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How feelings affect map learning: The role of positive and negative emotions in spatial memory

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Abstract:

Reading maps (cartographic or digital) to acquire environmental information is a common experience. Learning spatial information from maps involves processing and memorizing details about landmarks and their interconnections. The outcome is an internal representation of the environment, referred to as a 'cognitive map' (Tolman, 1948). Map learning is related to various individual (psychological) and external (environmental) factors. Among the psychological factors, there is the individual's emotional state. Emotions are a combination of valence (the positivity or negativity of the emotion) and arousal (the intensity of emotional activation), ranging from negative valence – low arousal (e.g., sadness) to high arousal (e.g., anxiety), and from positive valence – low arousal (e.g., calmness) to high arousal (e.g., excitement). However, to the best of our knowledge, even though reading and recalling information from maps in emotionally charged contexts may be a common experience no study has specifically investigated the role of emotions in map learning. A growing body of psychological (spatial cognition) research indicates that emotional aspects are closely tied to cognitive map formation, as investigated following navigation in environments. Positive emotions appear to enhance the quality of the cognitive map (e.g., Ruotolo et al., 2019), while negative emotions seem to impair it. For example, studies have demonstrated the negative effects of emotions related to time pressure on the accuracy of the cognitive map (e.g., Credé et al., 2019). Other research has shown that stress increases reliance on familiar routes rather than novel shortcuts, resulting in longer distances travelled and greater time required to complete tasks (e.g., Boone et al., 2024).

Therefore, we aimed to investigate the role of emotions in map learning and its subsequent recall. In Study 1, we aimed to examine the impact of a condition eliciting negative emotions by comparing it to a more positive emotion condition, using a within-subject design. In Study 2, we aimed to examine the effects of negative-valence emotions by comparing high- and low-arousal conditions on spatial information recall, using a within-subject design. Across all studies, individual differences - such as age, gender, trait levels of positive and negative emotion, and spatial anxiety - will be considered as potential factors related to the recall of spatial information learned from a map and to emotions.

Study 1 (negative vs. positive condition) involved 177 participants (90 women and 87 men) ranging in age from 18 to 70 years (M = 42.27, SD = 14.94). Participants were recruited through word of mouth by the experimenters. They completed the questionnaires and tasks online on Qualtrics (in about 25 minutes). After reading and signing the consent form, all participants provided their personal information (e.g., age, gender, frequency of navigation tool use) and completed measures of trait positive and negative emotions (PANAS, Terraciano et al., 2003) and the Spatial Anxiety Scale (SAS; De Beni et al., 2014, adapted from Lawton et al., 1994). They reported their emotional valence and arousal using the Affective Slider (AS; Betella & Verschure, 2016) before reading and imagining themselves in a described scenario In the negative emotion condition, the description involved being in an unfamiliar city, memorizing a route from a map to reach a target landmark before their phone battery runs out in 3 minutes. In the positive emotion condition, the description involved being in an unfamiliar city with plenty of time to spare before reaching a target landmark, allowing them to enjoy the city (the presentation of the two conditions were randomized between participants). Participants were then presented with a fictitious city map. The map (960x720 pixels) depicted a network of city roads with a path marked in red and 14 landmarks labelled with text. Participants had three minutes to study it. After the map learning phase, they evaluated their emotions by rating their valence and arousal using the AS. Following a filler task, participants completed two spatial information recall tasks: - order Task (route knowledge): Participants were asked to recall the landmarks in the correct order along the path; - Distance estimation task (survey knowledge): Participants were asked to estimate the distance between landmarks along the path and the target landmark.

Participants then completed another filler task before rating their valence and arousal again, both before and after reading the second description of situation. Then they learned the second city map (two different but similar and comparable maps

were used) and completed the spatial tasks again. Finally, participants were asked to recall the two situations presented and their level of immersion in each, defined as how much they were able to empathize with the described situation.

Results showed no differences in either the order or distance estimation tasks based on the negative vs. positive condition. However, participants who reported feeling more positive after reading the situation, as well as those who reported feeling more immersed, performed better in order task. These results suggest that positive emotions felt during map learning may be associated with better recall of route information, and feeling inside the situation, regardless of its emotional valence, also plays a role. Concerning individual differences, we found that older adults' performance on the order task decreased with age, but no interaction emerged between emotional effects and age, suggesting that the relationship between emotion and map learning seems independent of age. Similarly, no role of gender emerged. Furthermore, no effect was observed in the distance estimation task, suggesting that it may not have been sensitive enough to the factors investigated.

