

Conceptual combination

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DFT Summer School 2020

Problem statement

- When hearing a complex linguistic expression, we understand its meaning in virtue of
 - understanding the meanings of the words (“concepts”)
 - understanding the syntactical arrangement
 - combining them to determine the meaning of the whole sentence
- What are the neural processes that bring about this cognitive feat?

Scenario

- Speaker and listener
- Shared scene
- Speaker guide's listener's attention to objects in the scene via language
- e.g., “There’s a cactus below the tent and above the camel. Find the blue object above that cactus.”
- Model listener’s neural processes for understanding that phrase (effectively finding the object)



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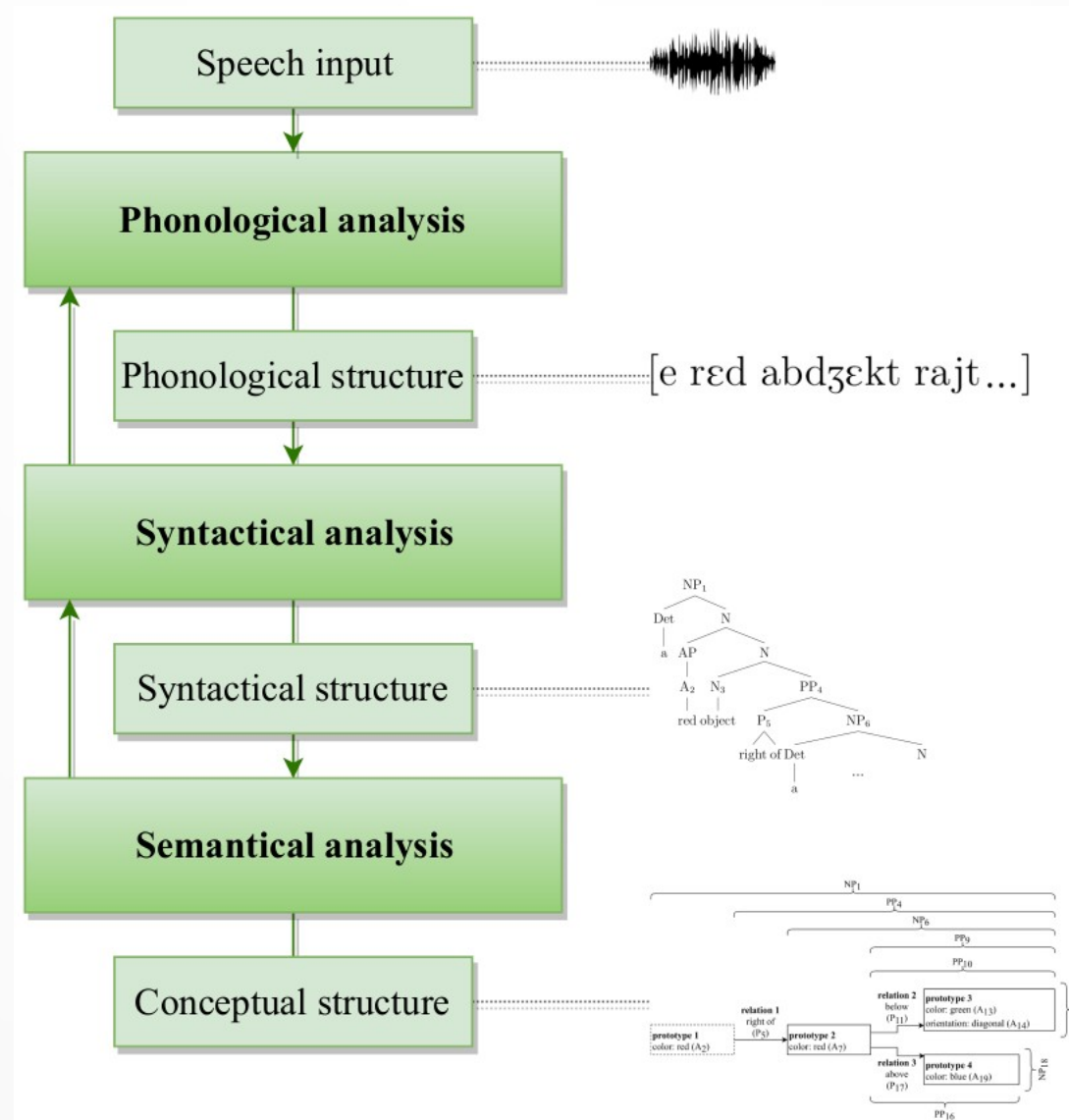


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The Parallel Architecture

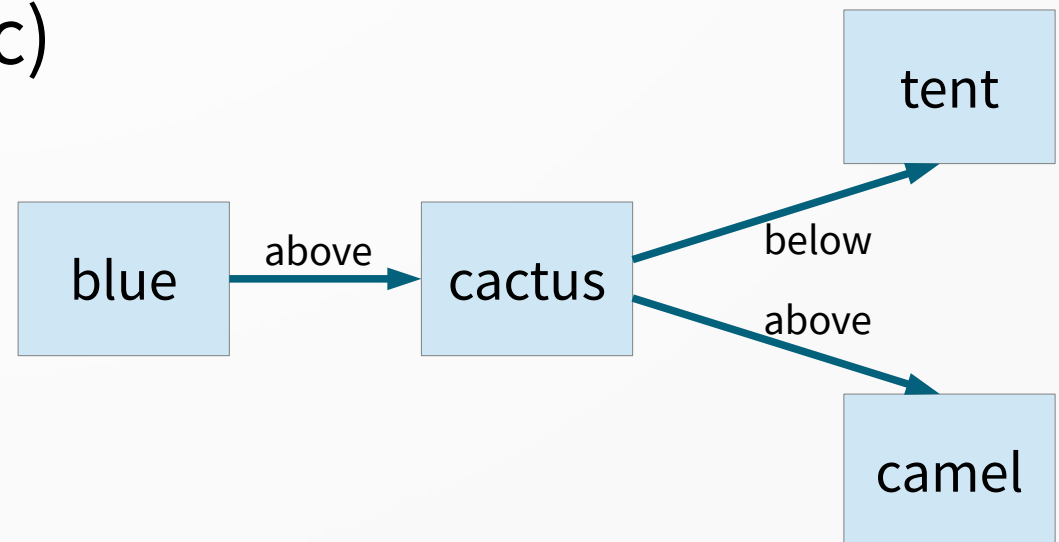


Parallel Architecture. Adapted from Jackendoff (2002).

Conceptual Structure

- conceptual structure of a sentence:
a mental representation that encodes the meaning of the sentence
- roughly encodes the information that can also be encoded in some logic (e.g., predicate logic)

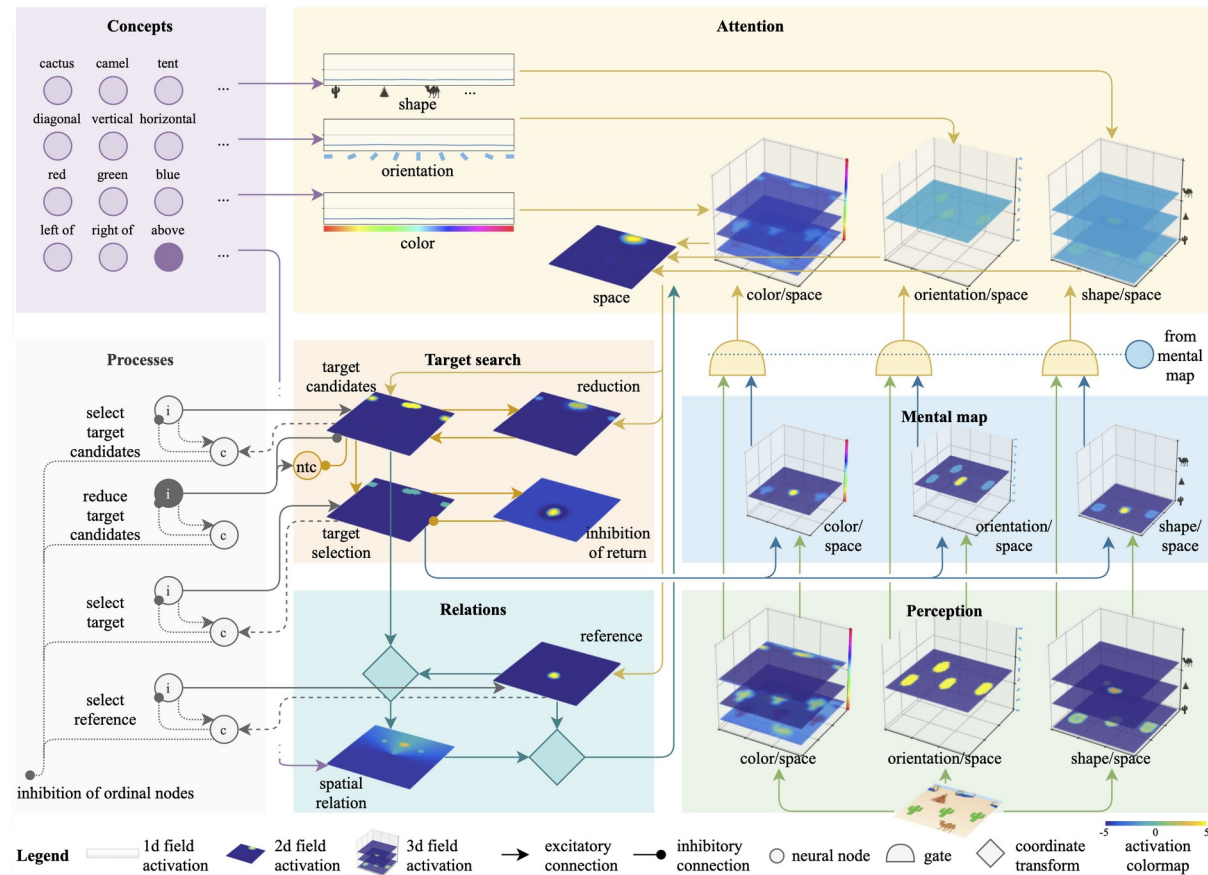
“There's a cactus below the tent and above the camel. Find the blue object above that cactus.”



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

1. select target candidates cactus
2. select reference tent
3. eliminate target candidates below
4. select reference camel
5. eliminate target candidates above
6. select target
7. select target candidates blue
8. select reference cactus from mental map
9. eliminate target candidates above
10. select target



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

1. select target candidates
cactus

2. select reference
tent

3. eliminate target candidates
below

4. select reference
camel

5. eliminate target candidates
above

6. select target

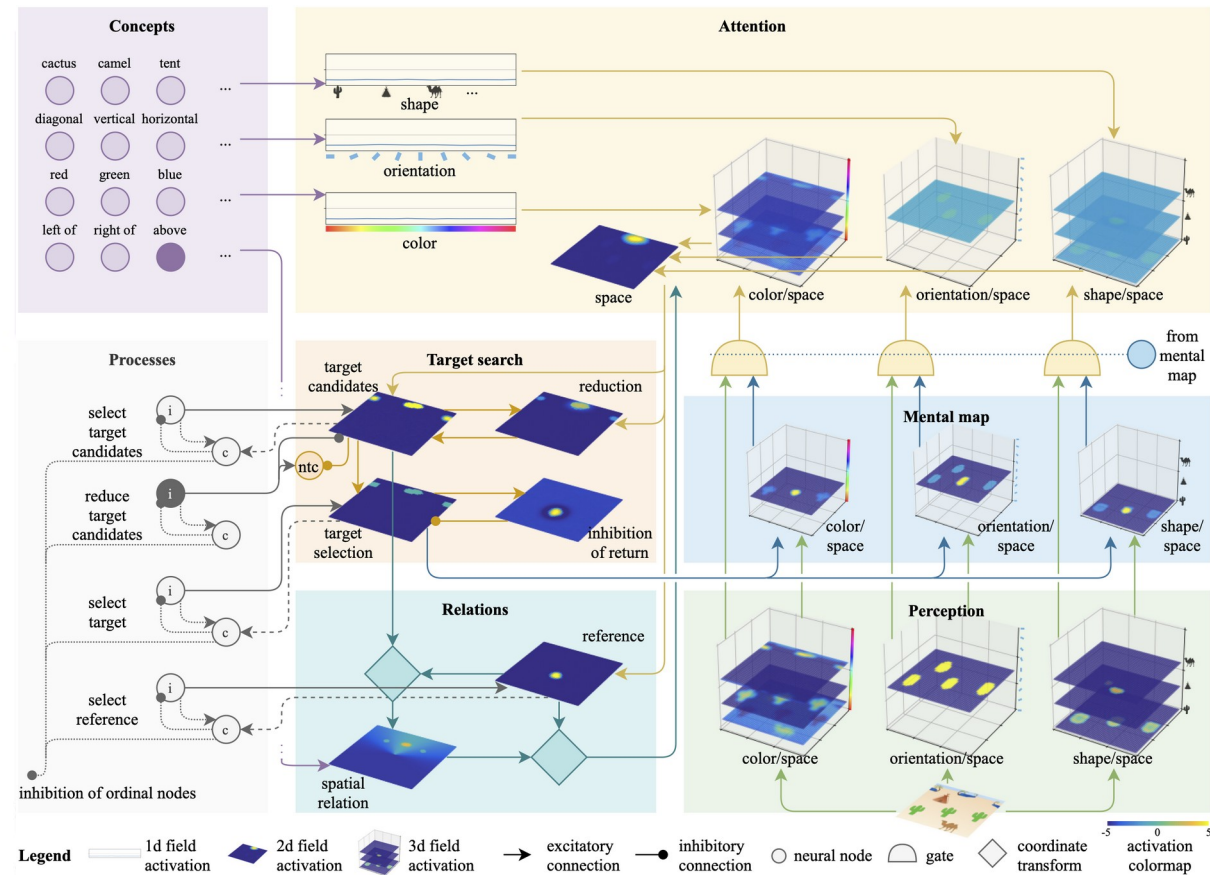
7. select target candidates
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from mental map

9. eliminate target candidates
above

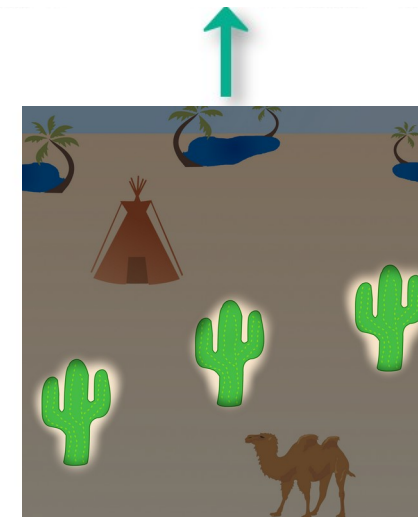
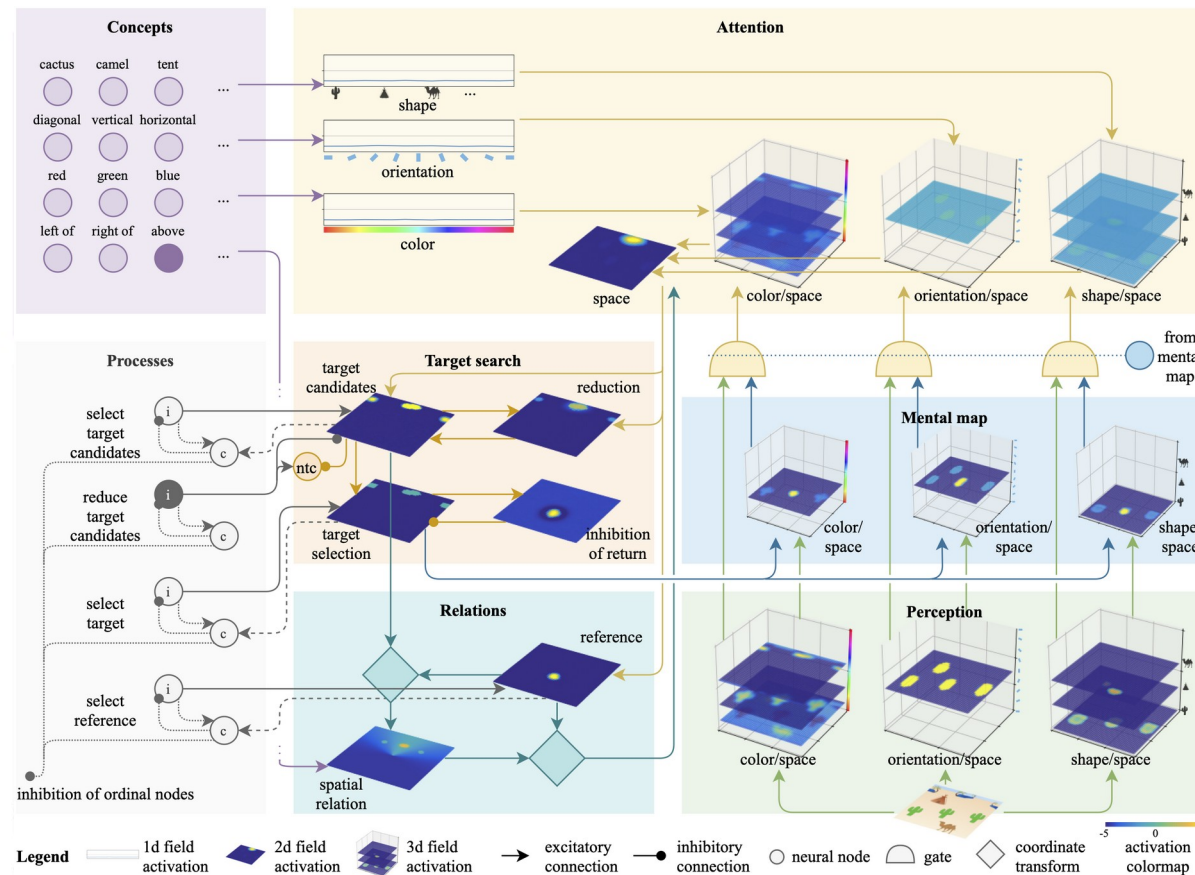
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language pre-processing

