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The impact of map-structuring elements on object location memory error

Annika Korte *, Julian Keil, Frank Dickmann

Institute of Geography, Ruhr-Universität Bochum, Bochum, Germany 1st Author – annika.korte@rub.de, 2nd Author – julian.keil@rub.de, 3rd Author – frank.dickmann@rub.de

* Corresponding author

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Abstract:

Maps are used to transmit spatial information using different kinds of visual features (Thorndyke & Stasz, 1980). They support orientation, wayfinding and formation of cognitive maps. However such cognitive maps often contain distortions (Okabayashi & Glynn, 1984; Tversky, 1992), which can cause errors in object location recall and distance estimations. It has been shown that overlaying a map with space-referencing elements like grids leads to higher spatial accuracy in recall of object locations compared to conditions without these elements (e.g. Bestgen et al., 2017; Dickmann et al., 2019; Edler et al., 2014; Martin et al., 2008; Wolfe et al., 2002). Otherwise, Huttenlocher et al. (1991) showed recall errors towards a prototypic locations for dots presented in a circle according to the category adjustment model. Landmarks, as well as grids, can support the estimation of spatial relations (Edler et al., 2014; Sadalla et al., 1980). An important distortion effect in this context is the landmark attraction effect, where objects are memorized as being closer to the landmark than they really are (Bryant & Subbiah, 1994; Hubbard & Ruppel, 2000; Sadalla et al., 1980; Tversky & Schiano, 1989). Probably geometrically arranged grid crosses on maps (e.g. used to provide cues of an underlying grid system) lead to the same distortion effect in spatial memory as landmarks as they also showed lower spatial accuracy in recall than continuous grid lines (Edler et al., 2014). We wanted to examine the influences of prototypic location and landmark attraction effect on object location memory.

We investigated the influences of full grid pattern and grid crosses presented on rural maps and blank backgrounds on object location memory performance. 91 subjects (58 males) with a mean age of 25.52 years (SD = 3.79 years) conducted a screen-based object location memory task. We chose a combined within- and between-subjects design, where half of the participants saw rural maps and the other half blank backgrounds. Randomised within each group participants saw one of the grid types (full grid pattern or grid crosses) during the first eight trials and the other grid type during the following eight trials. Examples of all four conditions were shown in figure 1.

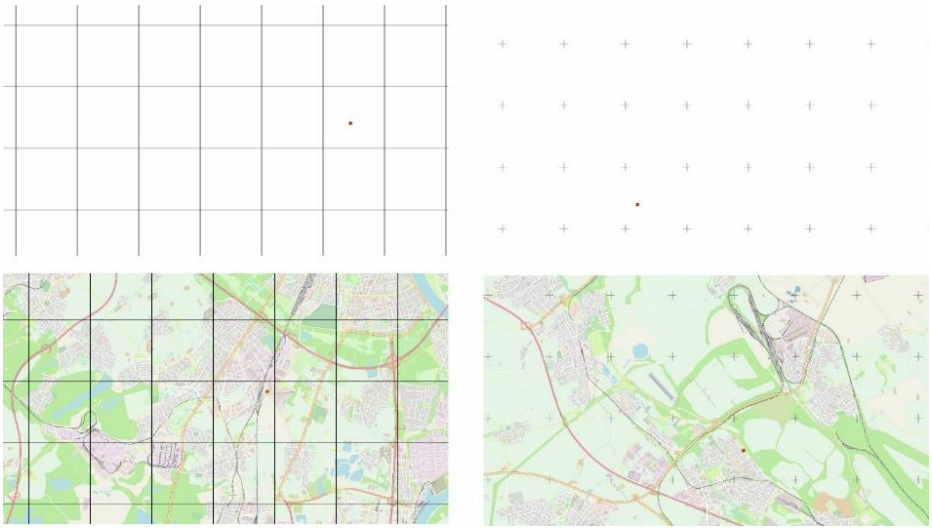

Figure 1. Exemplary encoding phase of all four different conditions.

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Participants' task was to encode the location of a red dot presented on the screen and to recall this position as exact as possible after an alphabetical distractor task. We investigated the influence of the presence of a map and the corners of the continuous grid pattern and the grid crosses as well as their interaction on errors in object location memory.

Analyses showed no significant pull effect of the nearest corner of grid pattern nor the nearest grid cross in both conditions (rural map, blank background). However, we could show a significant main effect of the presentation of full grid or grid crosses on the recall error distance with respect to the nearest grid corner/cross (in the following named grid error). The recall error away from the nearest grid corner (continuous grid) was significantly higher than the recall error away from the nearest grid cross (push effect). Results also revealed a significant main effect of the direction of the closest grid corner/grid cross on grid error. The push effect was significantly lower if the nearest grid corner/grid cross was in the up left or up right compared to down left or down right. Correlation matrices revealed a significant relationship between grid error and recall error on the Y-axis, but no significant relationship of grid error and recall error on the X-axis. Therefore, it seems like most of the differences in grid error based on an over- or underestimation on the vertical axis.

The push effect of grid corners in the condition with continuous grid lines fit to the category adjustment model (Huttenlocher et al., 1991). According to this model, viewers use the categorical information, in this case the grid square, to enhance their accuracy in recall but tend to place the dot closer to the prototypical region. This effect is significantly lower in the grid cross condition. Probably the distortion towards the prototypical region and the landmark attraction effect, as effects with opposite directions cancel out partially in this condition.

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