Bournemouth University

ADRC
Ageing & Dementia Research Centre
Bournemouth University

Understanding orientation and navigation in later life: The application of Psychology in Ageing and Dementia Friendly Design Guidelines

Chapter 2: Introduction to Navigation

1. INTRODUCTION TO NAVIGATION

Successful navigation is a complex task, requiring a number of sensory and cognitive processes, enduring as well as transient representations of space (Wolbers & Hegarty, TICS article). Sensory inputs from our visual and auditory receptors provide information on the way that our surroundings look and sound. Vestibular receptors in our ears, and proprioceptors in our muscles and joints, detect movement and provide information of how we move through space. These inputs are processed by a number of different areas in the brain to allow us to localise and orientate ourselves, and to plan routes to our required destination.

Navigation can be based on two principle navigation systems, the *path integration system* and a *landmark-based navigation system*. Path integration refers to the process of updating perceived self-motion information to keep track of position and orientation during travel. The landmark-based navigation system, in contrast, relies

on landmarks or environmental cues (detailed definition below) to determine where we are in the world and to guide navigation to a destination.

While the path integration and the landmark-based navigation system work in parallel in everyday navigation, we will here focus on the landmark-based navigation system. It is the system that relies on environmental cues/landmarks to support navigation and the system that can be supported by appropriate design of the environment.

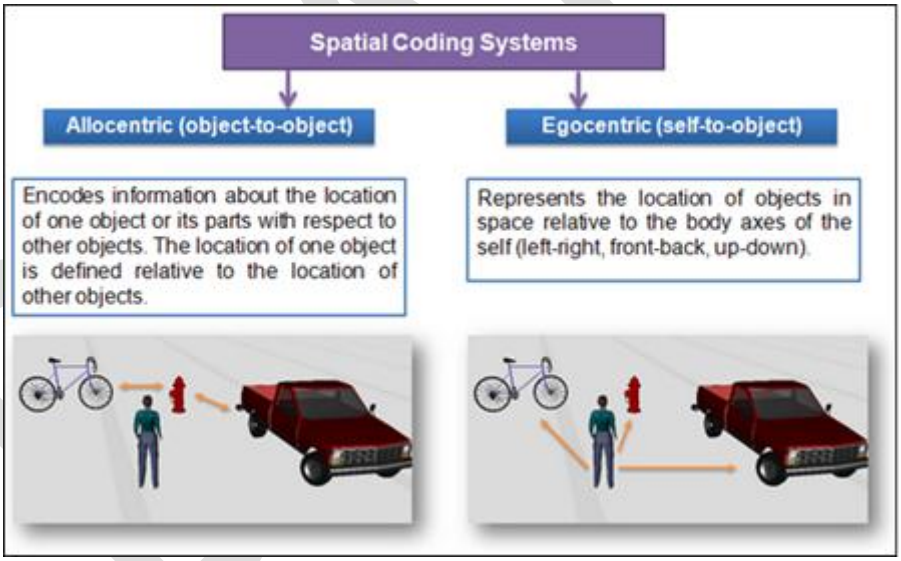

Figure 3: Schematic drawing of allocentric (left) and egocentric (right) coding systems

Source: http://www.nmr.mgh.harvard.edu/mkozhevnlab/?page_id=308

To make things more complicated, navigators can encode spatial information either in an egocentric (body-centered) or allocentric (world-centered) reference frame or

coordinate system. This distinction is important, as egocentric and allocentric representations and corresponding navigation strategies are supported by different brain areas (Hartley et al., 2003), some of which are affected more strongly than others in typical and atypical ageing (Lithfous et al., 2013) (Figure 3).

3.1 Egocentric strategies

Egocentric strategies are often also referred to as ‘route’ or ‘response’ strategies. Routes are learned from the perspective of the individual as they navigate through the environment. These strategies are most commonly used in familiar environments, where a well-known route can be replicated in a series of stimulus-response reactions. The individual associates a specific navigational response with a particular landmark stimulus; for example, turn left at the church. Egocentric strategies rely on the caudate nucleus and the parietal cortex in the brain, and are typically retained later in life. These routes are rigid and inflexible, i.e. they only allow you to navigate between start and destination, but allow older adults to navigate successfully within well-known environments.

EGOCENTRIC STRATEGIES

- Routes are learned from the perspective of the individual
- Series of so called stimulus-response associations – "Turn left at the church."
- Rigid and inflexible -> Rely on caudate nucleus and parietal cortex in the brain. Typically retained later in life

3.2 Allocentric strategies

Allocentric strategies are also known as 'place' or 'wayfinding' strategies. A 'cognitive map' of the environment is constructed, which is independent of the position of the individual; instead, it is based upon the positions, distances and orientations of navigational features, such as buildings or road signs, relative to each other. These strategies rely upon the ability of the navigator to manipulate their cognitive map internally, make sense of it from all viewpoints, and then plan a route from one location to another. Allocentric strategies are more flexible than egocentric strategies, allowing us to design new routes and plan short cuts through less familiar environments. However, allocentric skills are linked to the hippocampus and the entorhinal cortex in the brain, which are the first areas to deteriorate during typical ageing. Consequently, these skills decline in older age, and elderly people often report that they avoid unfamiliar environments due to difficulties with navigation.

ALLOCENTRIC STRATEGIES

- Independent of the position of the navigator.
- Cognitive map constructed.
- Flexible.
- Allow new routes and short-cuts to be designed.
- Rely on the hippocampus and the entorhinal cortex in the brain.
- Decline during typical ageing.