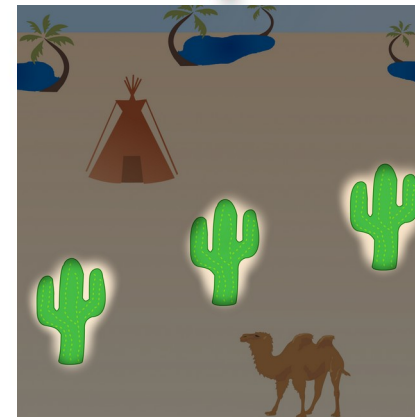
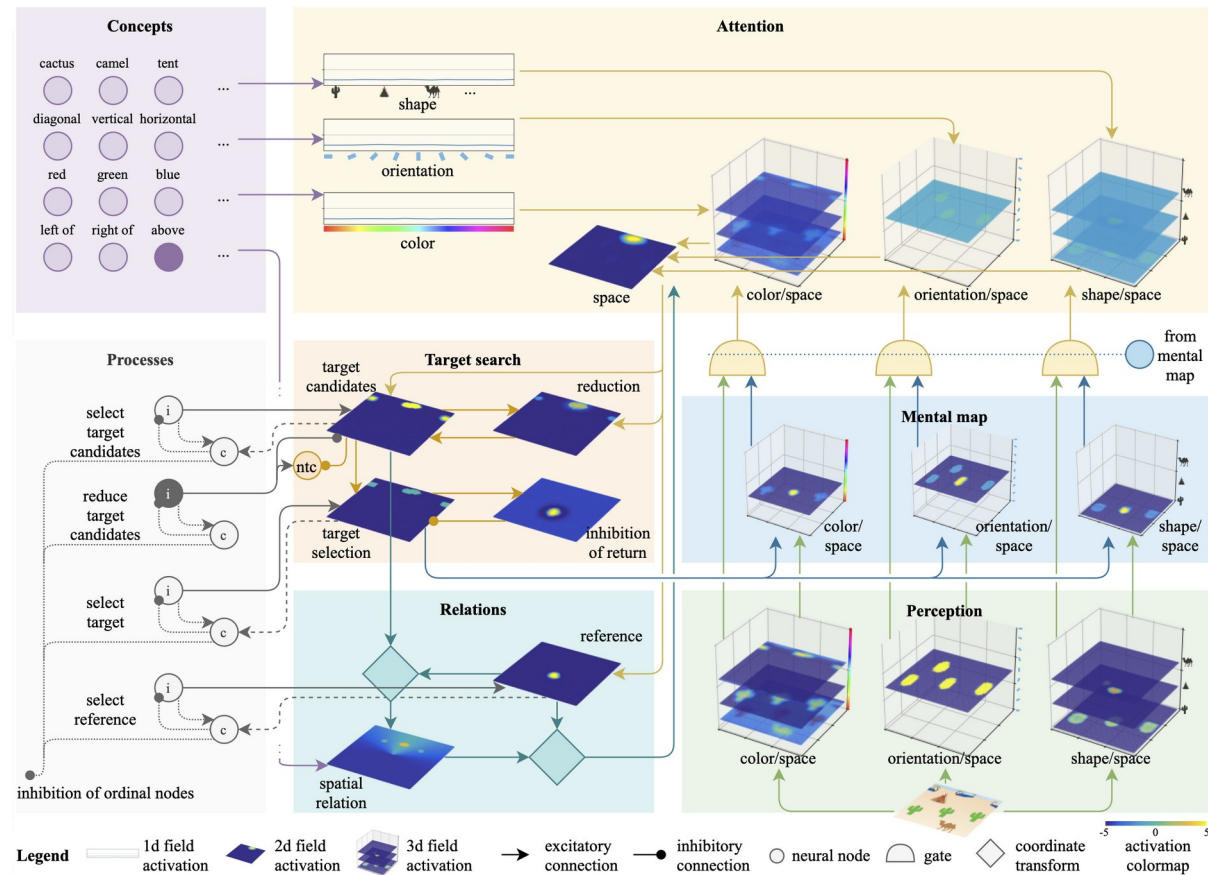
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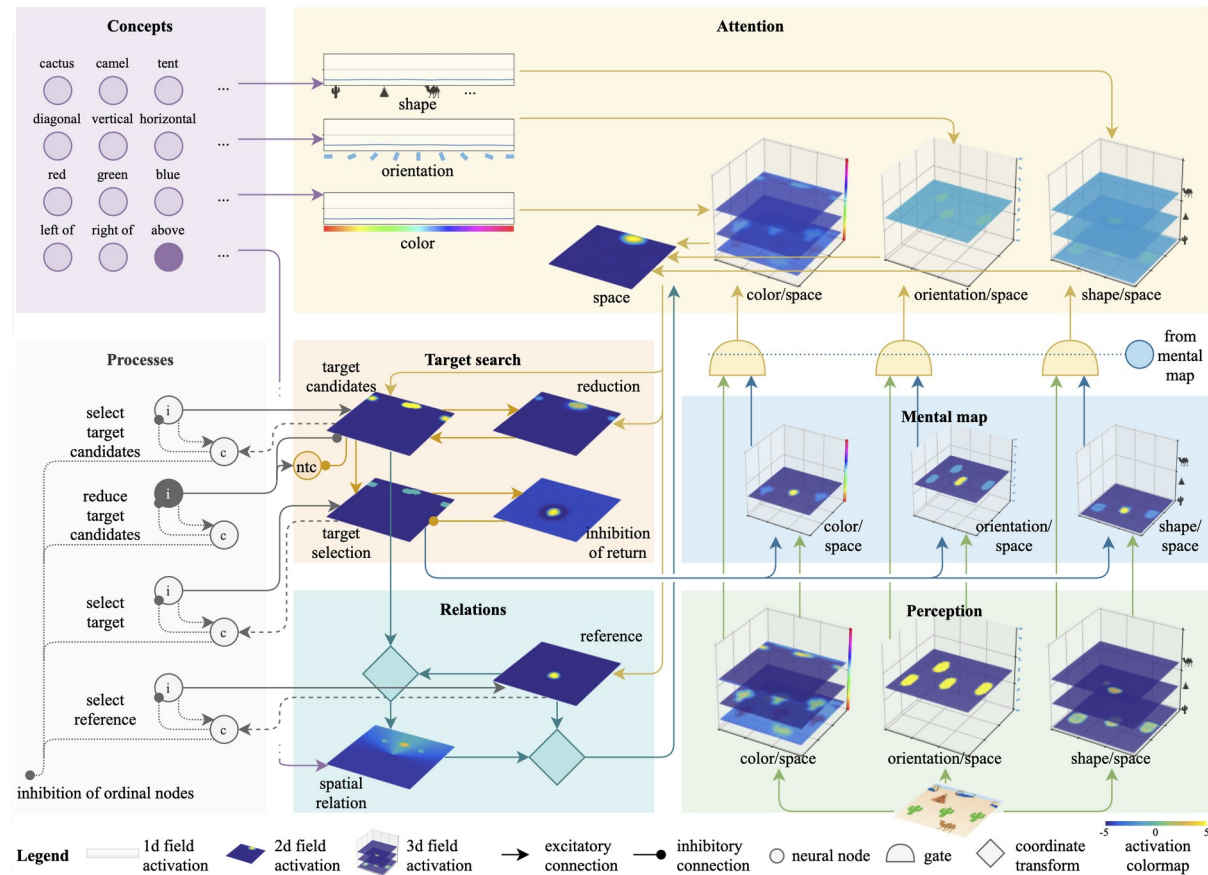
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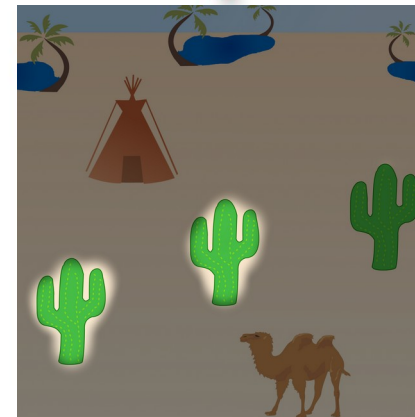
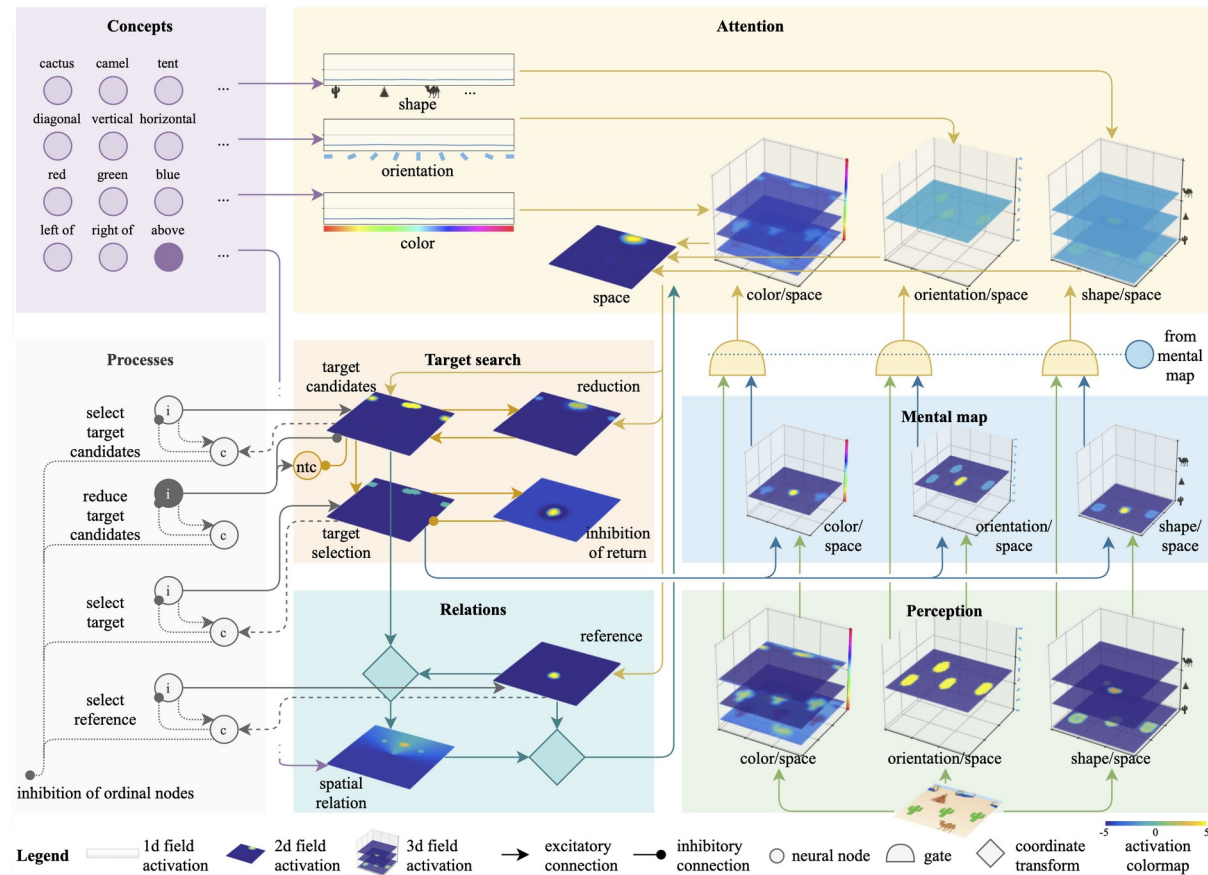
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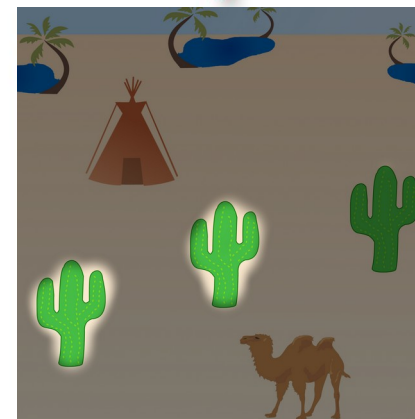
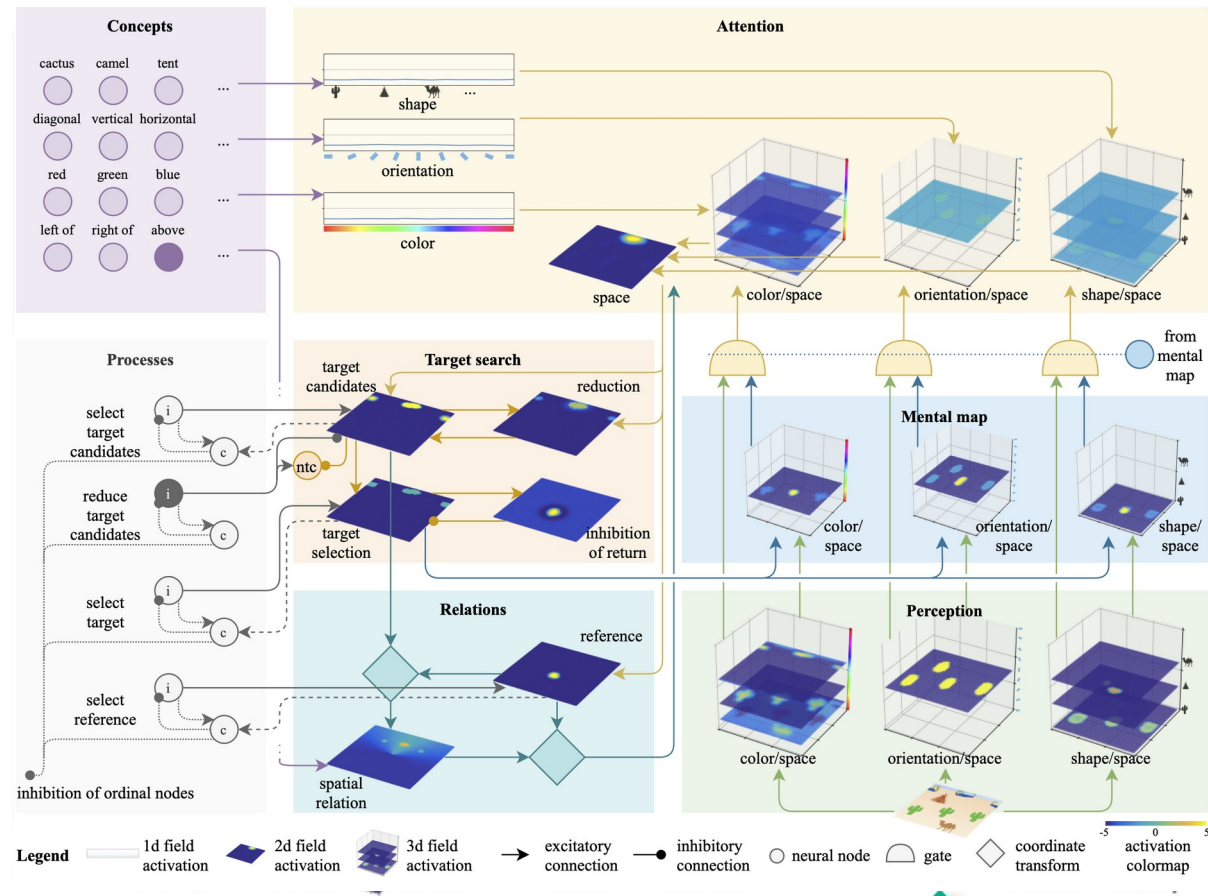
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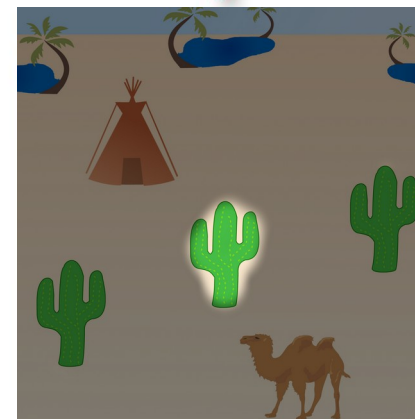
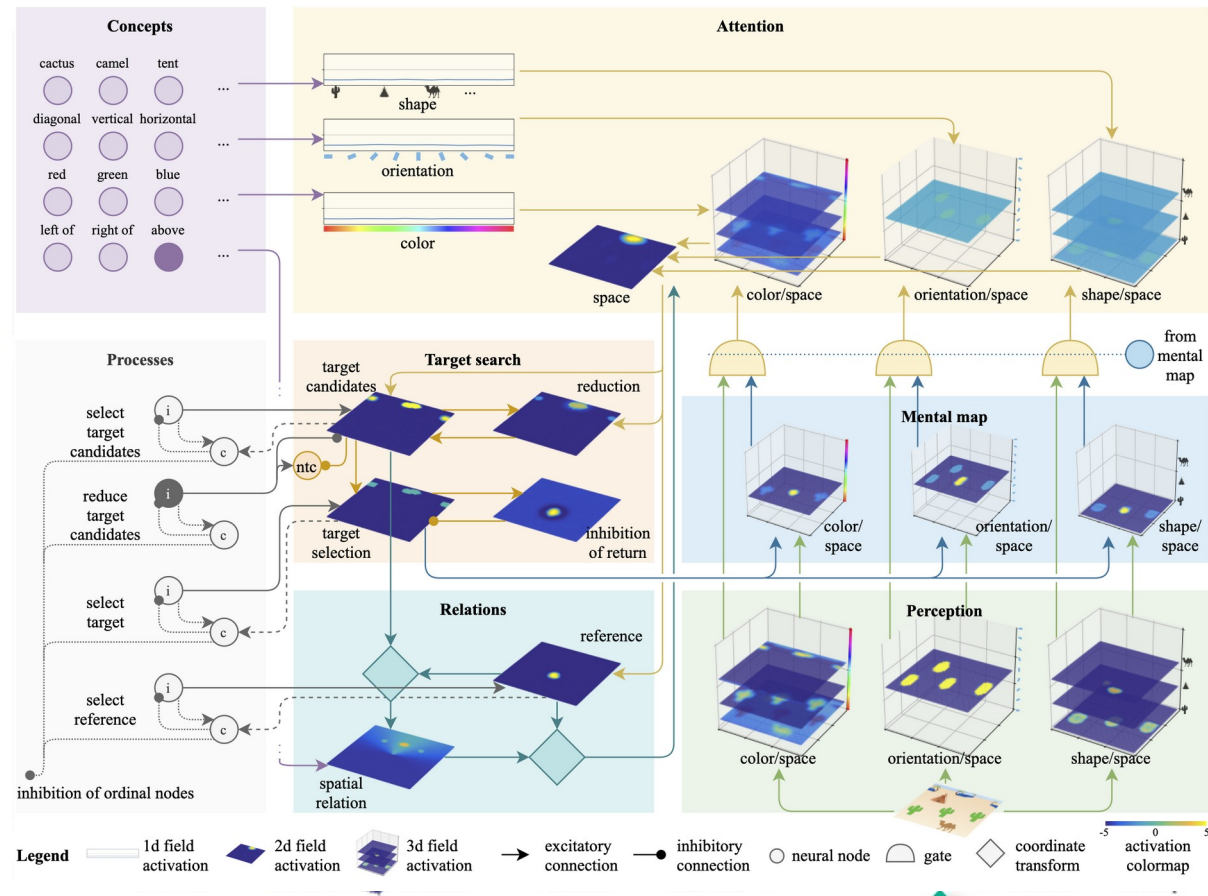
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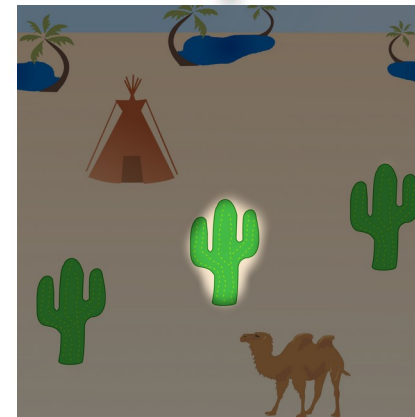
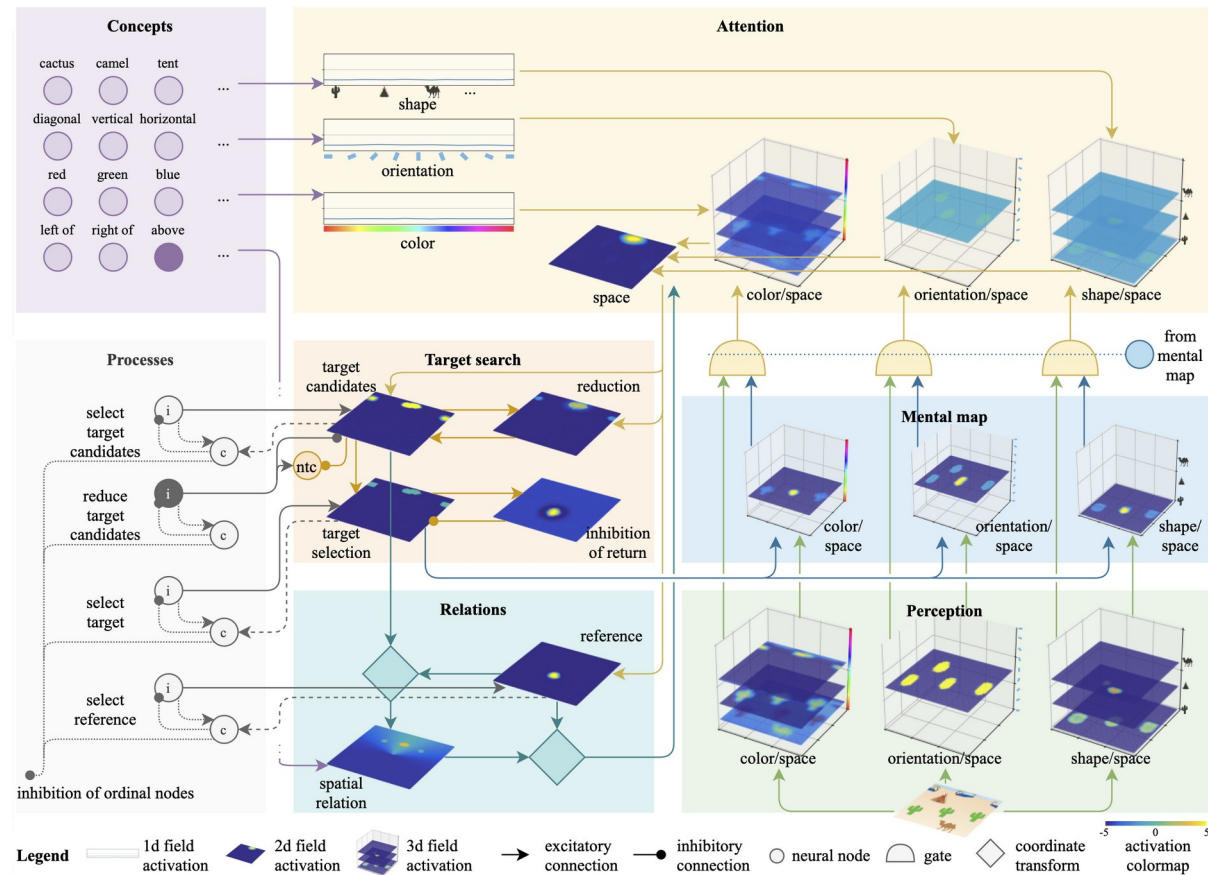
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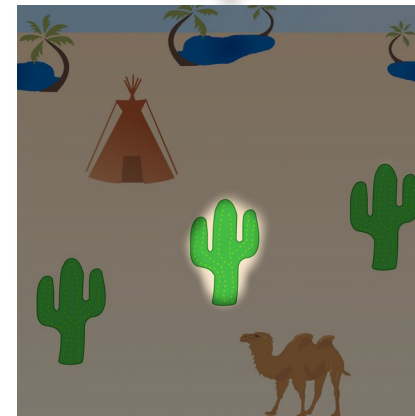
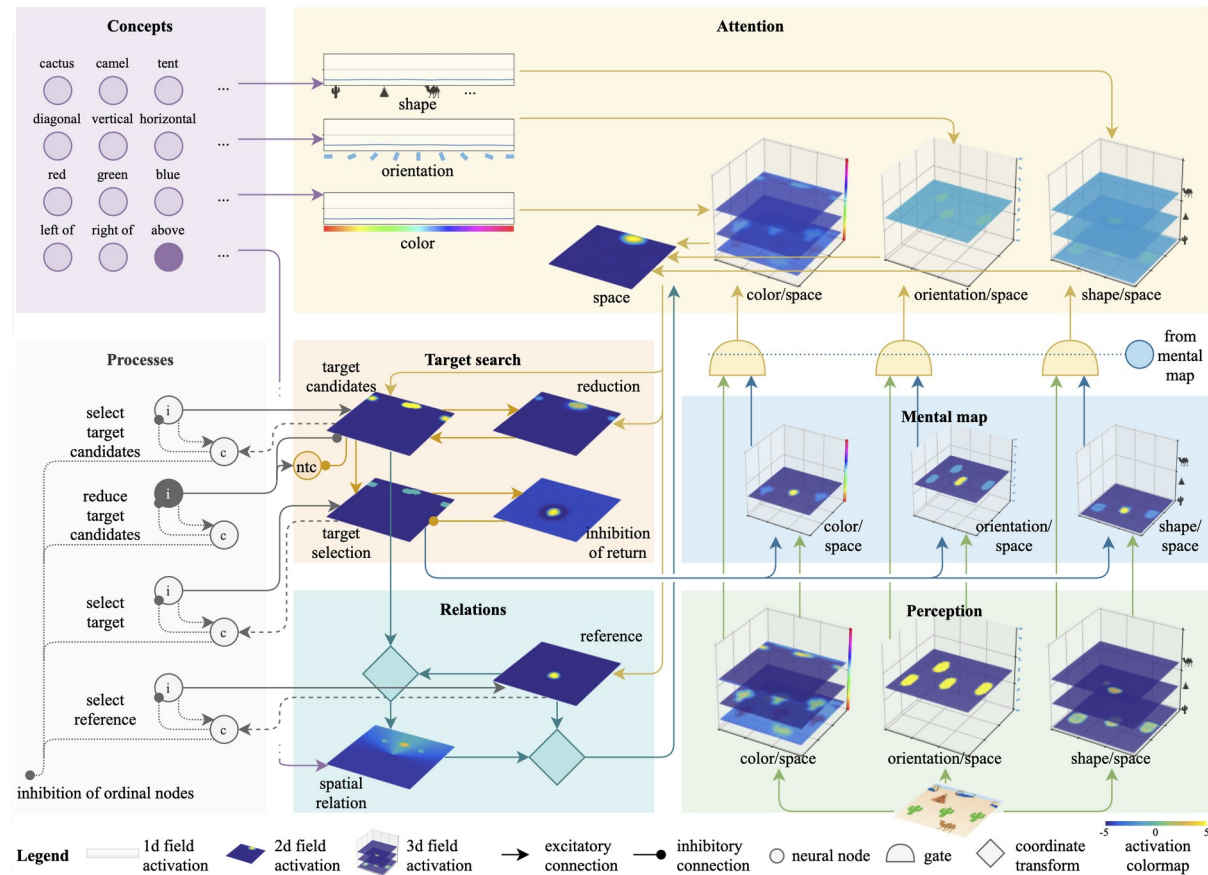
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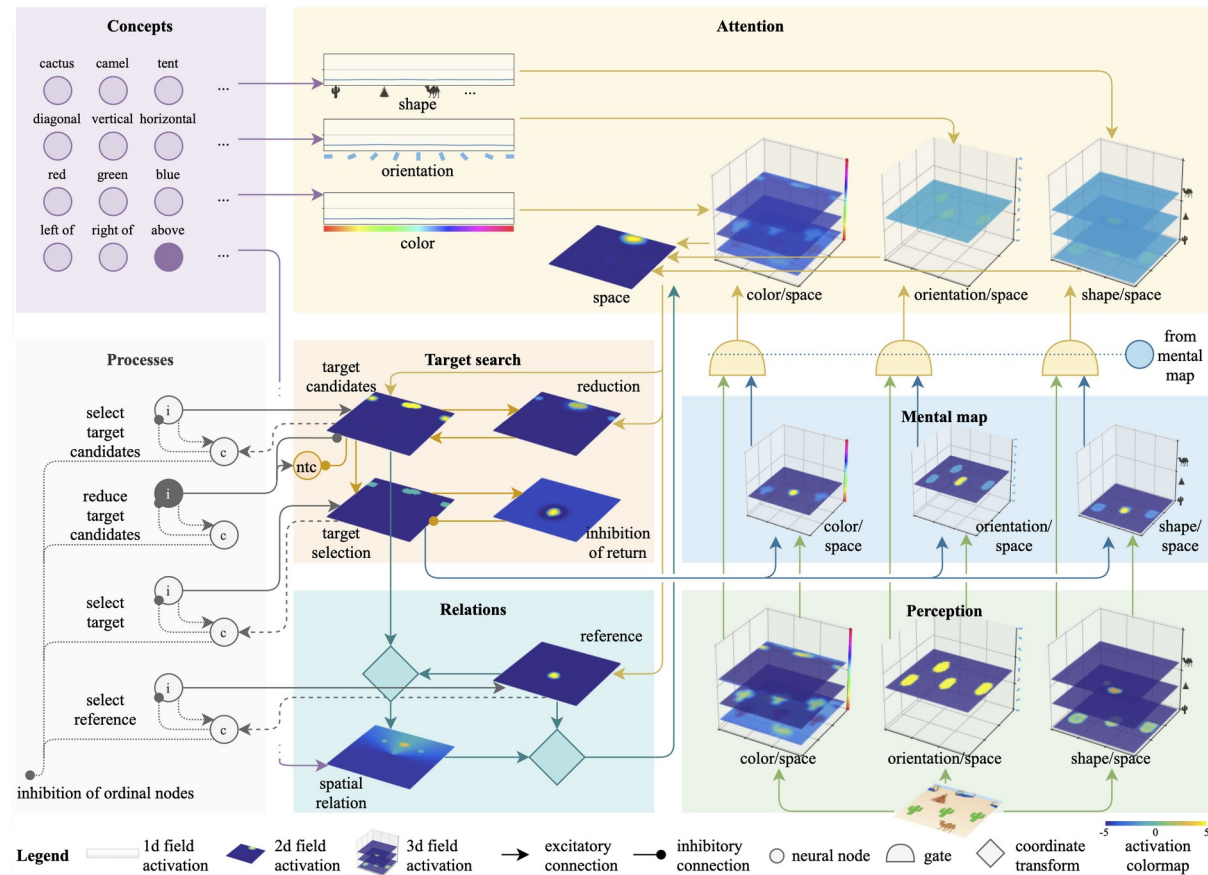
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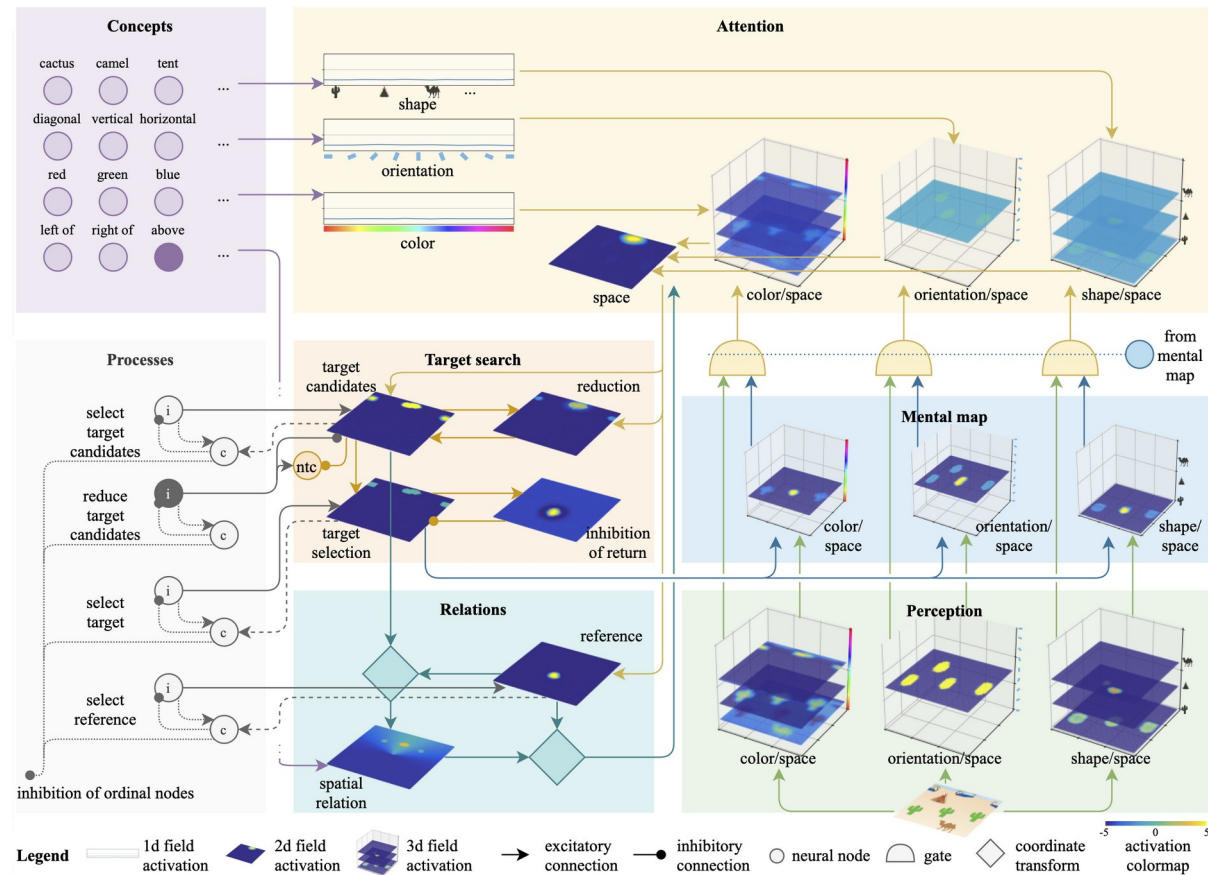
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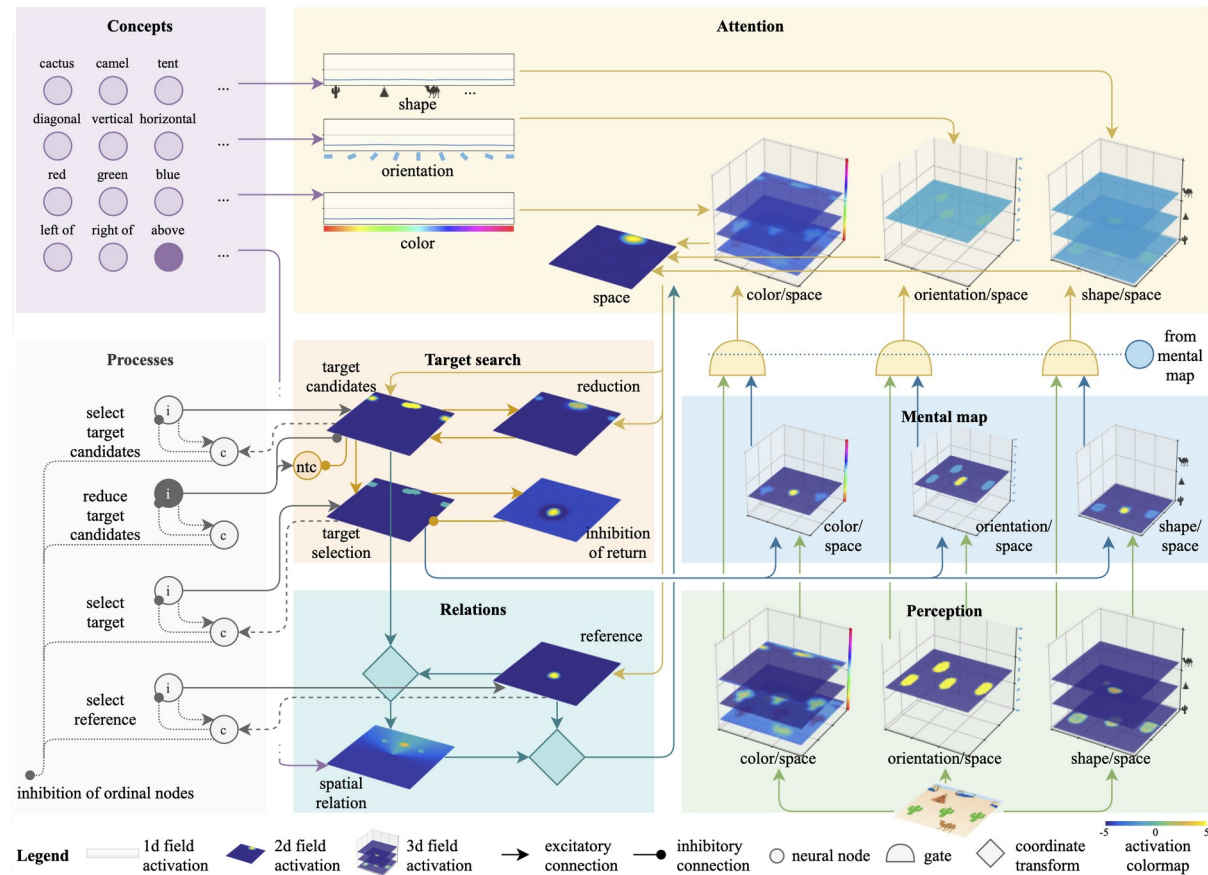
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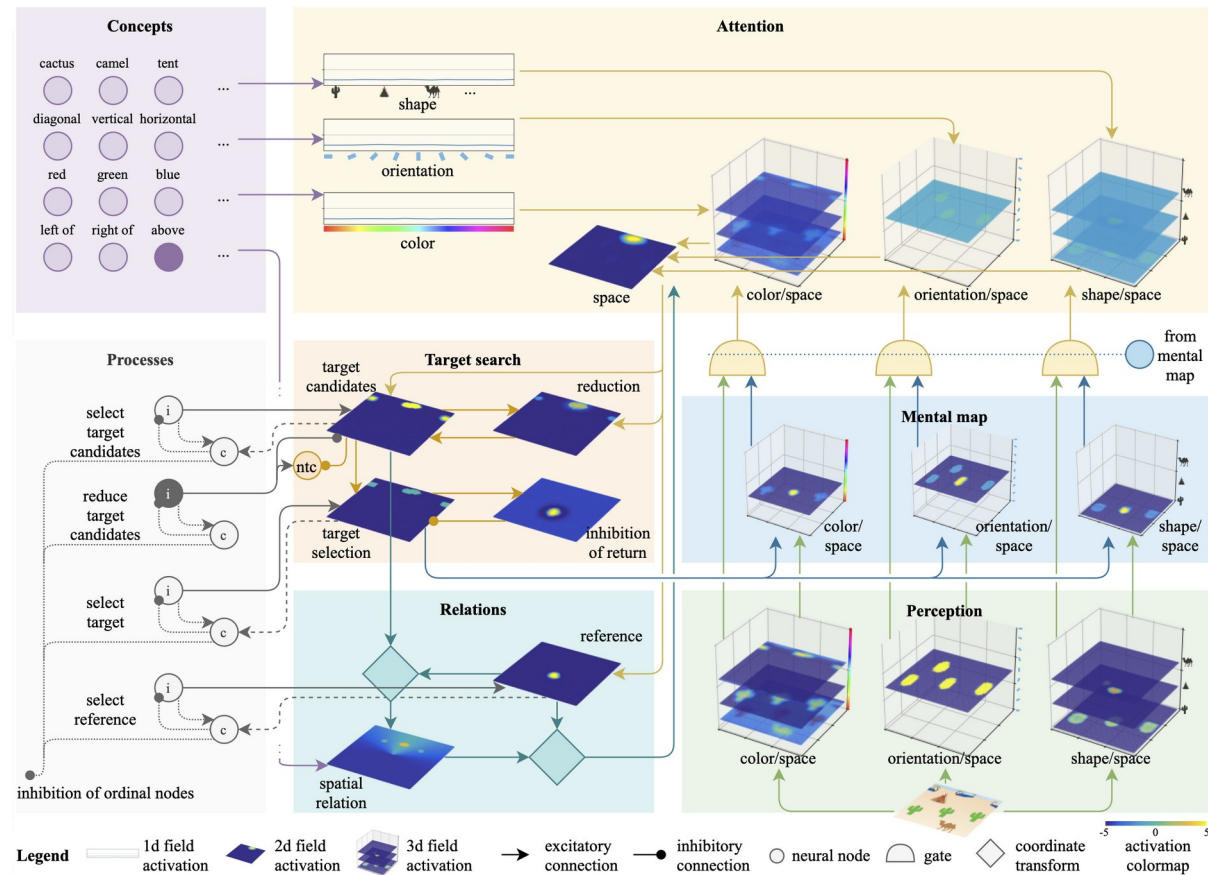
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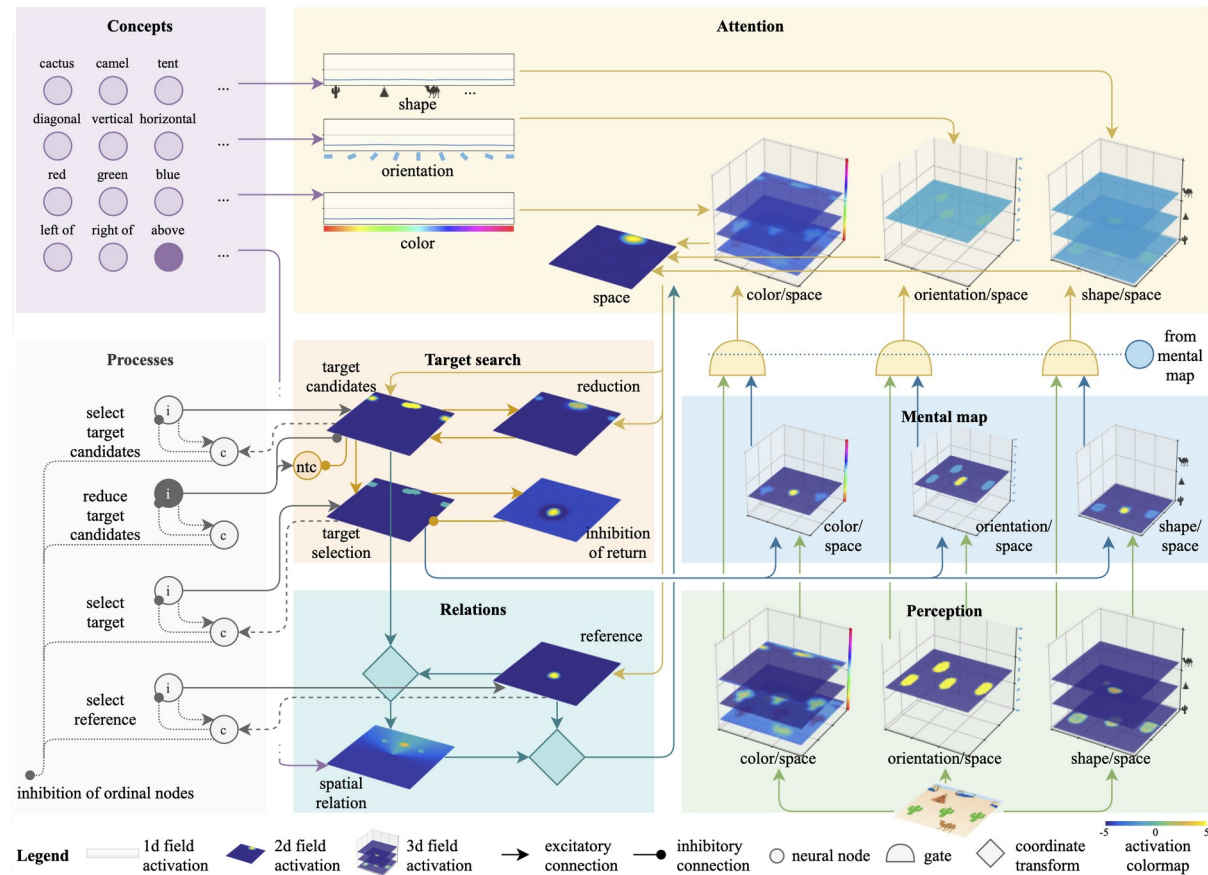
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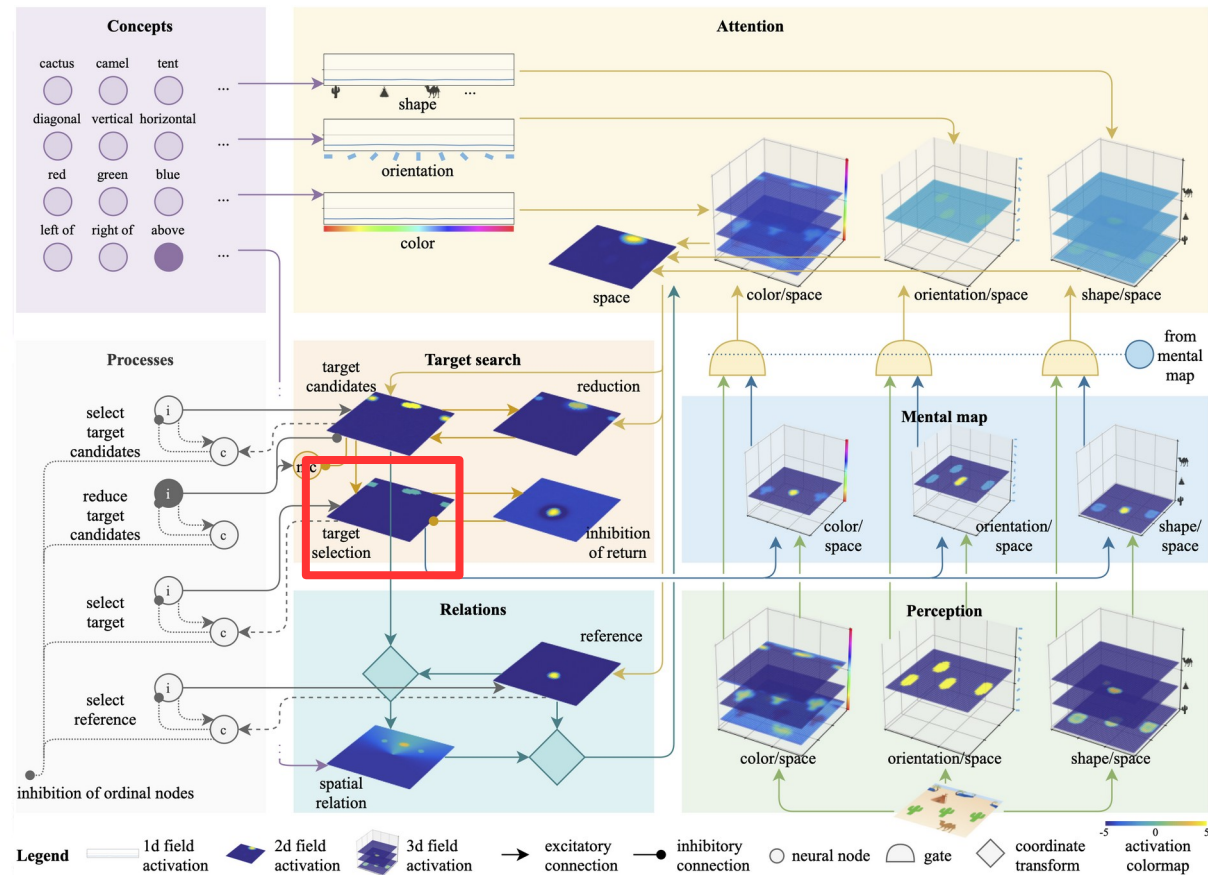
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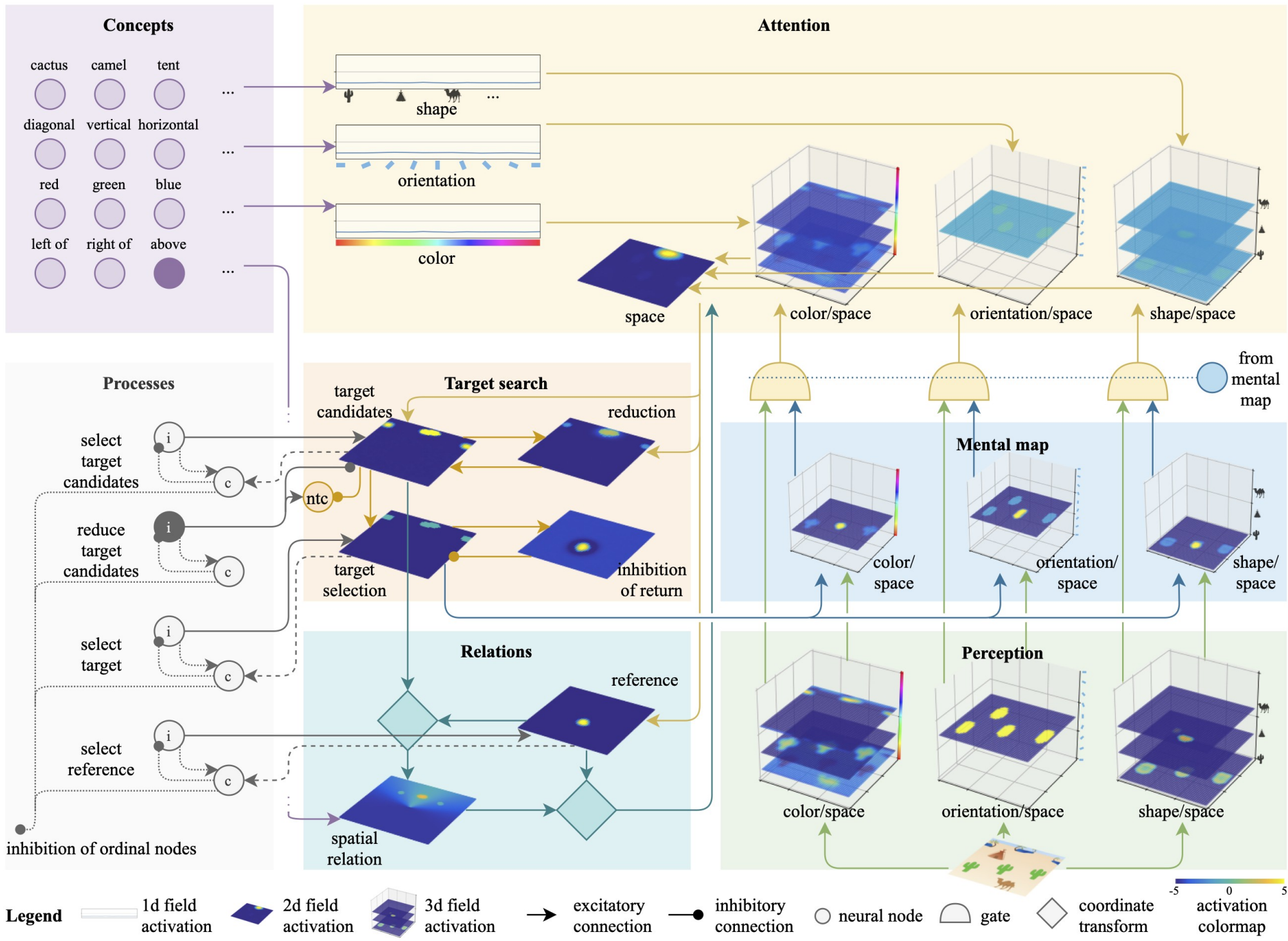


