Personal Perspective: Visual Experience is not Necessary for Productive Spatial Cognition

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ABSTRACT

The competence to perceive the spatial surroundings is vital to tasks ranging from catching nearby objects to complex navigation through an unknown environment. Yet, many studies testing the functioning of visually impaired people in spatial tasks reported mixed results. Although the role of vision still remains critical in various aspects for such activities, vision experience is not necessarily needed for productive spatial cognition. The neural plasticity of the remaining modalities can reorganize the human brain to compensate the effects of blindness in order to efficiently implement the spatial cognition for navigating. The ability to discern the true nature of the human spatial cognition will lead to potential precise applications in the development of aids for visually impaired people.

1. Introduction

Blind and visually impaired people are faced with the confrontation when they try to locate their way through the human-made surroundings that can be problematic to get through [1, 2]. Research on blindness and visual impairment has largely addressed these difficulties by making an effort to gather related information and then achieve an appreciation and insight into the cognitive mechanisms underlying complex navigation without vision in order to invent new aids in helping for obstacle avoidance and route selection [1-4].

2. Spatial Cognition

Spatial cognition is a crucial ability through which an organism obtains, represents, arranges, comprehends and navigates the environment; catches distinguishing objects; mentally performs a function on objects; and corresponds related information about objects and the environment to others [1-3].

Spatial cognition allows individuals to adjust to and interact with their environment [1-3]. This is to amend or align (oneself or something else) according to surroundings or circumstances [1-3]. Spatial mental representations are tremendously imperative in everyday life

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for numerous human activities, allowing humans to adjust to their environment, specify the location of objects in order to interact with them, and or along with other things of a similar kind [1-3].

3. The Role of Vision in Spatial Cognition

Because of its superior spatial resolution, vision is regularly the predominant and cardinal sensory modality in spatial cognition and object recognition [5]. For example, the creation of spatial mental representations of the environment based on an auditory experience is likely expected to necessitate the modification and tuning of the visual system to perform expeditiously [3, 5]. Tactile stimuli are also generally remapped in sighted normal people into externally distinct correlatives primarily regulated by visual inputs [3, 5]. Therefore, normal vision grants "by default" an external integrated outline and setting for multisensory (e.g. auditory-manual) action control [5].

There is an accepted agreement on the vital role of visual experience in the development of spatial cognition, which is to appropriately direct the process of such maturation [5]. Vision has superiority to other senses in respect to encoding spatial details and then functioning as it guarantees the concurrent awareness and recognition of numerous stimuli in the surroundings despite the perceptible movement of the array on the retina for the duration of locomotion [5]. This is in turn enabling humans to acquire and then learn more invariant spatial characteristics from the surrounding outline, configuration, and features [5]. Psychophysical data also signify the notion that when sensorial rivalry arises, audition and touch are dominantly biased by concurrently presented visuospatial details in a powerful manner establishing that sighted individuals have a tendency to construct and arrange spatial information in line with a visual frame of reference [6]. Neurophysiological data further prove the observation that the visual response is critically essential for spatial learning [6].

The loss of vision is therefore anticipated to crucially impact on spatial cognition [5]. Nevertheless, there is also evidence to indicate that in the absence of vision, the achievement of spatial knowledge is not entirely lacking [1-3, 5].

This directs us to find out how the blind people have a propensity to depend on an egocentric/body-centered reference frame while representing objects in space and to create "route-like"/sequential mental representations in navigation [7]. In contrast, sighted subjects are able to give rise to allocentric mental representations (in which objects' locations are represented regardless of the observer's position) and to originate "survey-like" representations of the navigational space [7]. This is due to the fact that the available overriding sensory experience constructs discrepancies in the spatial performance of a blind and a sighted individual [7]. Thus, blind people are likely to employ their body as a reference frame (mostly depending on egocentric spatial representations) and to concentrate on near or peripersonal space, that is, on the part of space where they are able to precisely discover with their arm or long cane [7]. Particularly, the manner spatial details are represented expresses the manner it is gained at the perceptual level, namely in a sequential way [1-3, 7]. For instance, to depart from their house to a shop for shopping, blind people are likely to make "route-like" rather than "survey-like" types of representation, chiefly depending on the awareness of landmarks [7]. However, individuals without visual experience are not completely unable to employ allocentric reference frames or to obtain survey knowledge, but that the lack of visual experience makes this route more challenging to perform [3, 5, 7-9].

