incorrect; 1 = correct; 2 = no answer; 3 = forgotten;

onset\_session: onset time of session (relative to start of the code, pretty arbitrary but useful to identify new code starts) (s)

onset\_familiarization: onset of familiarization phase(s)

onset\_encoding: onset of encoding phase (s)

onset\_retrieval: onset of retrieval phase (s)

onset\_trial: onset of trial (s)

onset\_cue: onset of the cue (s)

onset\_trigger: onset of the trigger (always 150 ms before stimulus onset for familiarization and encoding, 150 ms before cue for retrieval) (s)

onset\_stim: onset of stimulus (s)

onset\_DaD\_stim: onset of DaD stimulus (s)

onset\_DaD\_reinst time of DaD reinstatement response (s)

onset\_DaD\_loc: time of selection of correct location (s)

onset\_ret\_reinst: time of retrieval reinstatement response (s)

onset\_catch: onset of catch question (i.e. answer alternatives appearing on screen) (s)

onset\_catch\_resp: time of catch answer button press (s)