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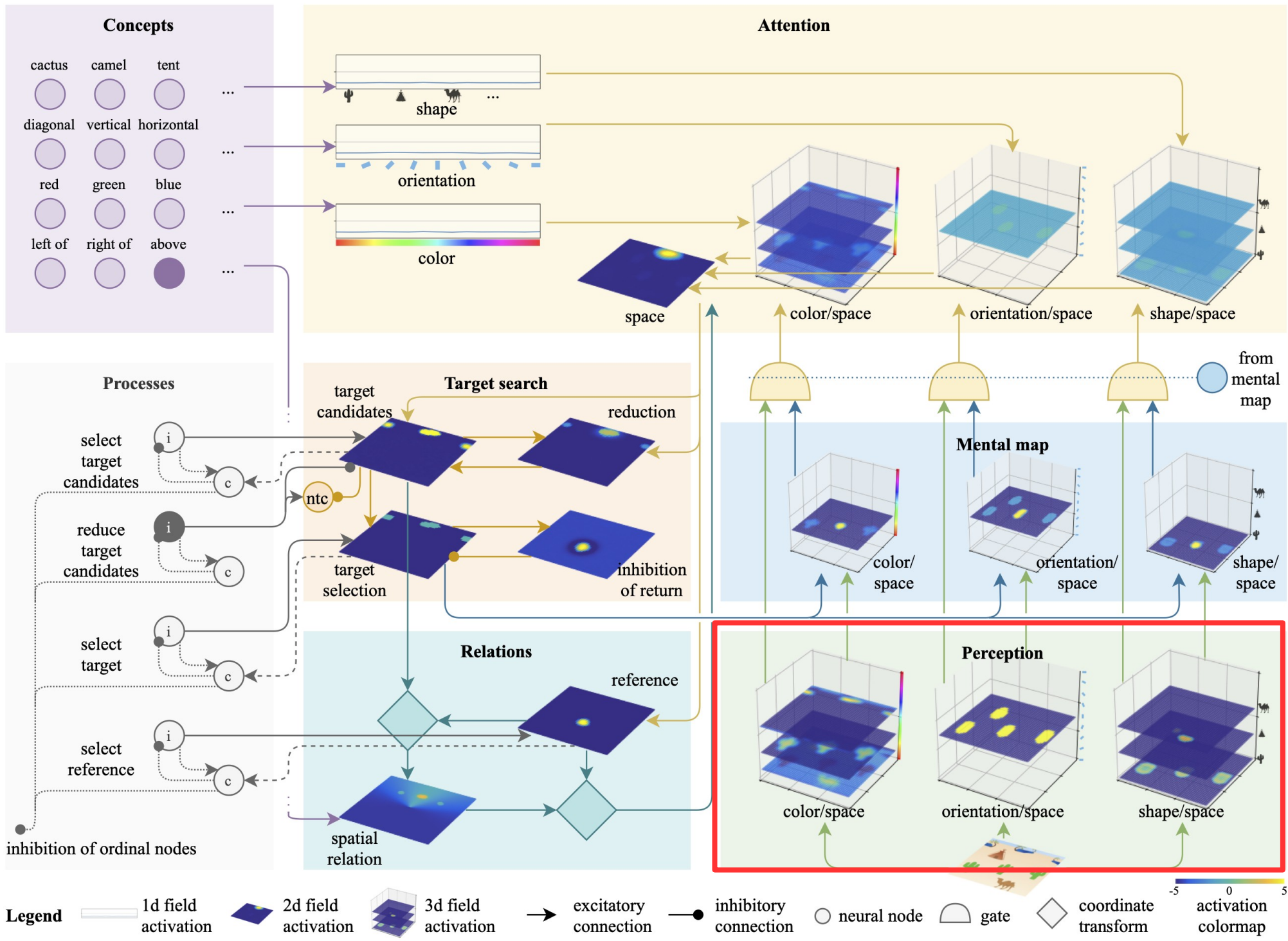
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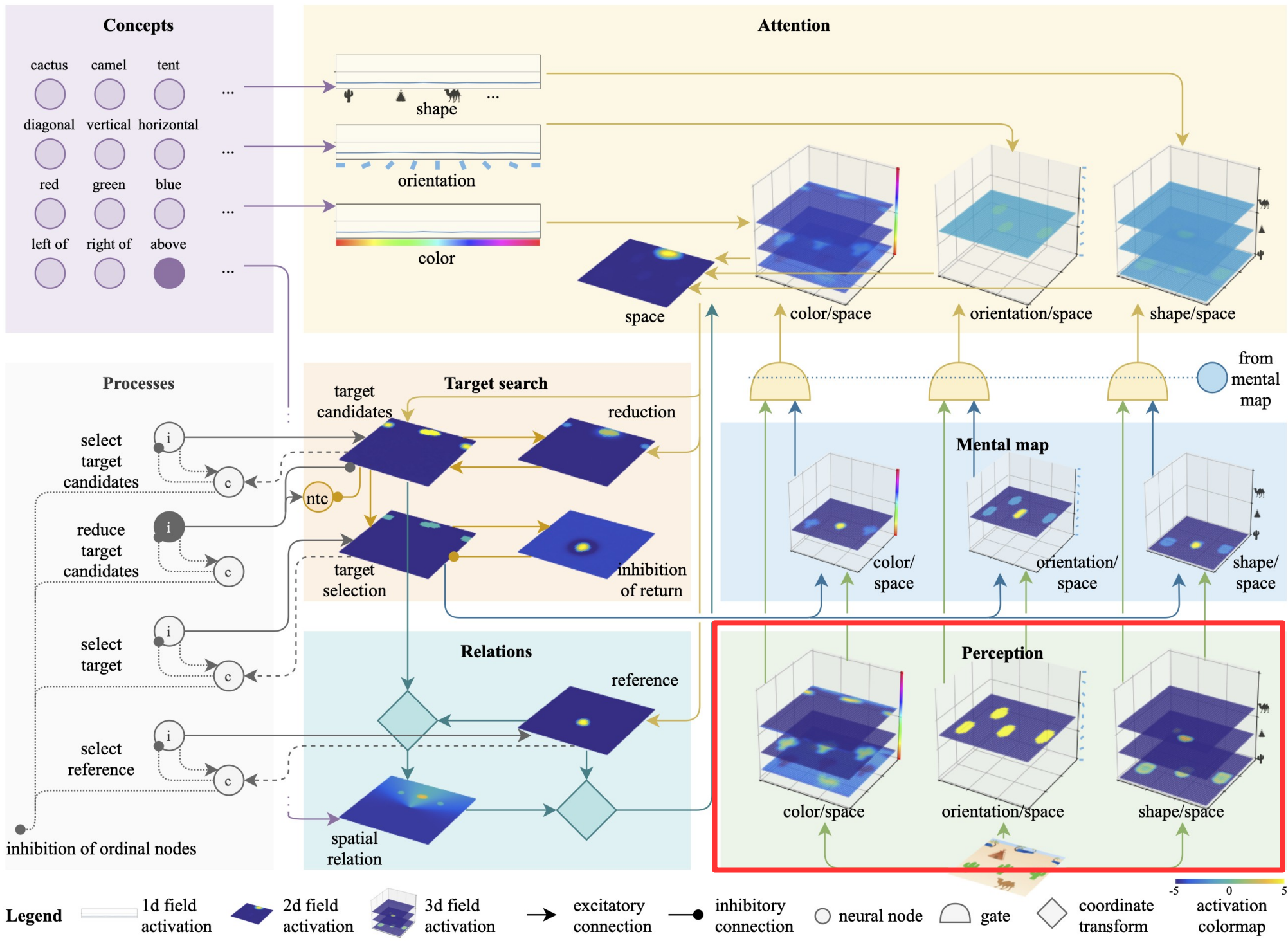




