Space coding for sensorimotor transformations can emerge through unsupervised learning

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The posterior parietal cortex (PPC) is fundamental for sensorimotor transformations because it combines multiple sensory inputs and posture signals into different spatial reference frames that drive motor programming. Here we present a computational model mimicking the sensorimotor transformations occurring in the PPC. The model was a stochastic neural network (Restricted Boltzmann Machine) consisting of one layer of visible units (encoding sensory input) and one layer of hidden units (feature detectors) connected by bidirectional symmetric weights. The input was composed by a bidimensional retinotopic map and two posture maps encoding eye and head position, in line with neurophysiological data. Training was unsupervised and it was only concerned with efficient coding of the sensory data. After training, the activity of the hidden units was used to compute a motor program (a population code on a bidimensional map) through a simple linear projection and delta rule learning. The average motor error, calculated as the difference between the expected and the computed output, was less than 3°. Interestingly, gain modulated visual receptive fields spontaneously emerged in the hidden layer: although hidden units developed strictly retinotopically organized visual receptive fields, their response amplitude was markedly modulated by eye and head posture signals. The model demonstrates that space coding for sensorimotor transformations similar to that observed in the PPC can emerge through unsupervised learning. Furthermore, the receptive field properties of the hidden units are strikingly similar to those of PPC neurons. The results suggest that gain modulation is an efficient coding strategy to integrate visual and postural information towards the generation of motor commands.

Facing the past: cognitive flexibility in the front-back mapping of time

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In many languages the future is in front and the past behind, but in some cultures (like Aymara) the past is in front. Is it possible to find this mapping as an alternative conceptualization of time in other cultures? If so, what are the factors that affect its choice out of the set of available alternatives? In a paper and pencil task, participants placed future or past events either in front or behind a character (a schematic head viewed from above). A sample of 24 Islamic participants (whose language also places the future in front and the past behind) tended to locate the past event in the front box more often than Spanish participants. This result might be due to the greater cultural value assigned to tradition in Islamic culture. The same pattern was found in a sample of Spanish elders (N = 58), what may support that conclusion. Alternatively, the crucial factor may be the amount of attention paid to the past. In a final study, young Spanish adults (N = 200) who had just answered a set of questions about their past showed the past-in-front pattern, whereas questions about their future exacerbated the future-in-front pattern. Thus, the attentional explanation was supported: attended events are mapped to front space in agreement with the experiential connection between attending and seeing. When attention is paid to the past, it tends to occupy the front location in spite of available alternative mappings in the language-culture.

From top to bottom: spatial shifts of attention caused by linguistic stimuli

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Interacting with the world around us involves dealing with constant sources of information. In order to deal with the vast amount of information received, humans must selectively filter and focus attention on relevant aspects for the current situation. In the context of language processing, this suggests that processing linguistic stimuli results in attention shifts that are of functional relevance for daily interactions. Indeed, it has been shown that abstract positive concepts such as "God" result in vertical attention shifts (Chasteen, Burdzy, & Pratt, 2010). However, in contrast, words referring to concrete entities (e.g., bird) result in slower object discrimination when presented in congruent locations (e.g., up vertical location) (Estes, Verges & Barsalou, 2008), usually attributed to perceptual simulations occupying spatial positions related to the word. We investigate attention shifts in a simple target detection task using task irrelevant words referring to concrete entities. We hypothesised that words such as *bird* produce an attentional shift in the direction of the typical location of the word's referent in the world (e.g., bird up in the sky). A centrally presented task-irrelevant word is followed by a visual target in the upper or lower visual field. Simple target identification was facilitated for targets presented in locations matching the typical location of the word's referent. This supports the hypothesis that encountering words result in congruent attention shifts in the vertical space.

Motor simulation in the memory of a spatial model: the effect of the mass of objects

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Numerous studies have shown that motor simulation is involved during the understanding of action-related sentences or words. This is taken as evidence that meaning is modal and embodied. The aim of this research is to study the effect of motor simulation on the construction of a spatial mental model. In a first experiment, participants had to read three texts, which described someone acting on objects located in a room. The sentences of the texts varied in the object mass presented (light or heavy), and in effort intensity of the action performed (no-, low- or high-effort). At the end of presentation, participants were asked to perform a recognition task of the name of objects, and to draw a map of the room. Results show that heavy objects are better recognized than light ones, whatever the intensity of the effort of the action. In order to know whether this effect was a