

Autonomous Physical Exploration Influences Spatial Representation: Evidence From Blind and Sighted.

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Abstract

Evidences demonstrated that verbal information allows to construct a mental representation of space, even for persons who have no previous experience of sight. However, the construction of a mental model from verbal description is not presentation-free, as the verbal description anchors participants to a single perspective. The aim of our study is to test the perspective of spatial representation after the physical exploration of space, in order to avoid the influence of format presentation. We asked visual impaired and sighted participants to explore autonomously a room and then to perform a Sentence Verification Task, with sentences presented in an egocentric and in an allocentric version. We measured both response time and accuracy. Data demonstrated a better performance with allocentric perspective, even if the response time suggests that participants are more confident with the egocentric perspective. In conclusion, we suggest that the physical exploration of space leads to the development of an allocentric representation.

Keywords: spatial perception; spatial representation; visually impairment; physical movement.

Introduction

The role of vision in the development of spatial representation is a central issues in spatial perception. Evidences demonstrated that verbal information allows to construct a mental representation of space (Noordzij, Zuidhoek, & Postma, 2006), even for persons who have no previous experience of sight. Indeed, visually impaired persons (VIP) could adequately build up a mental representation of space, using multisensory cues, such as tactile, idiothetic or verbal information.

Commonly, researchers have focused on two main kinds of spatial representation, according to their different perspective. Route representation adopts a ground-level perspective, considering the point of view of the observer moving in an environment, and refers to an internal reference frame (bodily axes) and egocentric coordinates (such as: “to the right”, “to the left”). Survey representation, instead, adopts a bird’s-eye view perspective and refers to the personal knowledge about the topographic properties of the environment. It relies on a internal reference frame and fixed allocentric coordinates (such as: “to the north”, “to the south”). The modalities through which VIP encode spatial information – namely through idiothetic information (vestibular and podokinetic signals) – are essentially egocentric, suggesting that VIP develop a spatial mental model which is consistent with route representation. Furthermore, the VIP are impaired in generating a survey

representation of a not directly-experienced environment. Some empirical evidences support the hypothesis of the preference for route representation in VIP (Noordzij et al., 2006), while other studies disconfirmed it, demonstrating that even blind people are able to encode spatial information in a survey representation (Tinti, Adenzato, Tamietto, & Cornoldi, 2006). Commonly, researchers use to study spatial representation by providing participants with a verbal description of an environment and by evaluating the consequent perspective of the participants’ mental model. However, the development of a spatial representation from the verbal description of an environment is not presentation-free, as it anchors participants to the description’s perspective (Picucci et al. 2013).

The experience of physical exploration of the environment is another important factor that could influence spatial representation. The physical movements indeed provides idiothetic and podokinetic information regarding the environment, which are useful for the development of a spatial representation. Indeed, Loomis and colleagues (1993) suggested that the spatial competence could depend more on people experience in independent movement than on visual experience. Furthermore, a recent study by Schmidt and colleagues (2013), which paid attention to mobility skills, found a better performance of participants with a survey perspective condition and suggested that the spatial abilities of blind people could be improved by developing their independent movement. The independent movement seems to have an interesting role in guiding the spatial representation by enhancing the ability to develop a survey representation. However, to the best of our knowledge, there is no studies that evaluate whether the experience of physical exploration affects the perspective of the spatial representation of the previously explored environment.

The aim of the present study was to test the perspective of spatial representation after the physical exploration of space, in order to provide participants with idiothetic and podokinetic information and to avoid the influence of verbal description. Since literature provides contradictory evidences regarding differences among sighted and VIP concerning a preference in the spatial representation perspective, we tested both sighted and visual impaired participants in two separate experiments. We hypothesized a better performance for both accuracy and response time with survey representation than with route representation, not only for sighted participants, but also for VIP.

Experiment 1

Participants

A group of university students took part in this experiment in exchange of course credits.

Procedure

Participants were blind-folded before entering the room. They were asked to explore autonomously a room, with no time limit, and to imagine its spatial characteristics. In the meanwhile, the experimenter took note of the exploration strategy of participants. Then participants were asked to perform the Sentence Verification Task, with sentences presented both in egocentric and in allocentric versions. After the task, participants were asked to generate a tactile map of the explored room, by using LEGO blocks representing the objects inside the room.

We measured the accuracy and the response time in the Sentence Verification Task. Thereafter, two independent judges evaluated the performance in the LEGO map. Moreover, we observed the pathway and direction (clockwise or counterclockwise) of the exploration. As the pathway resulted to be the same for all the participants, we did not statistically analyze it.

Results

Results showed a faster response time for route perspective compared to survey perspective. Moreover, we compare the accuracy score with chance level (0.5) as criterion, for both perspectives. Results revealed a difference only for survey perspective, but not between the two perspectives. As regards the LEGO map task, we analyzed the scores obtain by participants who explored the room in counterclockwise and clockwise direction, but the analysis did not reach a statistical significance.

Experiment 2

Participants

A group of visually impaired participants took part in this experiment. Among these, there were both congenitally and partially blind.

Materials and procedure

Both materials and procedure were the same of experiment 1.

Results

Results showed a faster response time for route perspective compared to survey perspective. Analysis for accuracy, instead, showed a higher score in survey perspective compare to route perspective. Moreover, data from accuracy scores suggest difference from chance value only for survey perspective.

Concerning the LEGO map task, we analyzed the scores obtained by participants who explored the room in

counterclockwise and clockwise direction but, also in this case, the analysis did not reach a statistical significance.

Discussion and conclusion

Data partially confirm our hypothesis. As regards the Sentence Verification Task, we found a higher response time in survey perspective, suggesting that participants are more confident with a route perspective than with the survey one. On the contrary, considering accuracy score, evidences suggested a better performance in the survey condition. This effect seems to be more noticeable with visually impaired participants.

Different scores obtained in the LEGO map task by participants who explored the room in the two directions seem to suggest a possible higher performance for persons who explored the environment in the counterclockwise direction.

The experience of autonomous exploration of space seems to have an important role in the construction of an adequate mental model. More precisely, results suggest that the mobility skills and the experience of movement could enhance the development of survey representation rather than route representation, even if participants seem to be more confident with the route perspective. These data are consistent with Chrastil and Warren findings (2013), showing that podokinetic information is the primary factor of active learning for the acquisition of survey knowledge. Moreover, these findings could be interpreted also according to perception and action approach. However, further research should be conducted in order to better understand the contribution of the autonomous exploration compared to non autonomous exploration.

In conclusion, we suggest that physical movement might have an important role in guiding the development of spatial representation and in supporting both spatial updating and path integration, especially in absence of vision.

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