Legend

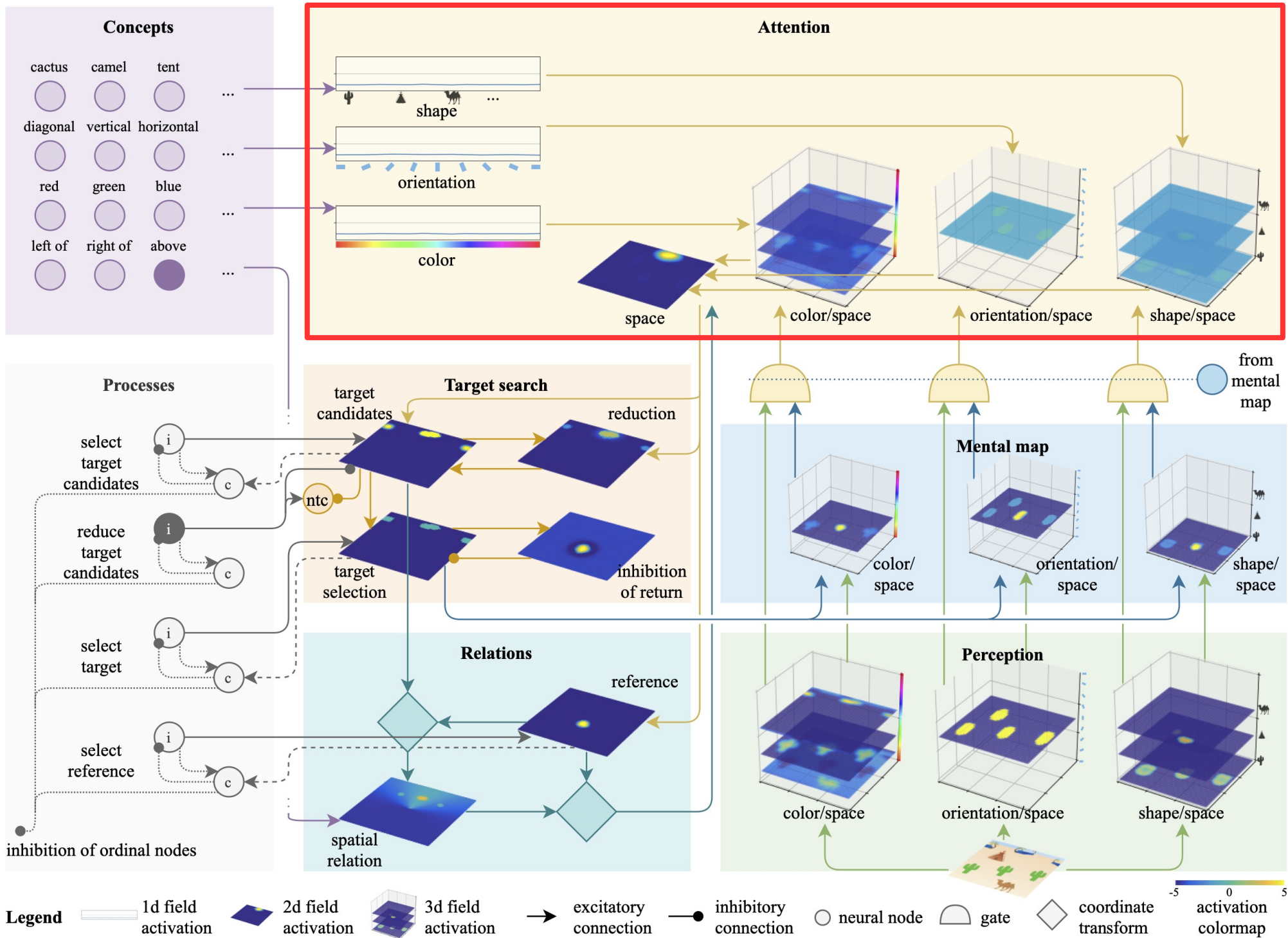


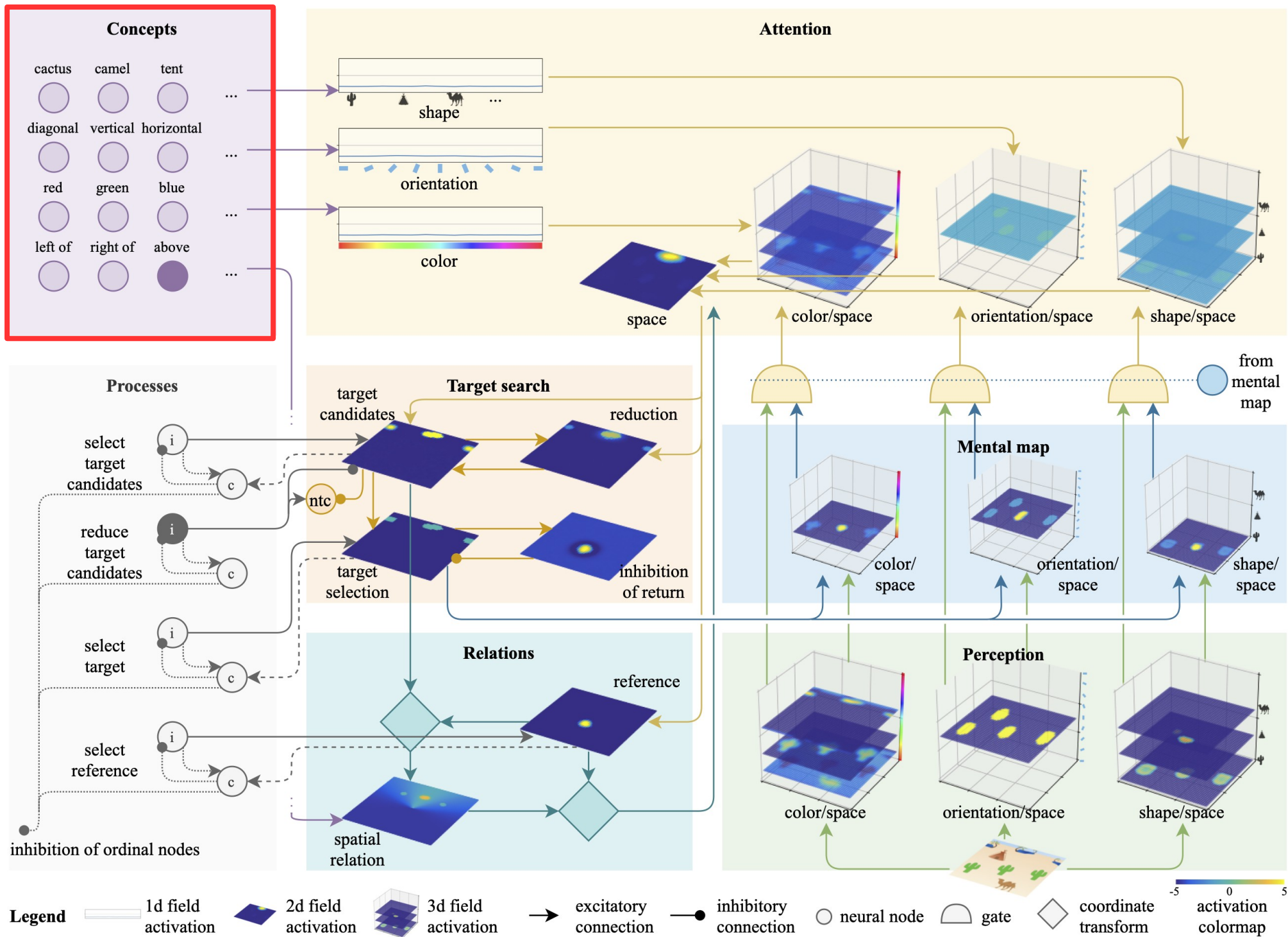


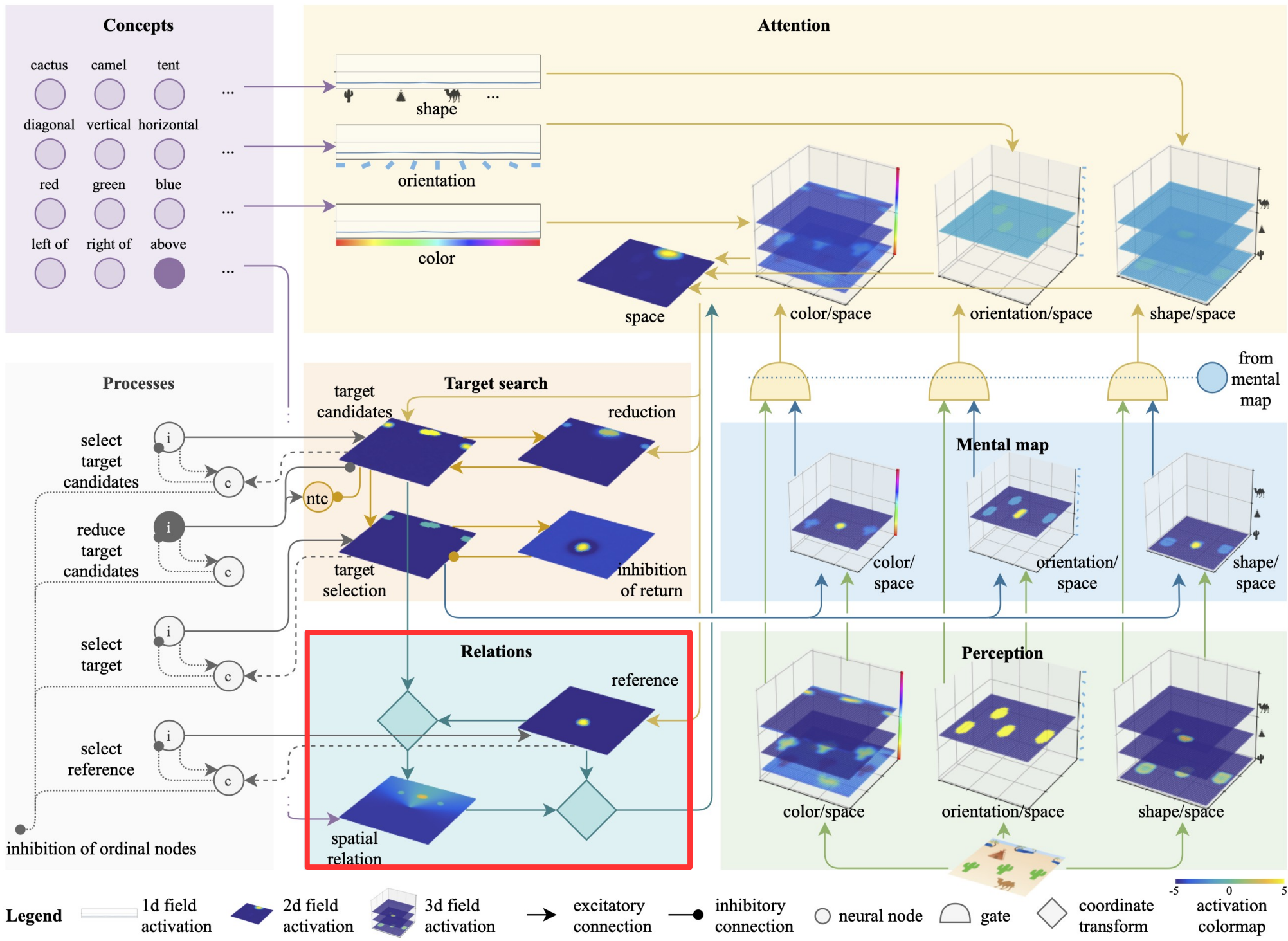


Legend



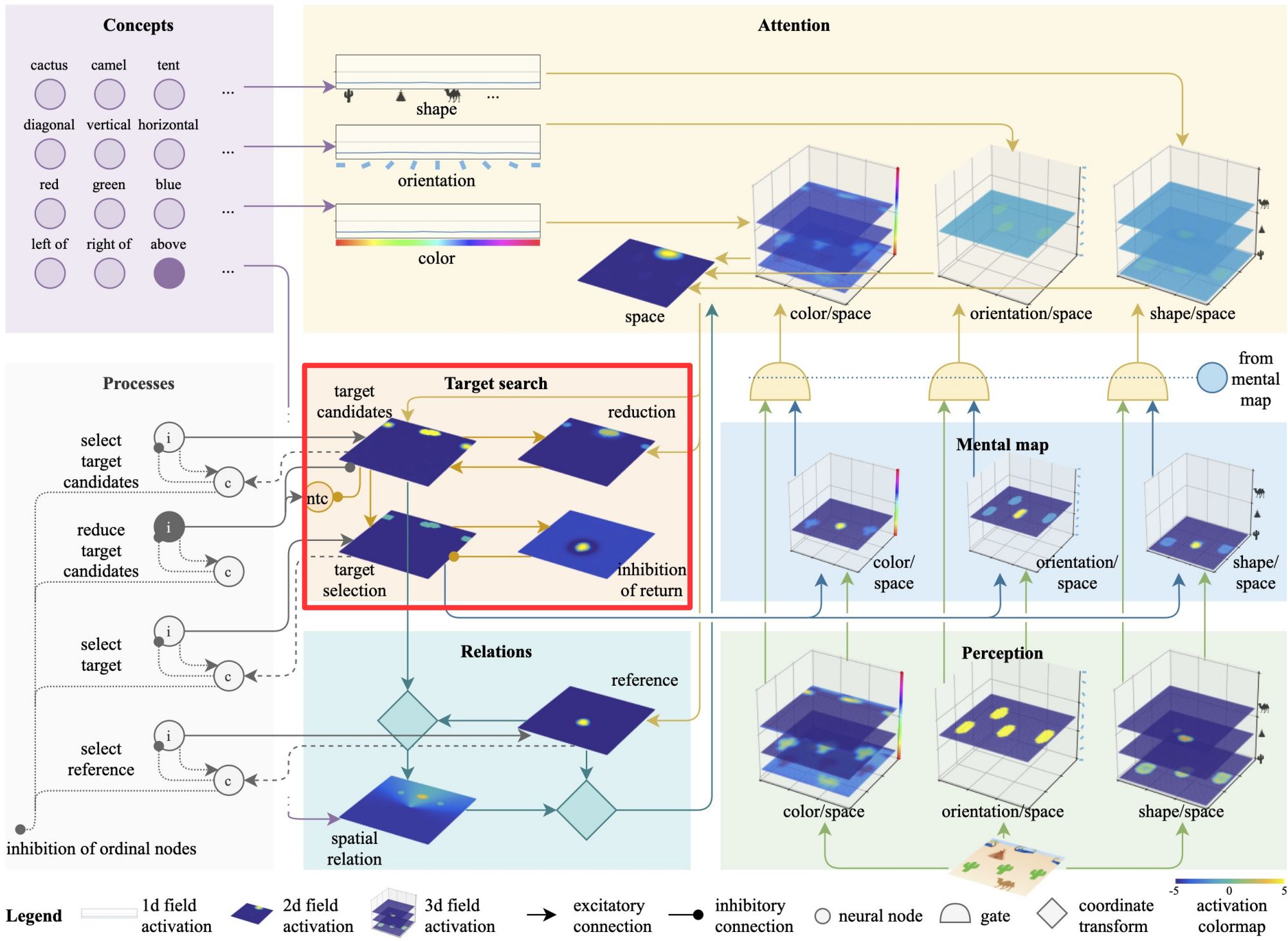


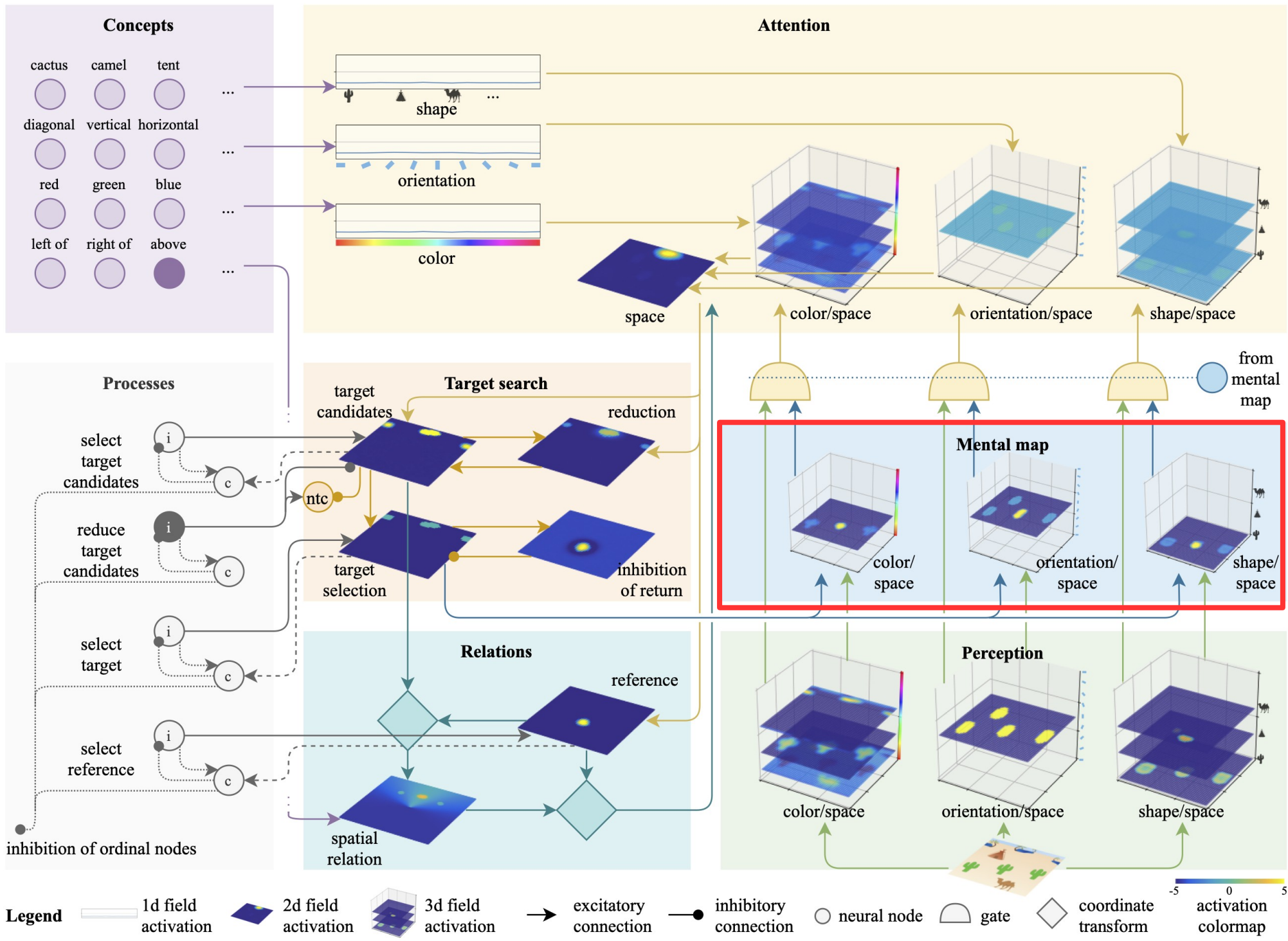




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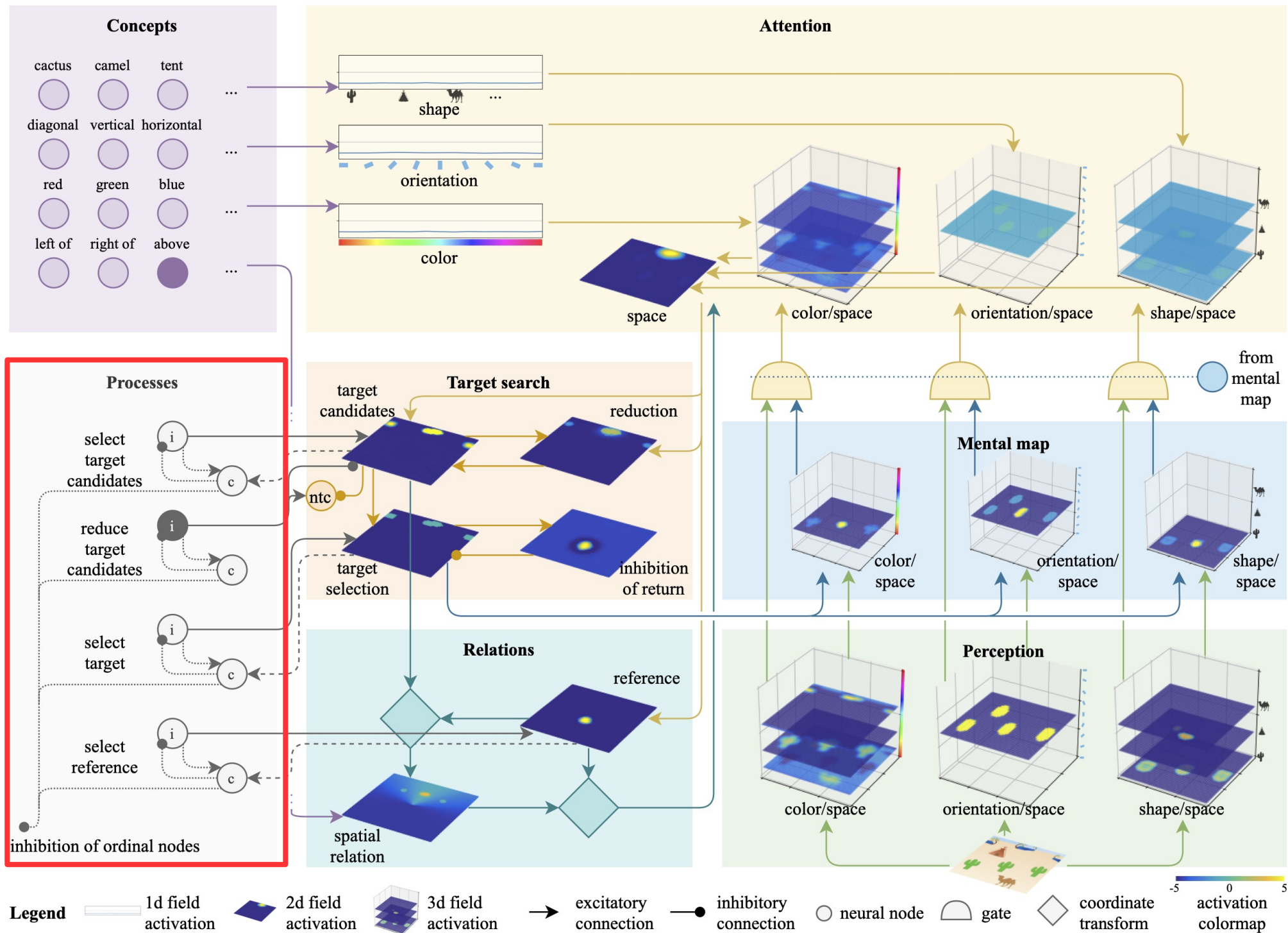






