Memory in Spatial Navigation

Mini-Project 6
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Spatial Navigation Experiment: Courier

In this project we will collect, analyze and interpret data on memory for spatial and temporal information. Our online experiment is Courier — a hybrid spatial-episodic memory task, in which subjects navigate a virtual town (as in a video game) and deliver items to different stores in the town and receive tips for their deliveries. At the end of each delivery day, subjects must recall which items they delivered and the average tip they received.

This task was designed to measure spatial memory in free recall dynamics. The task resembles a word-list free recall task, but with several key differences. First, the timeline with which subjects navigate from store to store determines the timing of each item encoding and as a result subjects have more control over the experiences that they are asked to remember. Second, the task of "finding the next store" between each delivery likely makes it more difficult to rehearse items. Third, the spatial context of the environment may further organize the subjects' memories, especially as they become more familiar with the environment layout.

To run in the experiment, please link to this URL: Courier experiment. At the beginning of the experiment, you will enter in some identifier (letters and numbers) that is unlikely to be used by anyone else. You will enter that identifier in Canvas along with your report.

For the purpose of this assignment, you may treat all the data as if they came from a single participant. If you can efficiently analyze the data from each of the participants individually, it is more accurate to analyze each person's data, and then average across people to create your final results.

Description of the data

In the data file, there are three sheets. In the sheet "Encoding Trials", each row indicates an encoding or study event in which a word was presented to the subject and a new delivery store was assigned, and the columns are as follows:

1. "Subject" - the subject index;

2. “Trial” - The number of the delivery day or list
3. “Serial Position” - The position of the delivery in the delivery day
4. “Trial Time” - the time of onset of the encoding period (word presentation) in milliseconds since the start of the delivery day or trial.
5. “Time bin” - the discrete “bin” that these times have been labeled with for simpler analysis. For example, a bin ranging from 5 to 10 seconds after the start of the delivery day would contain all encoding events in that time range. These 10 particular bins represent 10% percentiles. For instance, a bin label of 1 corresponds to delivery trial times in the lowest 0% - 10% of delivery trial times and a bin label of 3 corresponds to the range of percentiles of 20% - 30%. Using percentiles ensures that all bin labels have an equal amount of data in comparison to an approach such as binning with equal bins (e.g. 0-5 seconds, 5-10 seconds, etc.).
6. “Delivery Time” - Length of the delivery in milliseconds from start to completion.
7. “Item” - Delivered item.
8. “Recalled” - Whether the item was subsequently recalled (labeled with a 1) or not recalled (labeled with a 0)
9. “Presentation X-coordinate” and “Presentation Y-coordinate” - The Cartesian coordinates of the subject position at the time of word presentation within the 2D layout of the town.
10. “Store X-coordinate” and “Store Y-coordinate” - The Cartesian coordinates of the store of the next delivery within the 2D layout of the town.

The format of spreadsheet **Recalls** is as follows.

1. Subject index
2. List number
3. The total number of times a transition of lag -2, -1, +1, or +2 (where lag is in terms of differences of time bins instead of differences of serial positions) could have been made.
4. Recalled serial position (multiple columns, e.g., ’recall 2’ for serial position of second recalled item): contains time bin labels of recalled items in order of recall. `0` is a place-filler denoting no recall was made at a particular recall position (e.g., if a subject only recalled five words, ’recall 6’ and above would have values of zero). `-1` is a place-filler denoting an intrusion error. `-2` is a place-filler denoting duplicate items that are recalled multiple times from that list. Each list had a length of twelve items.

The **CRPs** spreadsheet contains computed CRP values for time bin lags -5 to +5 excluding lags -2 to +2. The **CRPs** spreadsheet has columns ’Lag’ and ’CRP’.

Interpretation and Data Analysis Problems

1. To measure the influence of absolute time on the dynamics of recall, plot the conditional response probability as a function of lag (the lag-CRP) in terms of time bins instead of serial or list positions as you completed previously. Compute the CRP for lags -2, -1, +1, and +2. CRPs for lags -5, -4, -3, +3, +4, and +5 can be found in the spreadsheet 'CRPs'. You should plot the CRPs from a lag of -5 to +5. Make sure to exclude transitions containing intrusions or repetitions. Compare this result to what you have previously seen in lag-CRP curves for the free recall word-list task.

2. Propose an analysis for illustrating people's tendency to learn the spatial layout of the environment and improve their navigation over the six successive delivery days. If a subject knew the layout of the virtual environment well, how would you expect their task performance to differ from a subject who was unfamiliar with the environment? Describe your method, show the results, and provide some interpretation.

3. Come up with a method of measuring the degree to which subjects organize their recalls based on the distances between the delivered objects. Can you think of a method akin to the lag-CRP curve for free recall, but using spatial distance or using the shortest path that people could have taken between stores? Does this tendency, if present, depend on how well people knew the layout of the environment? You do not need to implement your proposed analyses in these data but make sure your description is clear and well defined. You further do not need to restrict yourself to the data types given to you in this assignment and can assume that any information relevant to the task (e.g. the coordinates and viewpoints of the subject in the town during navigation) are recorded every 100 ms and available to you.

Software for analysis

Although you are encouraged to use Microsoft Excel for this assignment, you may use one of the following software packages: MATLAB, Python, R, Java, C. If you want to use a different software, please email the TAs for approval.

Submission

You should save your report as a PDF and submit it electronically through the Canvas site. **Word documents are not accepted.** You also need to submit the code or the Excel spreadsheet you used to do your analyses.