Study 2 (negative valence – high arousal (e.g., anxiety) vs. negative valence - low arousal (e.g., sadness) condition) involved 120 participants (72 women and 48 men; data collection is ongoing) ranging in age from 18 to 70 years (M = 34.45, SD = 15.88). The materials and procedure for Study 2 are the same as for Study 1, except for the situation descriptions provided to participants before map learning and spatial tasks used to test the recall of information. In this case, participants were presented with two negatively valenced conditions, each eliciting different levels of arousal. In the high arousal condition (anxiety, worry), the description involved being in an unfamiliar city where participants must memorize a route from a map to reach a target landmark before their phone battery runs out in 3 minutes. The target landmark is a hospital, and it is crucial to reach it for an important medical visit. In the low arousal valence condition (sadness, boredom), the scenario described being in an unfamiliar city with plenty of time before reaching the target landmark, which is a cemetery where participants must bring flowers for a commission they were asked to complete. The spatial information recall tasks presented consisted in: - Order Task (route knowledge): Participants were asked to recall the landmarks in the correct order along the path, assessing their route knowledge (as in Study 1); - Map placement task (survey knowledge): Participants were asked to identify the correct positions of landmarks on the map, choosing from among distractor options.

Results (on the sample collected) showed a decreased performance on the order task in the high arousal condition compared to the low arousal condition, but no such effect emerged for landmark placement. This suggests that negative valanced situations eliciting higher arousal may be detrimental to spatial recall in terms of route knowledge. Further, similar to Study 1, only for the order task, participants who reported feeling more activated after reading the situation, compared to before reading it, as well as those who reported feeling more immersed, performed better in recalling the order of the landmarks. These results suggest that when the situation engages the user of the map, it is beneficial for route learning. Concerning individual differences, as expected, we found that older adults' performance on both the order task and map placement task decreased with age. However, no interaction emerged between emotional effects and age, further suggesting again that the relationship between emotion and map learning seems independent of age. No role of gender differences was observed.

Taken together, the results of Studies 1 and 2 seem to newly show that the emotion of the map learner may relate to the spatial information they can gain from the map, specifically in terms of route knowledge, which is important for recalling the sequence of landmarks one would encounter (e.g., Ruotolo et al., 2019). Positive emotions seem to slightly improve this knowledge, while in the case of negative emotions, the more activating they are, the worse the performance. However, independently of the emotion elicited by the situation, if the learner immerses in the situation, this seems to benefit route learning. Further examination of the role of arousal in positive situations (e.g. euphoria vs relaxing pleasure) will be examined in a future Study 3. Concerning the role of individual differences related to emotions (e.g., trait emotional state and spatial anxiety), they do not seem to play a role in map learning. However, the age of the user emerged as an important factor to consider (Muffato et al., 2022), although its effect is independent of the emotions elicited by the situation.

To conclude, emotions elicited in users while they are learning a map may impact their subsequent recall of spatial (route) information. A deeper investigation into the intriguing association between emotion and spatial knowledge after learning a map is therefore important, in order to understand the impact of user-specific factors.

References (selection)

Boone, A. P., Bullock, T., MacLean, M. H., Santander, T., Raymer, J., Stuber, A., ... & Hegarty, M. (2024). Resilience of navigation strategy and efficiency to the impact of acute stress. *Spatial Cognition & Computation*, 1-32.

Credé, S., Thrash, T., Hölscher, C., & Fabrikant, S. I. (2019). The acquisition of survey knowledge for local and global landmark configurations under time pressure. *Spatial Cognition & Computation*, *19*(3), 190-219.

Muffato, V., Simonetto, A., Pellegrini, M., Tortora, C., & Meneghetti, C. (2022). Navigation ability in young, middle-aged and older adults: Different domains of knowledge and their relationship with visuospatial factors. *Journal of Environmental Psychology*, *81*, 101820.

Ruotolo, F., Claessen, M. H. G., & Van der Ham, I. J. M. (2019). Putting emotions in routes: The influence of emotionally laden landmarks on spatial memory. *Psychological research*, *83*, 1083-1095.

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