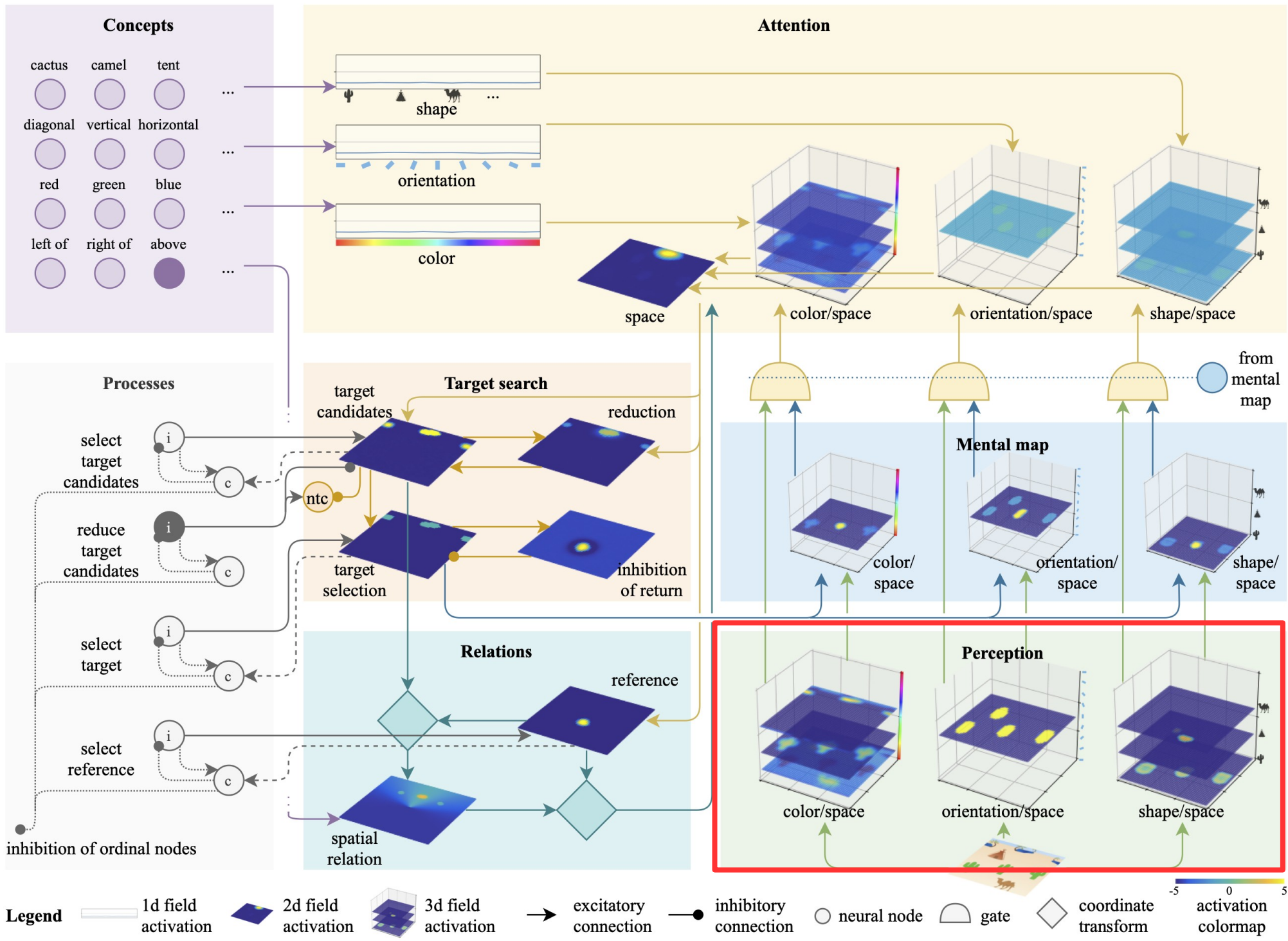
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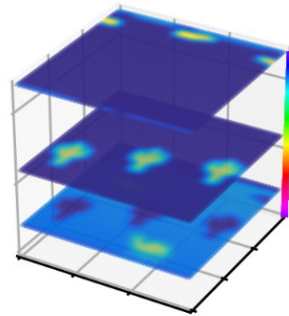
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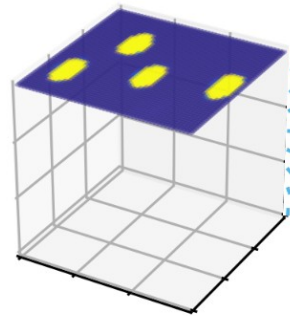


Perception

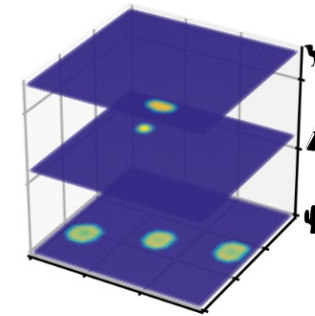
- Visual pre-processing extracts feature values that provide input to a three-dimensional field for each feature