The survey of the psychological features of blind people also establishes that human cognitive maturation is not only formed by the nature and amount of sensory experience but also holds a number of innate processes and cortical connections that are able to perform a series of actions, changes, or functions bringing about a detailed result in a supramodal manner [10]. Indeed, there are supporting documents confirming the observation that a peripheral deficit in the blind, although extremely damaging, does not block the development of high-level processes and courses such as those subserving the creation of mental representations or mediating spatial cognition, despite probable discrepancies due to the layout of the incoming details [1-3, 5].

Furthermore, although lack of visual experience comes with the cost of losing many things, visual experience, at least in terms of performance, is not an essential provision for the development of spatial inferential complex representations and the survey-type spatial processing as non-visual modalities play a part to an appropriate spatial encoding and uphold the formation of highly sophisticated spatial representations [1-3, 5, 11]. Therefore, the accessibility of information from resources and senses other than vision helps spatially well-informed blind individuals to productively deal not only with particular tasks on which they have been practiced in, but also with diverse forms of new and unfamiliar spatial inference [3, 8, 11]. Expressed in a different way, in the absence of vision, other sensory modalities gain larger weight than they otherwise would have and thereby insufficient information acquired via different dedicated sensory modalities allows individuals to counterbalance and redress the lack of vision [3, 8, 11]. In view of this statement, the lack of vision creates adaptive reconstruction in the spared sensory modalities of blind or visually impaired individuals through the neural plasticity [12, 13].

As a result, visual deficiency, rather than straightforwardly blocking the setting up of the survey spatial cognition coordination, enforces the blind individuals to deploy compensatory mechanisms through applying particular tactics to deal with difficulties in arranging sequential characteristics (more easily encoded in route representations) into genuine spatial associations (e.g. into survey representations) [1-3, 5, 7, 8, 11].

4. Future Directions

A better comprehension of the underlying mechanisms implicated in spatial cognition improvements and defects originated by visual loss is imperative not only to calculate to what extent the perceptual outcomes of early blindness convert to the real world sceneries but also to manufacture useful rehabilitation devices and assistive technologies to advance spatial expertise of the blind people [14]. Indeed, investigative results associated with spatial competence development in the absence of visual experience should offer significant clinical applications for the construction of innovative rehabilitation routines and tools to utilize compensatory approaches [14].

5. Conclusion

Spatial cognition and navigation without vision have been addressed through a range of viewpoints, methods, and directions in various scales of space. These diverse plans of action and analyses have improved our comprehension of spatial knowledge acquisition by blind and visually impaired individuals, including their potential capabilities, manoeuvring, and correlative mental representations.

The number of research on navigation schemes in blind and visually impaired people is scarce. In addition, many studies testing the functioning of blind and visually impaired people in spatial tasks reported mixed results. All together, due to the critical role of vision in spatial cognition it is believed that visual experience is crucial for some features of spatial cognition, which might not entirely develop in the absence of one preferred or indeed required sensory modality. However, productive spatial cognition can be achieved in the absence of vision. This knowledge will help in the progress of technological advances for navigational assistance designed for blind or visually impaired people.

Ethical Considerations

Compliance with ethical guidelines

This scientific article consists of the author's own lecture notes and his intellectual original philosophy. Review and original based materials have been appropriately cited in the lecture notes and the ethical guidelines have been respected.

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Conflict of interest

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