Excited to share a new open-access paper in @ScienceAdvances with @alex_carstensen, @ia_boni, @spiabantado, and @LanguageMIT about why people use different mental frameworks for SPACE. Part of the answer may be in the weirdness of left and right... A thread. science.org/doi/10.1126/sc...

INTRODUCTION

Space is fundamental to human cognition, but people mentally represent space in qualitatively different ways. For example, it will be apparent to many readers looking at Fig. 1 that the chair is on the right side of the room if you interpret a (subjective) description of a room like “it is the bed to your left” or “it is the wall to my right” as a spatial reference. Alternatively, if you interpret a (objective) description of a room like “the room is 10 feet wide” as a spatial reference, the chair is on the left side of the room. Such descriptions are allocentric (space, coordinate systems defined by features of the environment, independent of the observer’s perspective, e.g., the street, the river, or the hill on the other side of the street). Allocentric and allocentric frames of reference (FoRs) constitute fundamentally different ways of representing the spatial relations among objects at any scale (1–3, 5, 6, 9), from the monumental (e.g., the city is west of the mountain) to the microscale (e.g., the fork lies on her left hand). Although language groups typically have multiple FoRs at their disposal, they tend to use one type preferentially on a given spatial scale, according to cross-linguistic studies (1–3, 5–9).

In addition to talking differently about space, people also show differences in spatial reasoning and memory, even when they are not using language, as revealed by a variety of behavioral tasks. People use different neurocognitive tools to map different aspects of space (12); remember the location of hidden objects (5), task the path of moving objects through a maze (9) or across a three-dimensional space (22), and reconstruct novel configurations of objects (22); see Figs. 1 and 2. The key manipulation is in the allocation of the participants between learning and testing, which reveals their implicit spatial strategies. For example, in spatial reconstruction tasks like those we use here (Fig. 1, right), participants learn to reconstruct a novel array of objects at a study table and then either 1) fixate the test table (where they are asked to reproduce the same array) or 2) try to imagine the test table (where they are asked to imagine the test table).
Space is a core part of our experience, but the way people conceptualize space differs in some amazing ways. Many groups think about space “egocentrically” - using the sides of their own bodies: i.e. left or right, front or back.
But lots of cultures use the environment instead. So people might say you have a bug on your “north” ear or that the cup is “upriver” of the plate. Beyond language, this "allocentric" reference frame also shapes spatial MEMORY, like when people remember a path through a maze.

Why do people use these different reference frames? What causes people to talk and think about space using the sides of their body vs. the features of the environment, even for the very same objects? (See amazing work by @DBMHaun @TylerMarghetis @kensycoop @asifa_majid @MPI_NL)
We suspected it might be about left-right space, the trickiest of bodily axes. This distinction is super hard for kids (think: b vs. d) and even for some educated adults (No, your OTHER left!). Many cultures don’t make this distinction at all, and conflate mirror images/objects.
In our study, we tested people's use of spatial reference frames on two axes. If left-right spatial discriminability matters, then we figured they should prefer body-based space on the front-back axis but avoid it on the left-right axis, where body-based discrimination is harder.
Our participants were indigenous Tsimane’ adults, farmer-foragers who live in the Bolivian Amazon. Tsimane’ people have words for left, right, front, and back, but spend large amounts of time navigating the jungle and its waterways. @Helen_E_Davis tinyurl.com/tvbpbwnh
In our tests of spatial MEMORY, participants memorized an arrangement of objects and then turned around 180° and had to recall or reconstruct it from memory. The trick is that you get different answers depending on whether they used body-based space or environment-based space.
Benjamin Pitt @BenPitt · Nov 28, 2022

In our test of spatial LANGUAGE, one participant described to another participant various arrangements of toy animals. We recorded which kind of spatial language they used: body-based (eg. the chicken is on the right) or environment-based (eg. the chicken is upriver of the pig).

<table>
<thead>
<tr>
<th>Anchor</th>
<th>FoR (MesoSpace)</th>
<th>Proportion</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egocentric</td>
<td>Direct</td>
<td>14%</td>
<td>The animals are facing me</td>
</tr>
<tr>
<td></td>
<td>Relative</td>
<td>23%</td>
<td>The pig is on my side and the chicken is on the other side</td>
</tr>
<tr>
<td>Allocentric</td>
<td>Object-based</td>
<td>01%</td>
<td>The pig is on the chicken’s right</td>
</tr>
<tr>
<td></td>
<td>Landmark</td>
<td>29%</td>
<td>The pig is on the side toward the road</td>
</tr>
<tr>
<td></td>
<td>Geomorphic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Absolute</td>
<td>10%</td>
<td>The pig is upriver from the chicken</td>
</tr>
<tr>
<td>Other</td>
<td>Unclassifiable</td>
<td>29%</td>
<td>The pig is facing that way</td>
</tr>
</tbody>
</table>
We found the same pattern in every task: Tsimane’ adults preferred body-based (egocentric) space when dealing with the front-back axis but they largely abandoned it on the left-right axis, where they preferred environment-based (allocentric) space instead.
This challenges the claim that language groups have a "predominant" spatial reference frame in memory or in language. Rather, different reference frames can predominate on different axes, even in the same person, in the same context, using the same stimuli!

3.0 Frames of Reference across modalities

So far, we have acquired some new facts: (i) not all languages use the same predominant frame of reference, (ii) there is a tendency for the frame of reference predominating in the language to remain the predominant frame of reference across modalities, as displayed by its use in non-verbal tasks of various kinds, unconscious gesture, etc. The results seem firm; they appear to be replicable across speech communities.

We suggest that one of the non-linguistic determinants of FoR use may be people's perception of space, as governed by the spatial discrimination hypothesis. Since spatial relations (e.g., the relative locations of two objects) are experienced by people in context, they can all be defined by many spatial continua, some of which are egocentric and some of which are allocentric. On this account, all else being equal, people encode spatial relations using the spatial continuum along which those relations are easier to perceive or remember.

If so, then the FoR that a person uses in a given context should vary according to the relative discriminability of the competing spatial continua; contexts or experiences that make a given continuum easier to perceive or remember should increase people's reliance on that continuum to structure their spatial language and spatial memory, whether that continuum is defined by the body or the
These findings suggest that spatial discrimination abilities may be one of the influences on the spatial reference frame people use in a given context: where your environment provides clearer distinctions than your body, you use the environment!
And since we know that people’s left-right spatial discrimination abilities vary across cultures and over development, this idea can potentially help explain why we see differences in spatial reference frames across these contexts as well. @AlisonGopnik
Many thanks to El Gran Consejo Tsimane’, to our Tsimane’ participants, and to our amazing translators and field coordinators, who make this type of work possible!