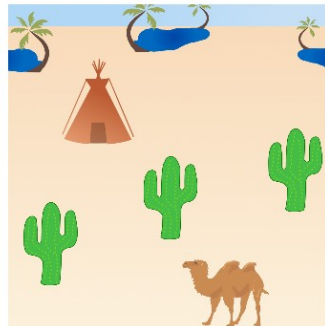
color/space perception field

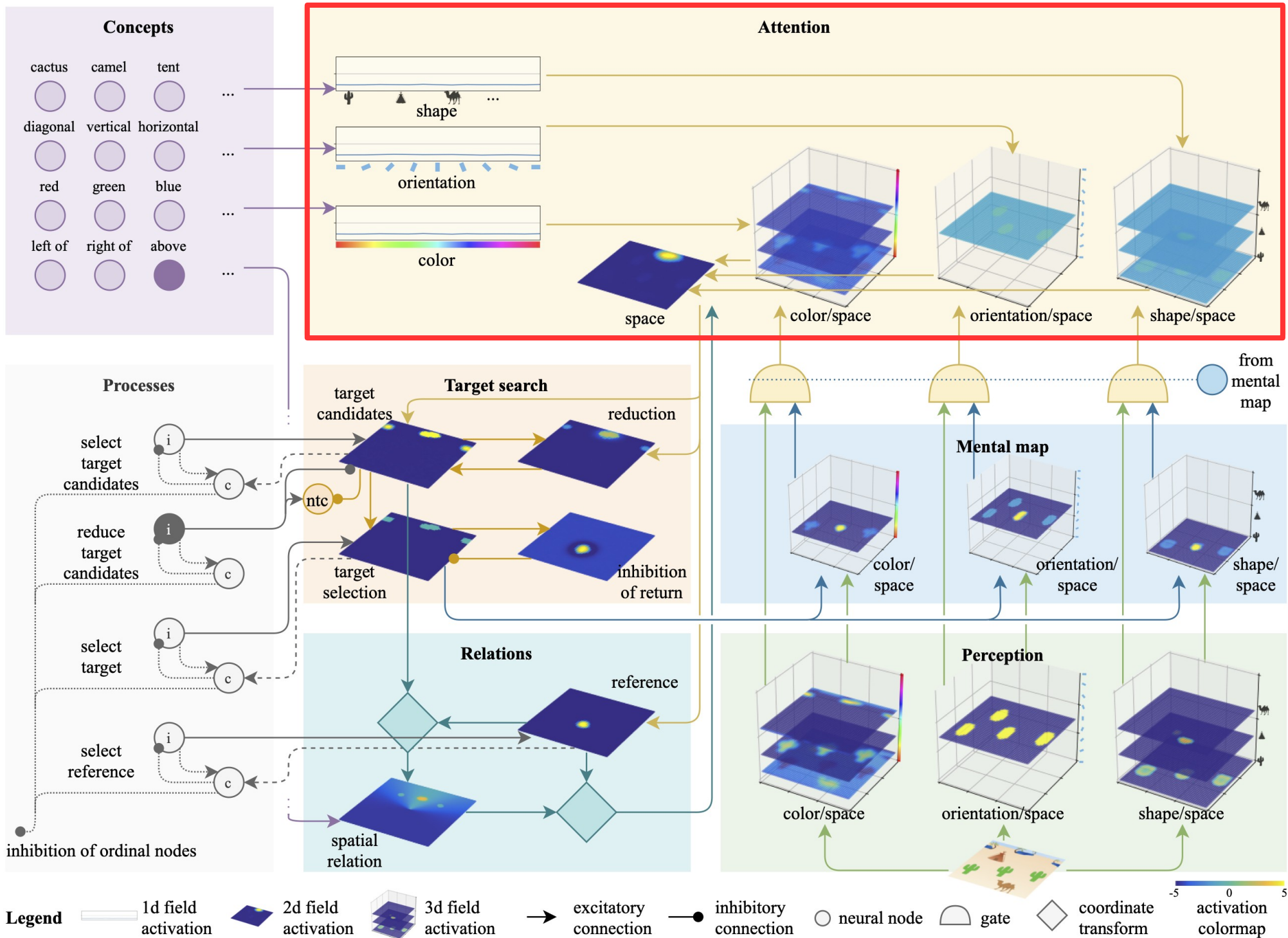


orientation/space perception field

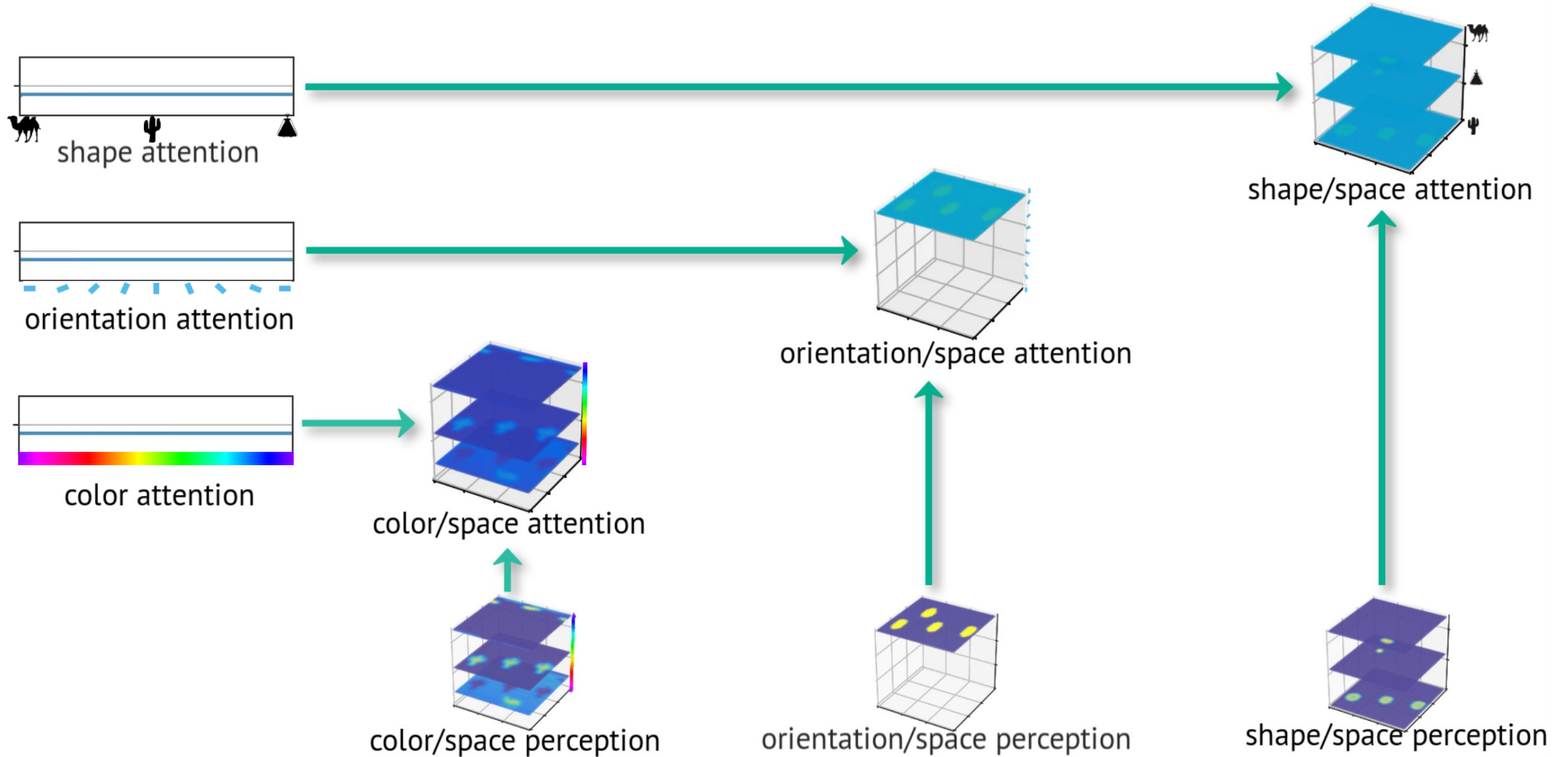


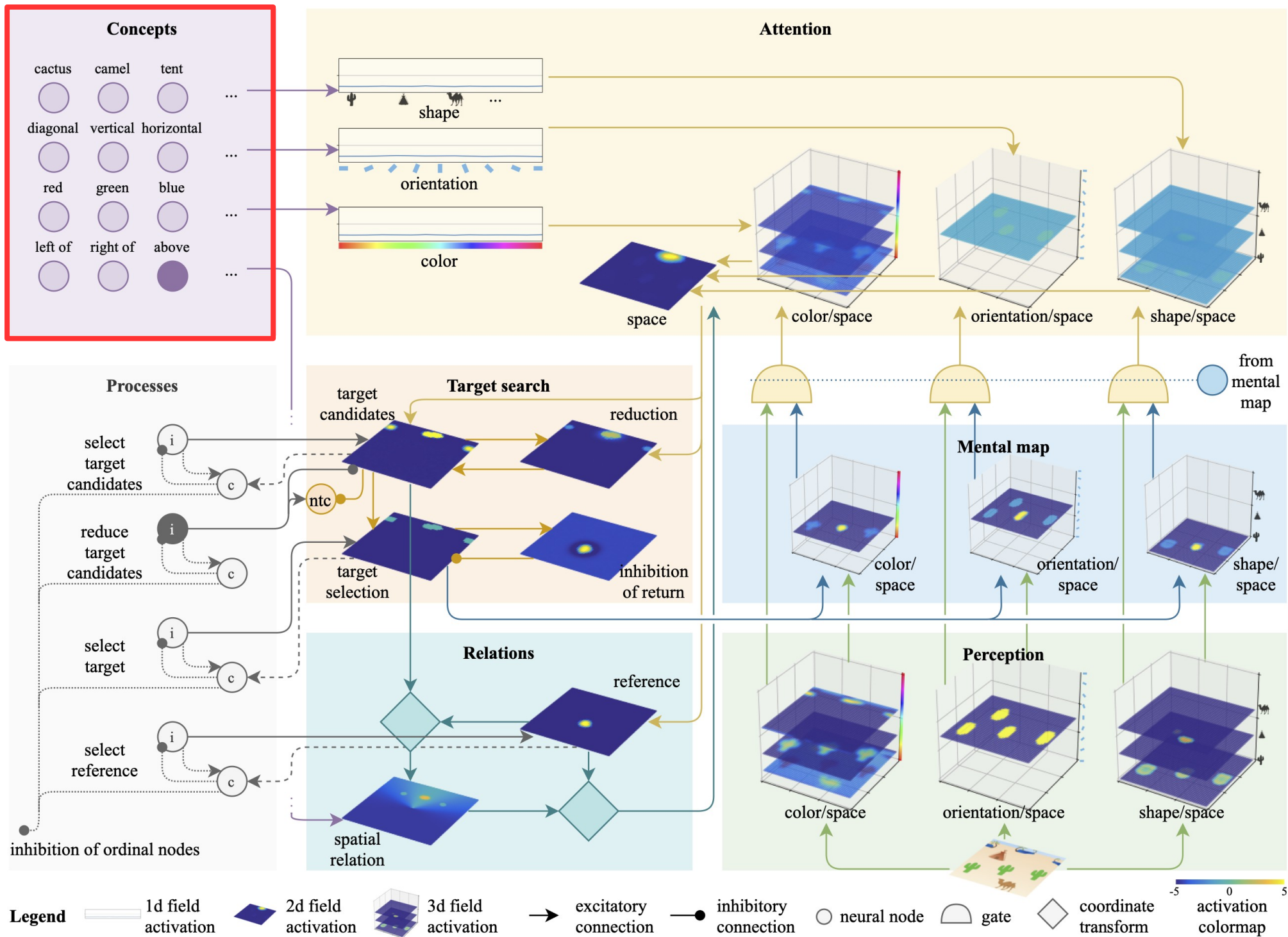
shape/space perception field



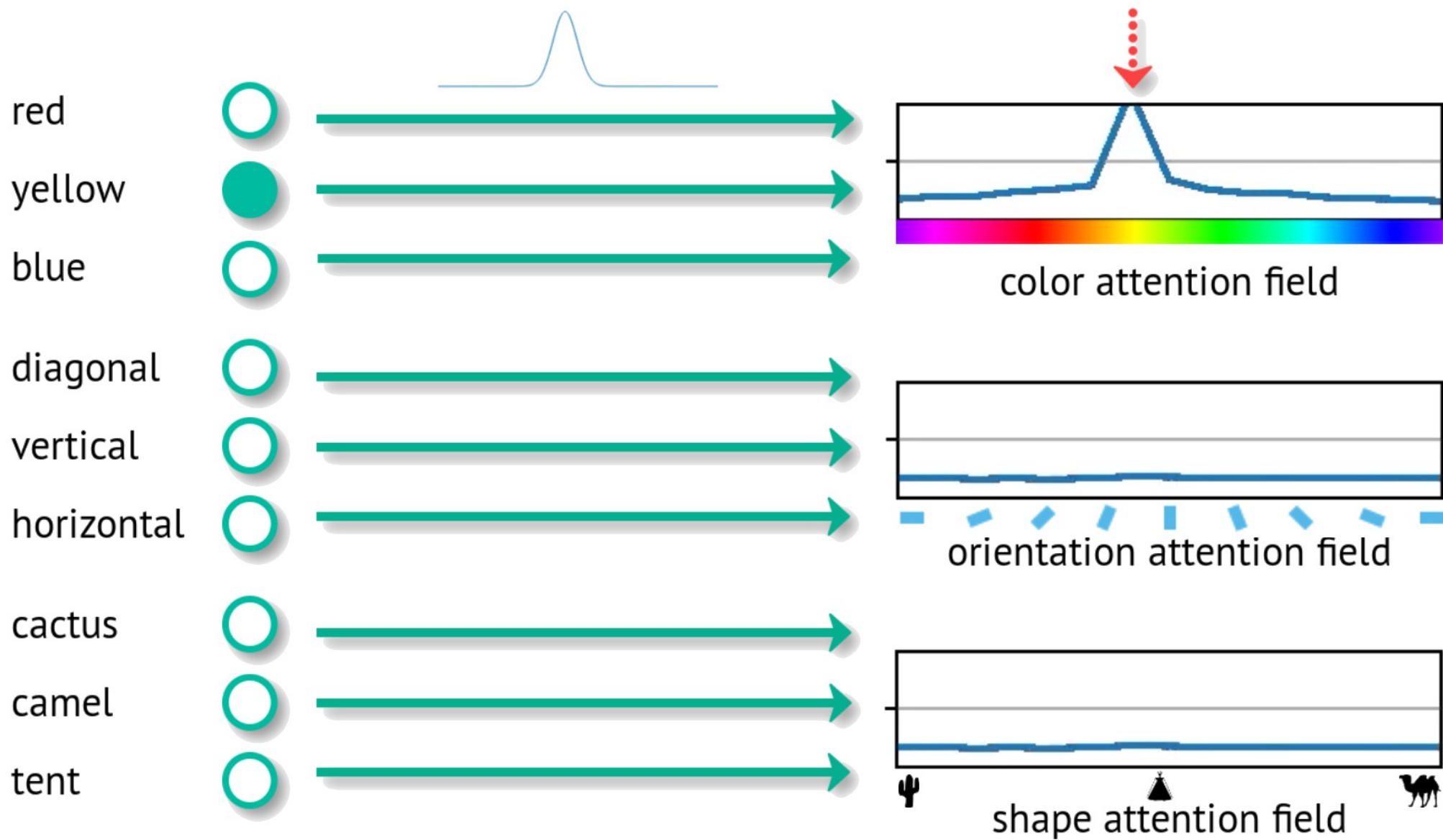


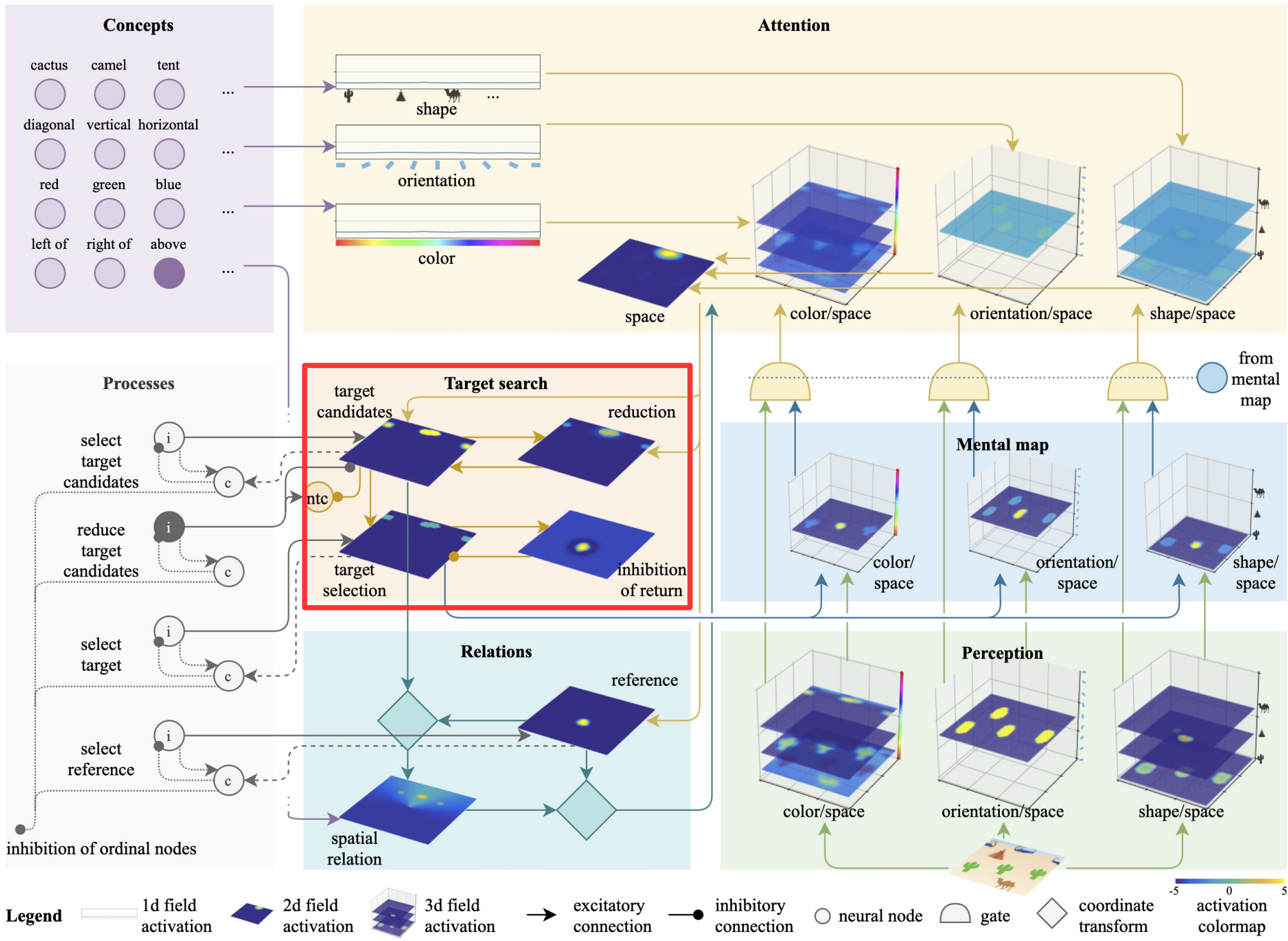
Visual search





Concepts

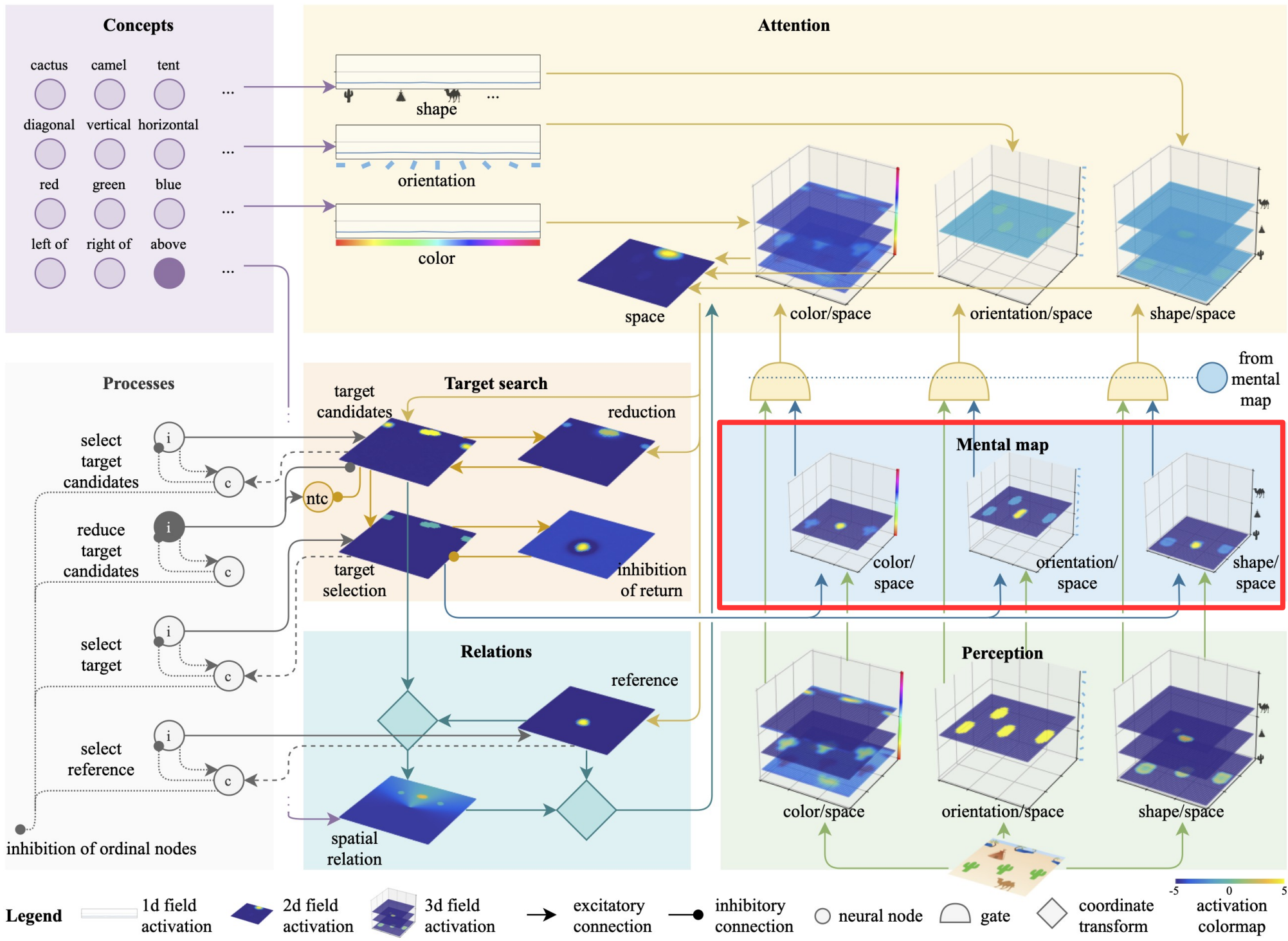




Target search



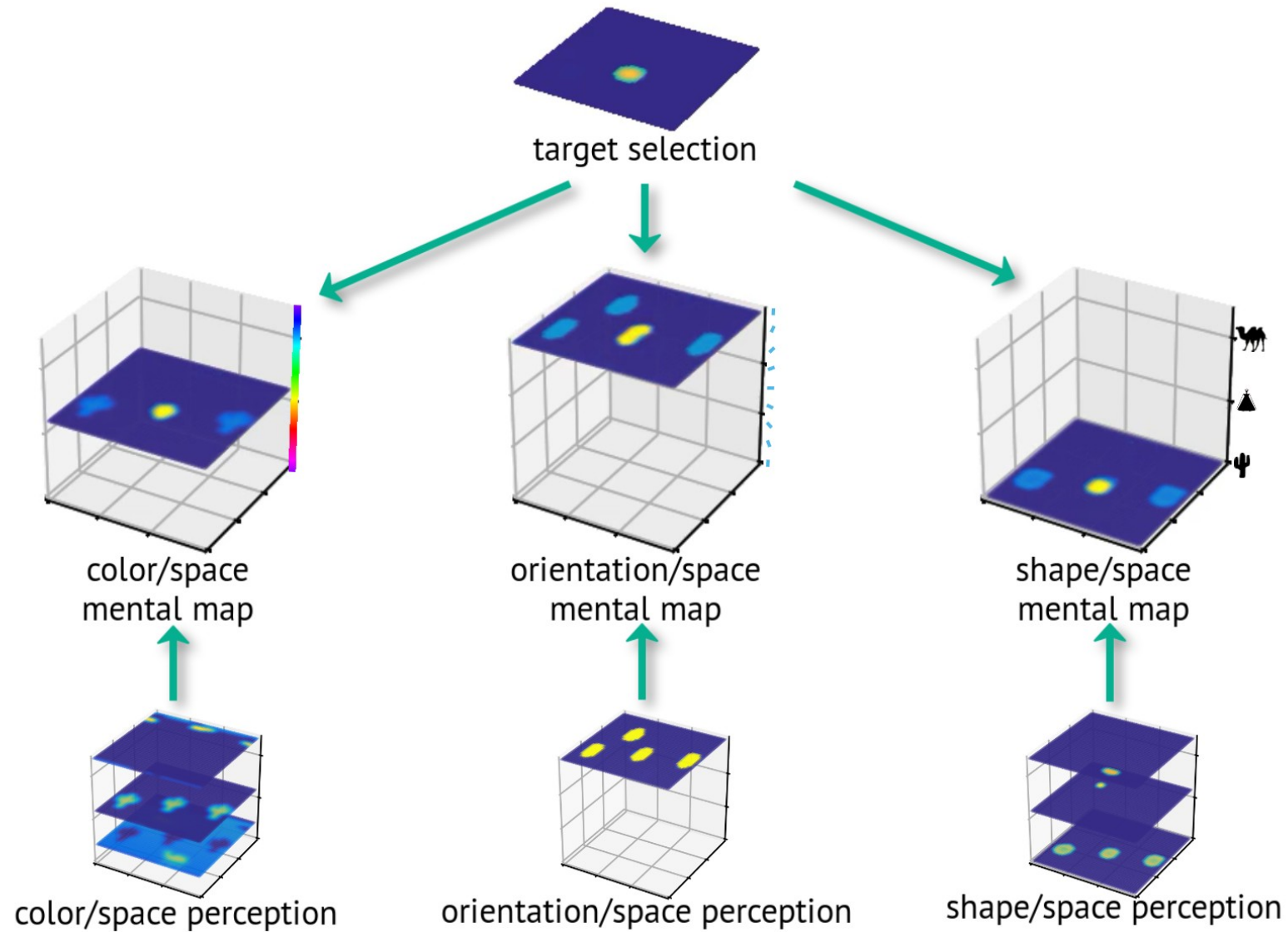
Tanenhaus, Spivey-Knowlton, Eberhard, Sedivy (1995)
Franconeri, Scimeca, Roth, Helseth, & Kahn (2012)

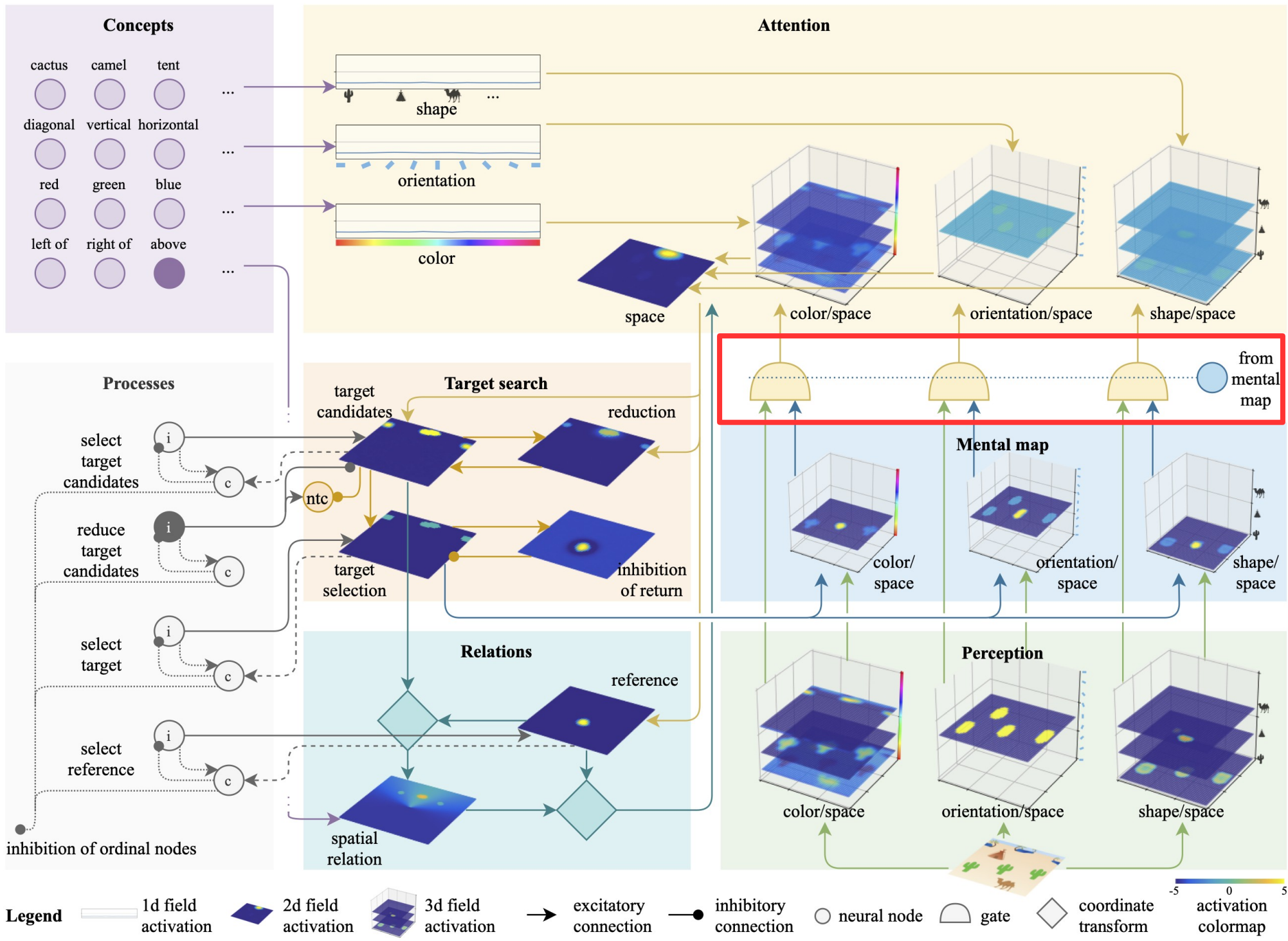


Legend



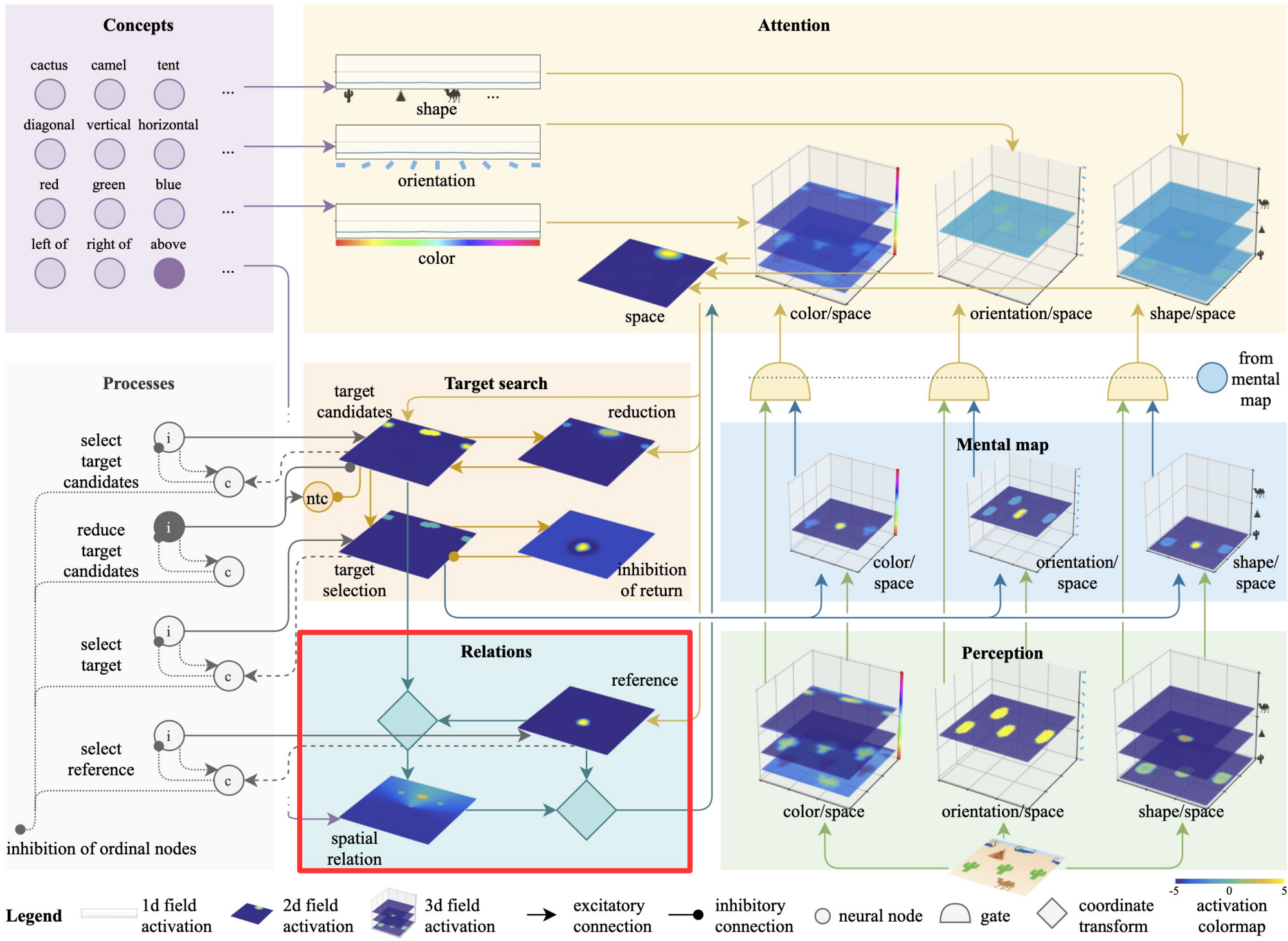
Mental map



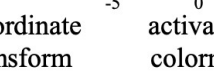
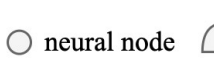
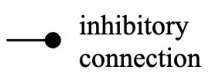
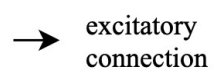
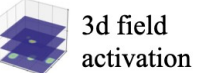
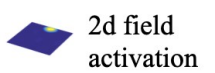


Legend





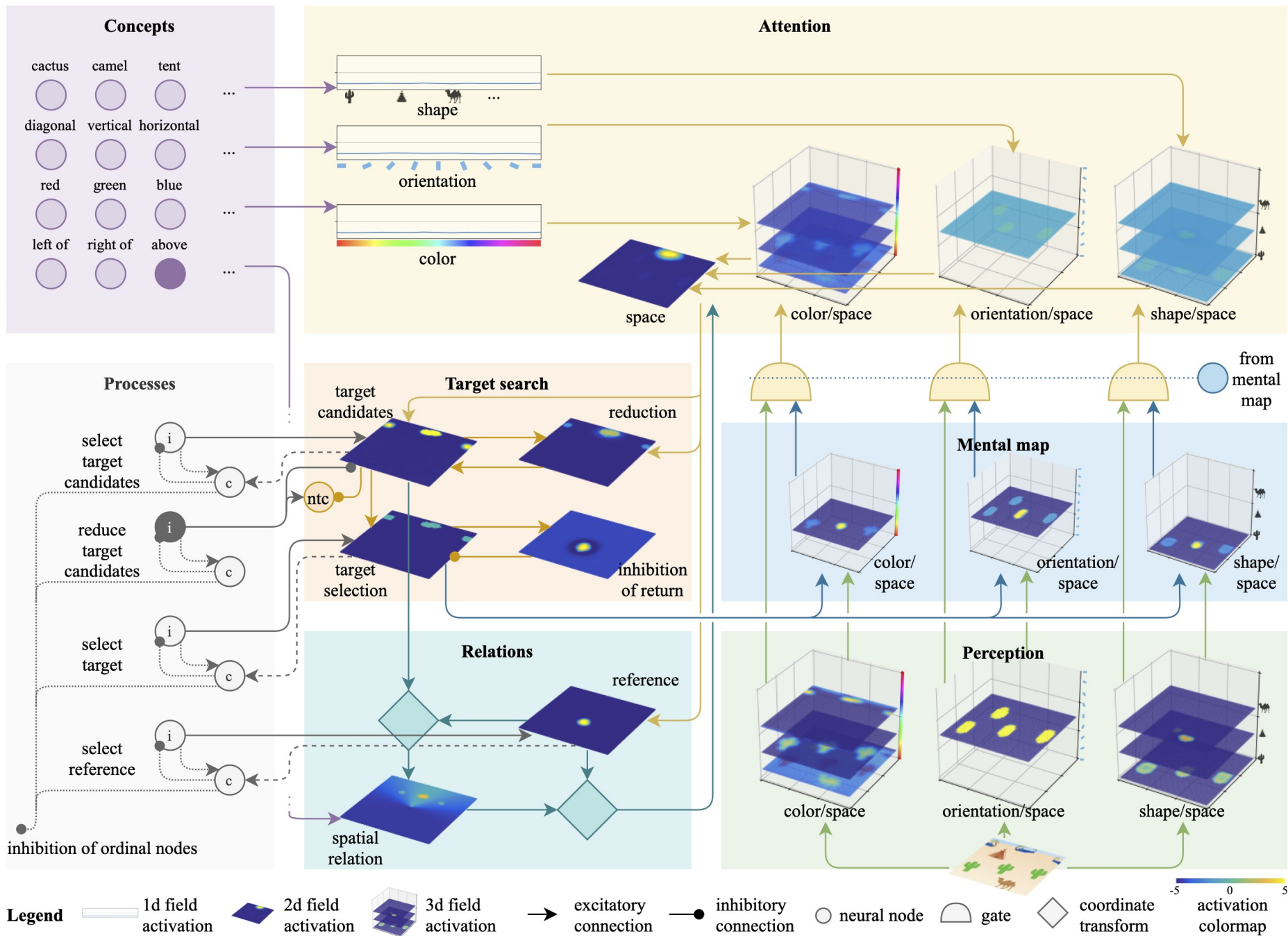
Legend



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language pre-processing

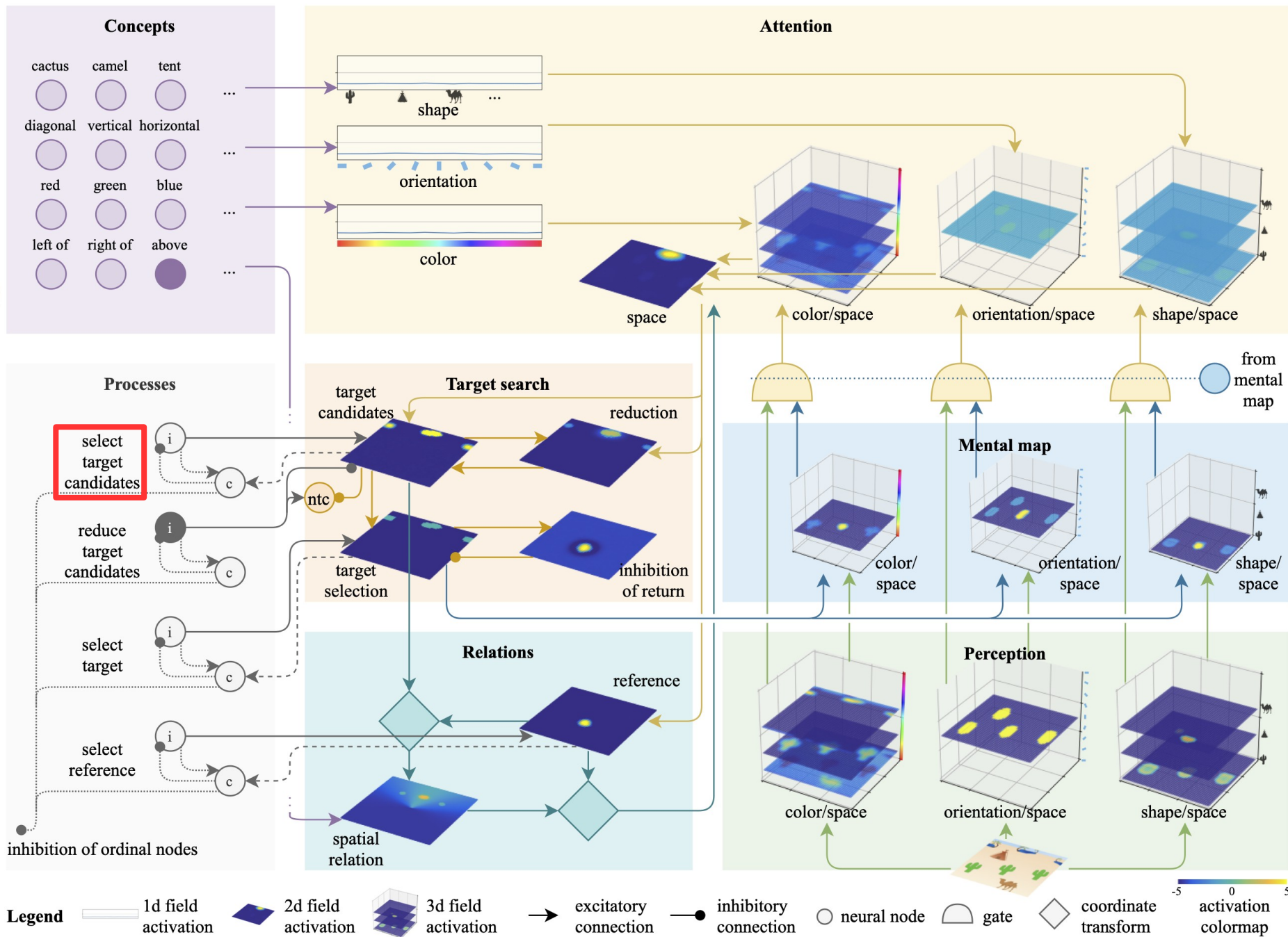
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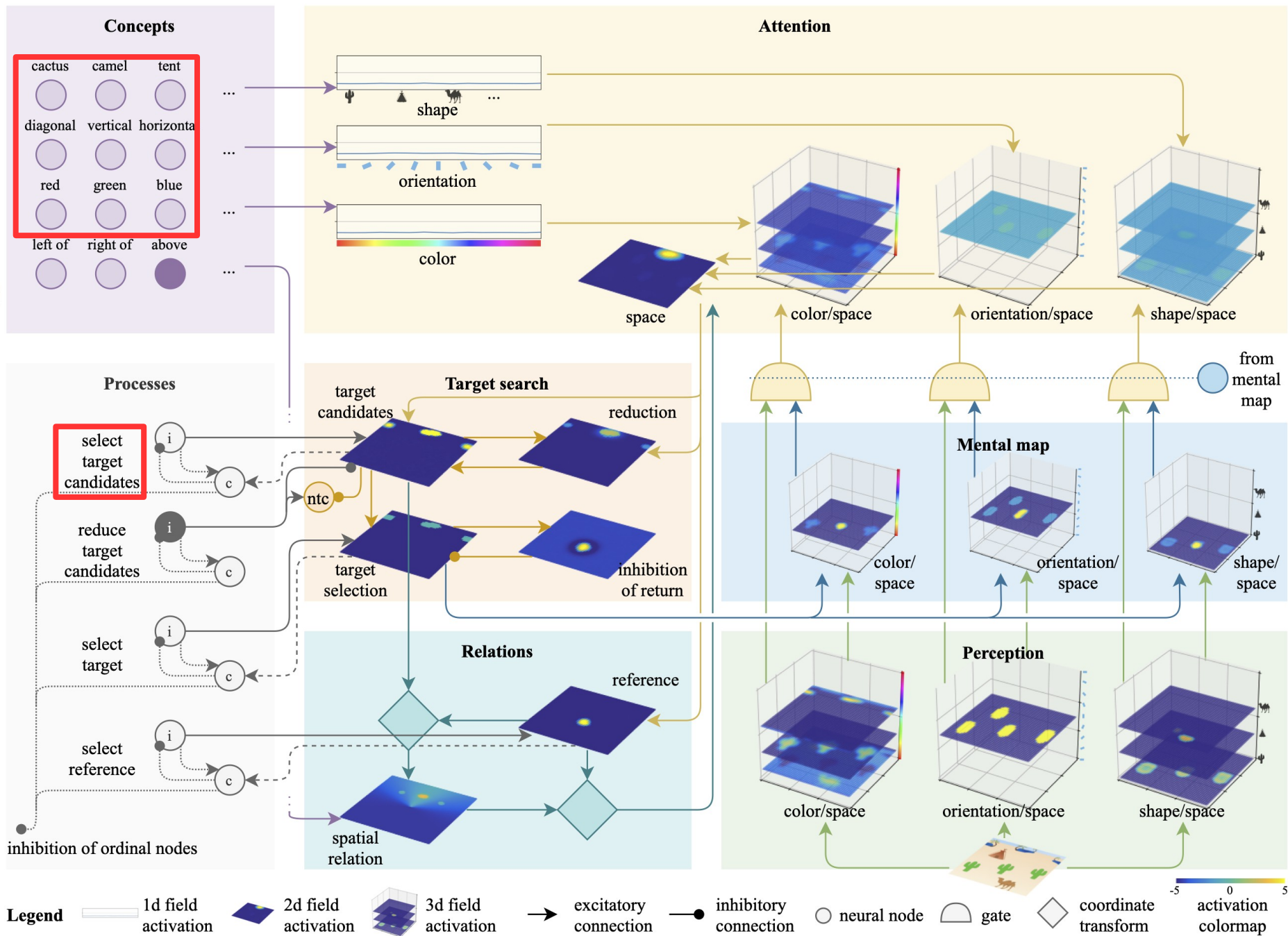
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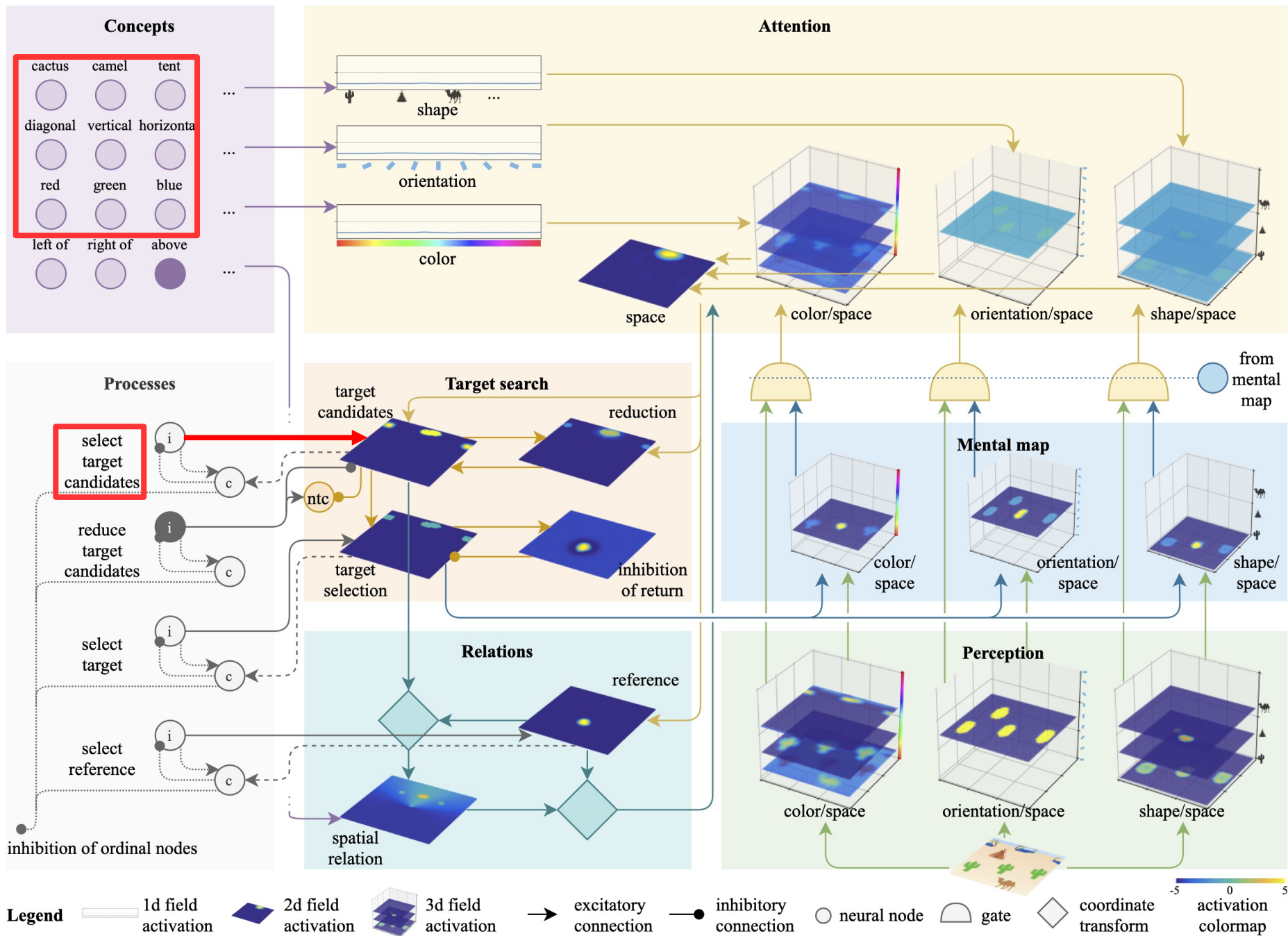
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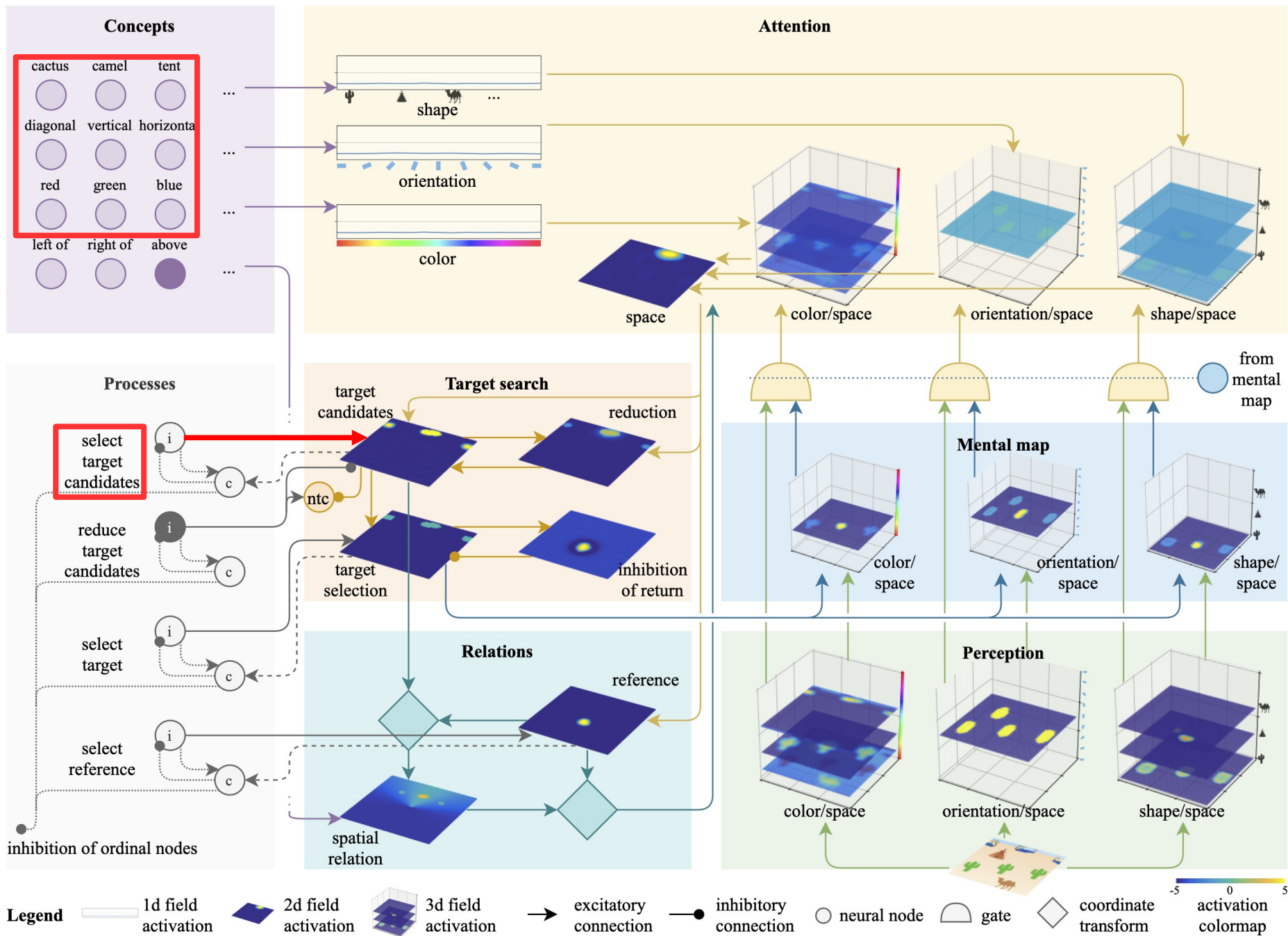
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9. eliminate target candidates
above

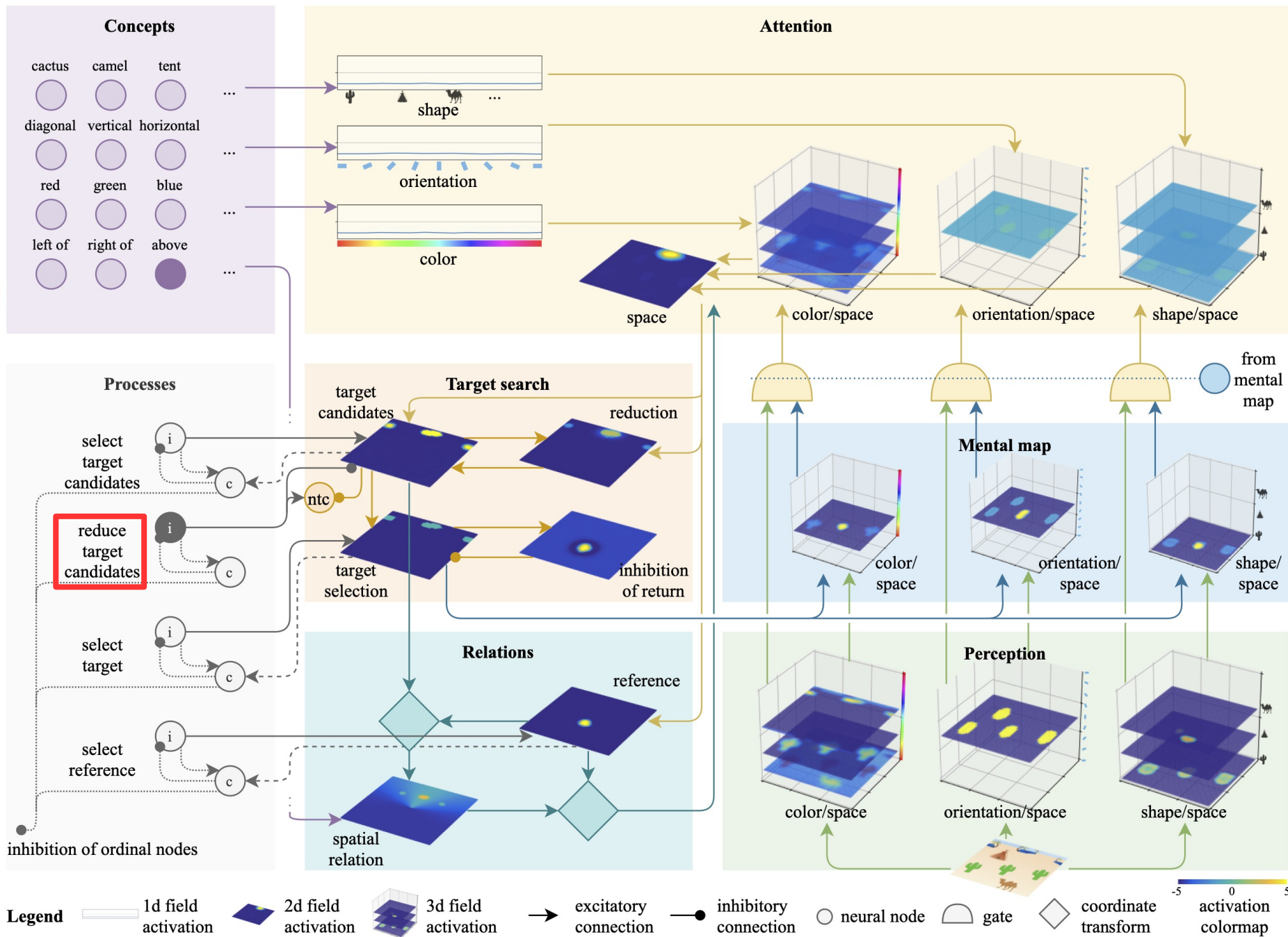
10. select target



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

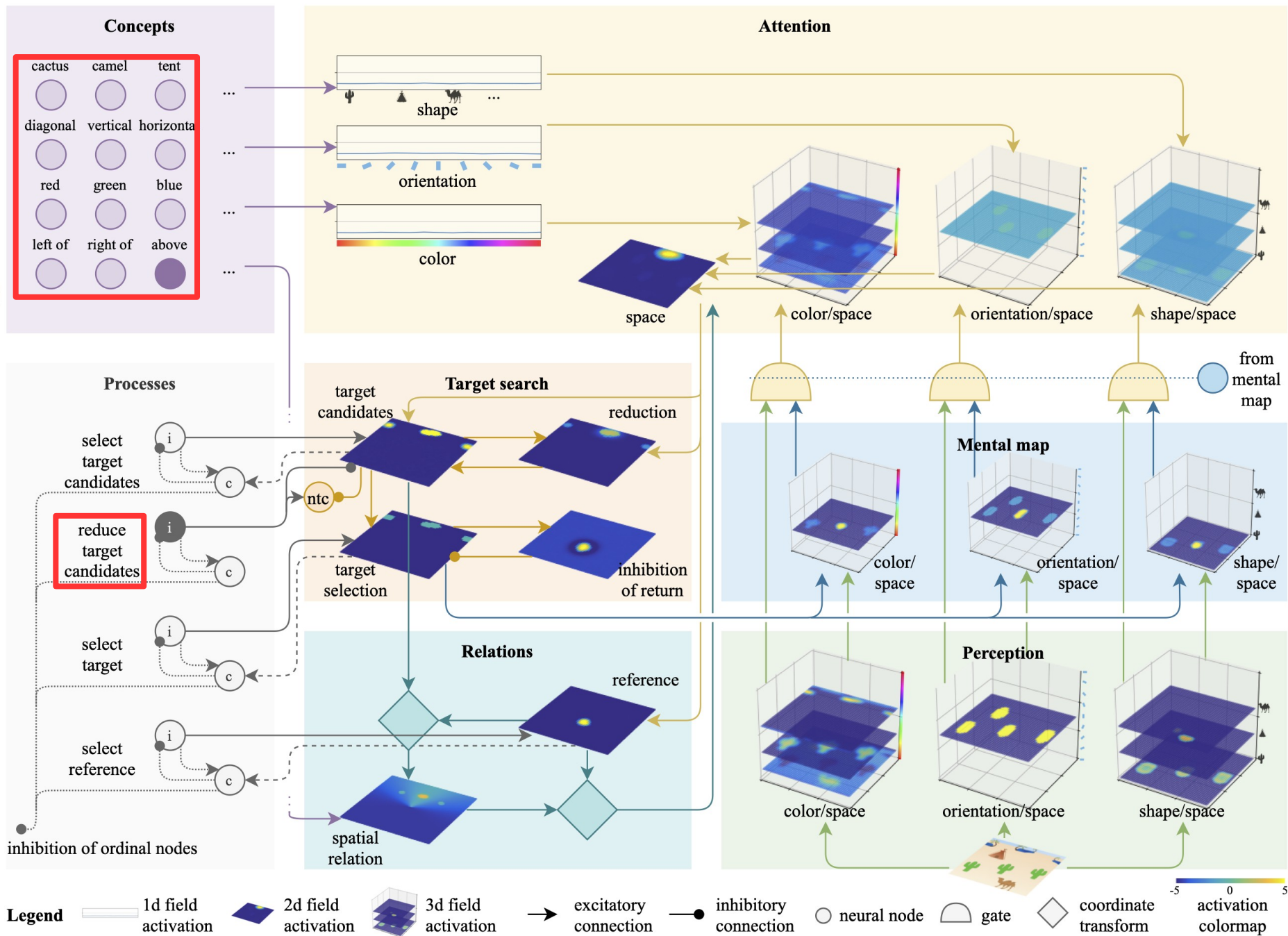
1. select target candidates cactus
2. select reference tent
3. eliminate target candidates below
4. select reference camel
5. eliminate target candidates above
6. select target
7. select target candidates blue
8. select reference cactus from mental map
9. eliminate target candidates above
10. select target



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

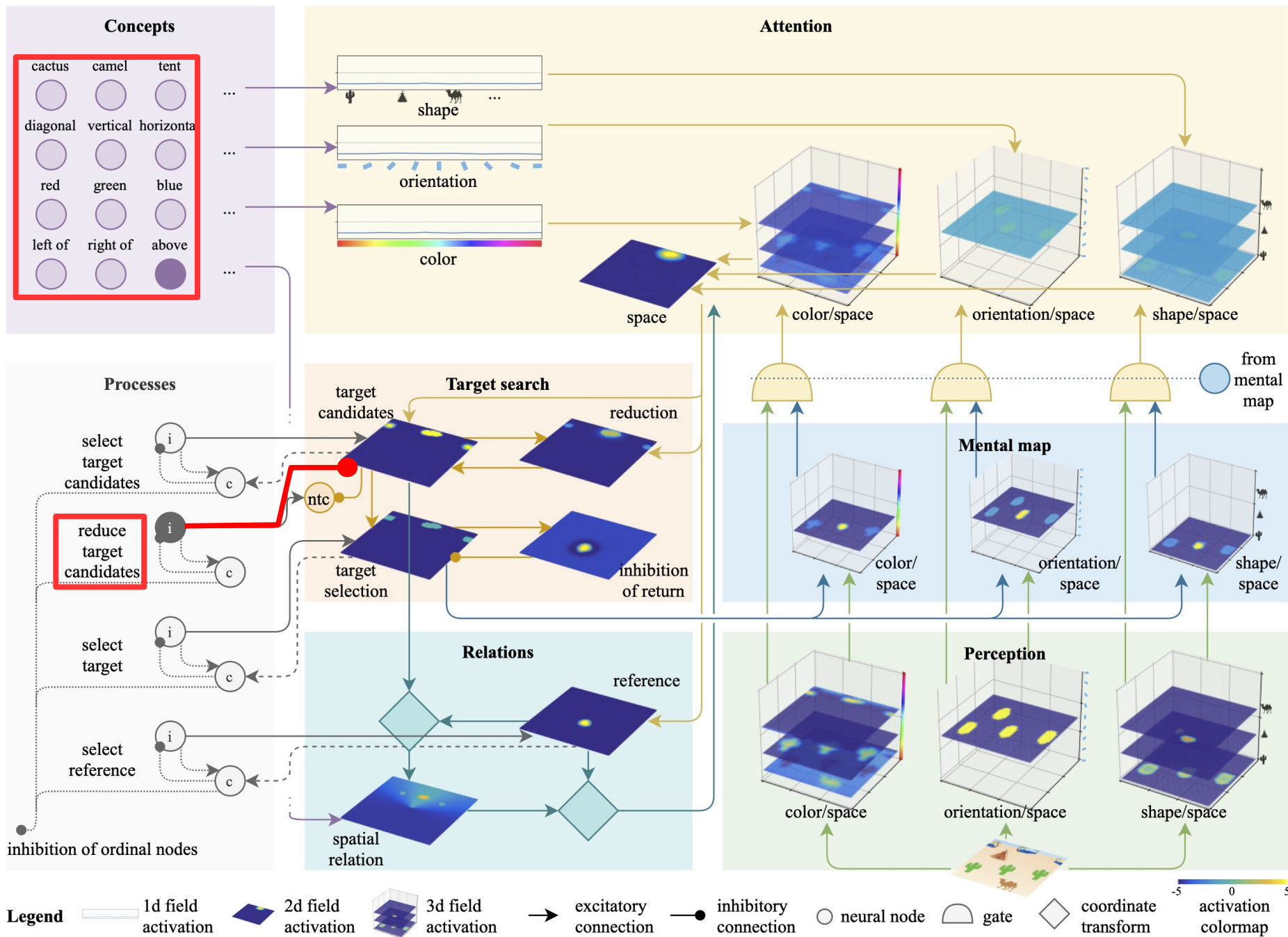
1. select target candidates cactus
2. select reference tent
3. eliminate target candidates below
4. select reference camel
5. eliminate target candidates above
6. select target
7. select target candidates blue
8. select reference cactus from mental map
9. eliminate target candidates above
10. select target



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

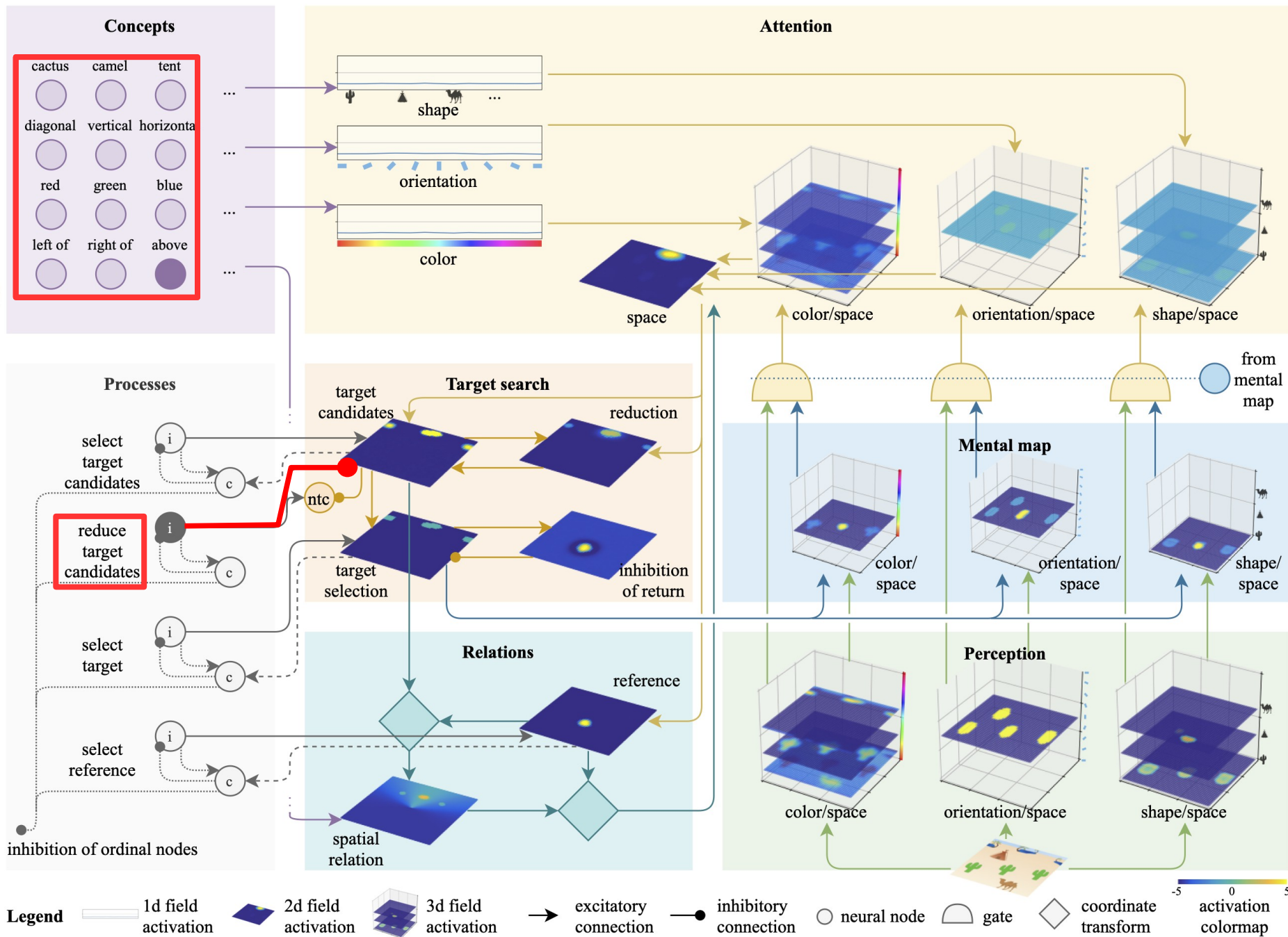
1. select target candidates cactus
2. select reference tent
3. eliminate target candidates below
4. select reference camel
5. eliminate target candidates above
6. select target
7. select target candidates blue
8. select reference cactus from mental map
9. eliminate target candidates above
10. select target



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

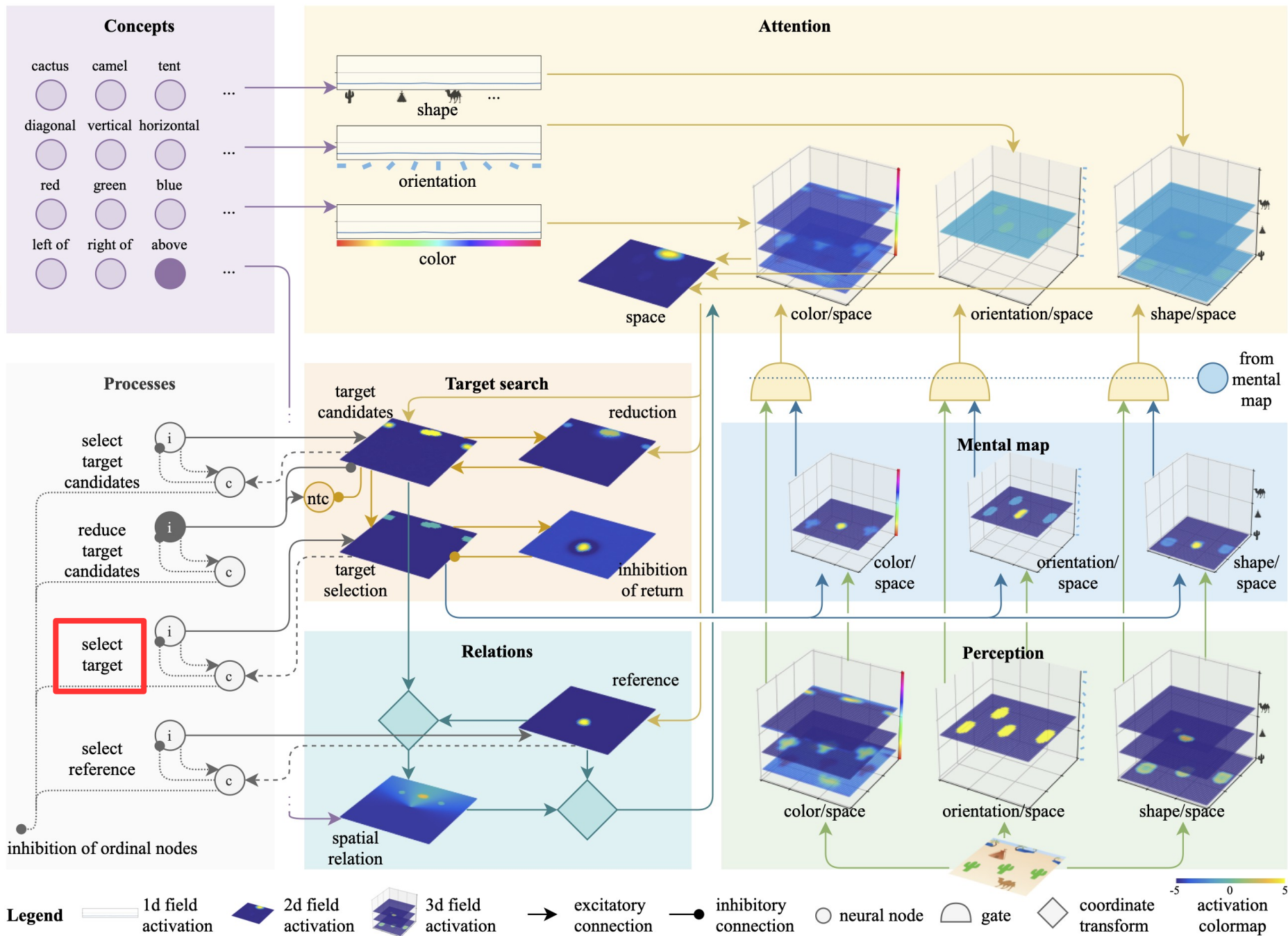
1. select target candidates cactus
2. select reference tent
3. eliminate target candidates below
4. select reference camel
5. eliminate target candidates above
6. select target
7. select target candidates blue
8. select reference cactus from mental map
9. eliminate target candidates above
10. select target



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

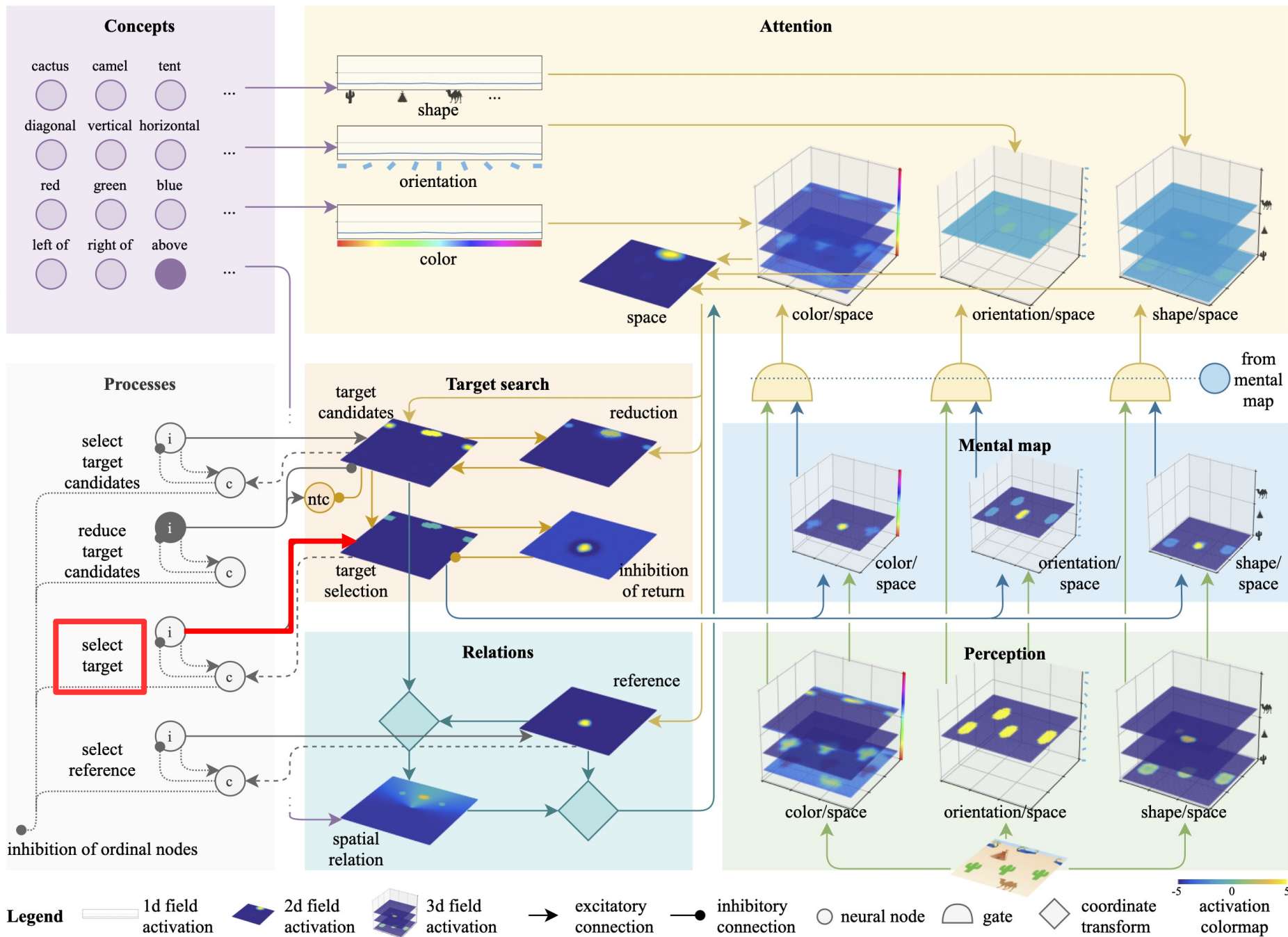
1. select target candidates cactus
2. select reference tent
3. eliminate target candidates below
4. select reference camel
5. eliminate target candidates above
6. select target
7. select target candidates blue
8. select reference cactus from mental map
9. eliminate target candidates above
10. select target



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

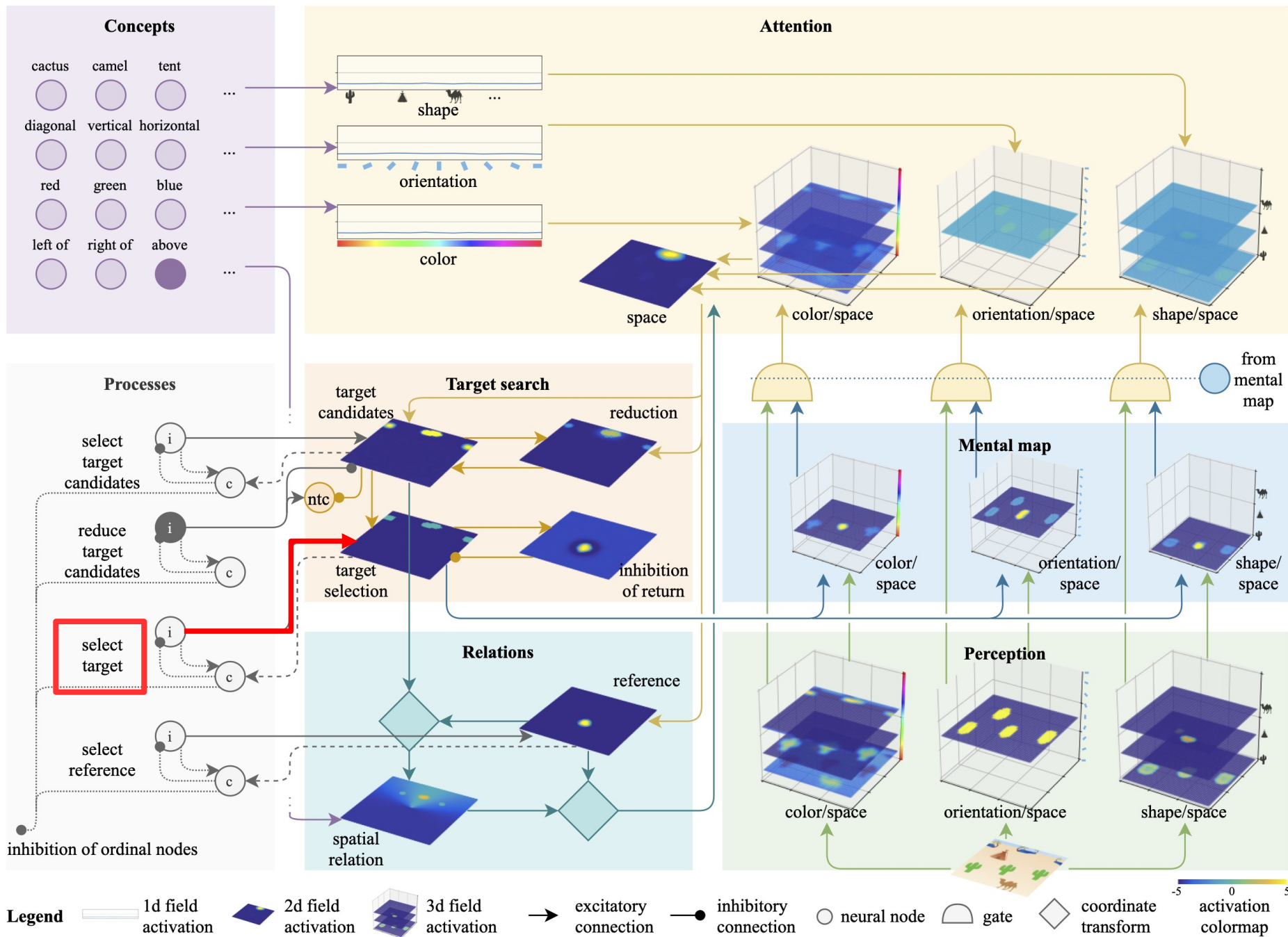
1. select target candidates cactus
2. select reference tent
3. eliminate target candidates below
4. select reference camel
5. eliminate target candidates above
6. select target
7. select target candidates blue
8. select reference cactus from mental map
9. eliminate target candidates above
10. select target



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

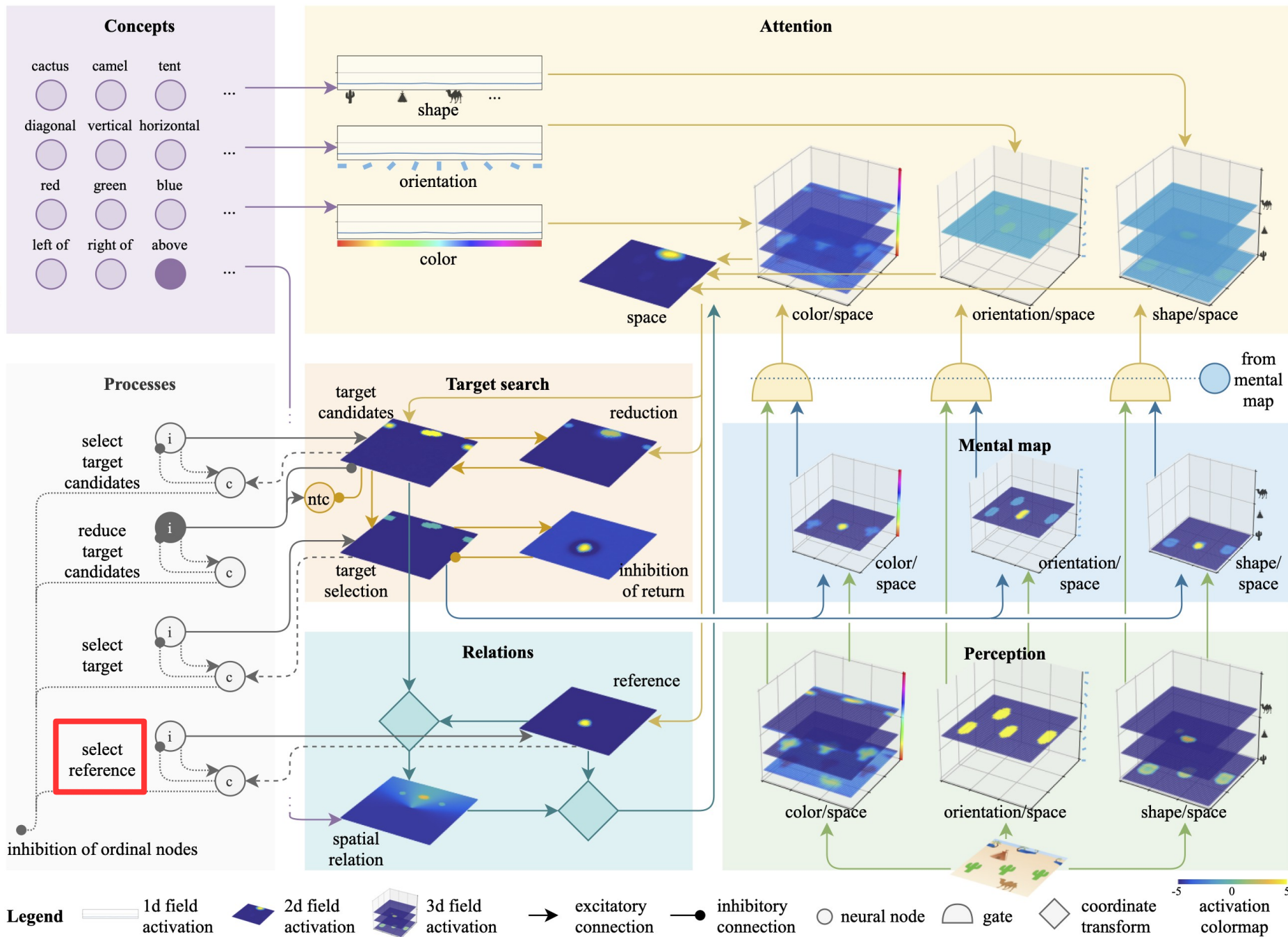
1. select target candidates
cactus
2. select reference
tent
3. eliminate target candidates
below
4. select reference
camel
5. eliminate target candidates
above
- 6. select target**
7. select target candidates
blue
8. select reference
cactus from mental map
9. eliminate target candidates
above
10. select target



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

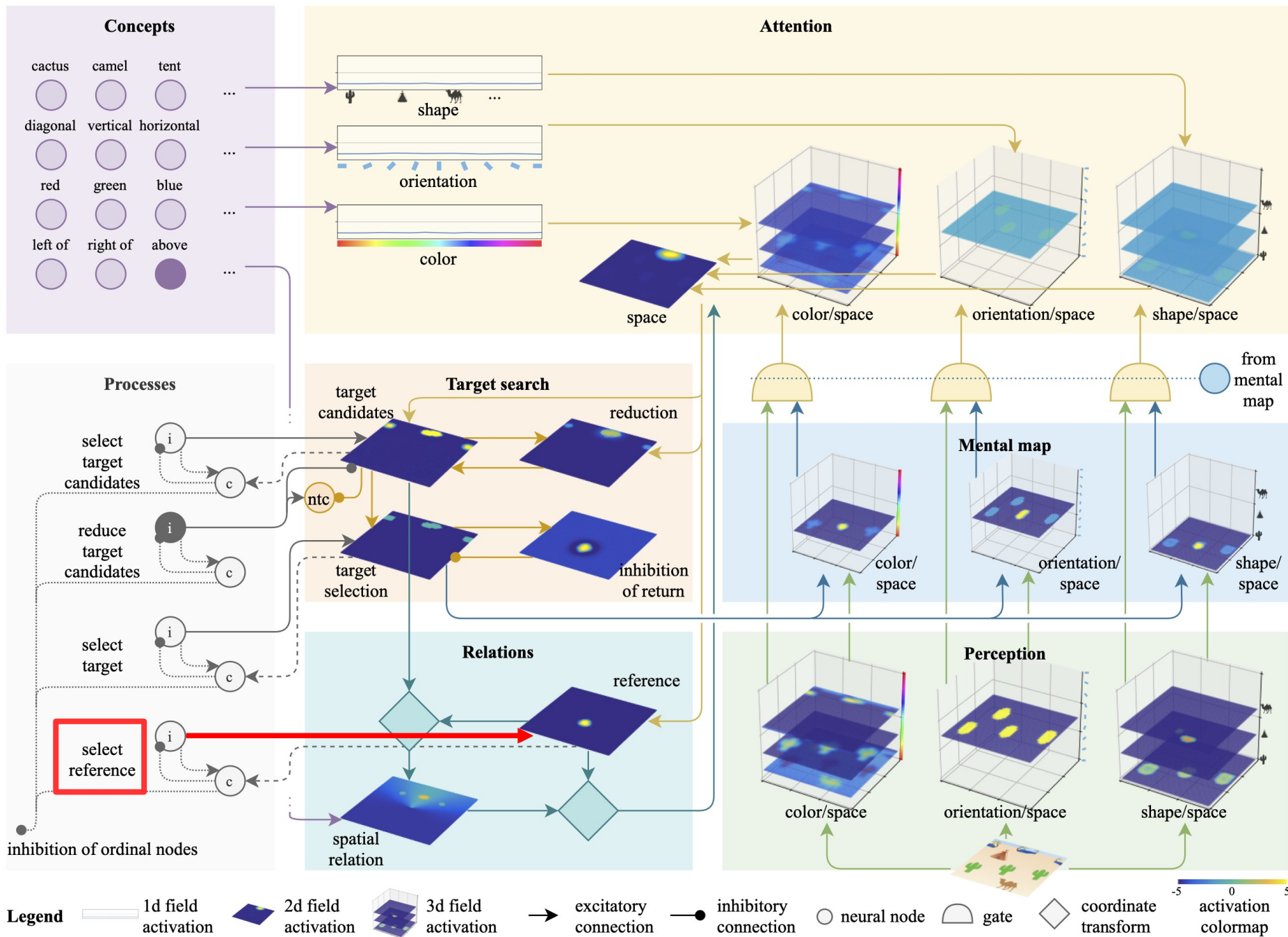
1. select target candidates cactus
2. select reference tent
3. eliminate target candidates below
4. select reference camel
5. eliminate target candidates above
6. select target
7. select target candidates blue
8. select reference cactus from mental map
9. eliminate target candidates above
10. select target



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

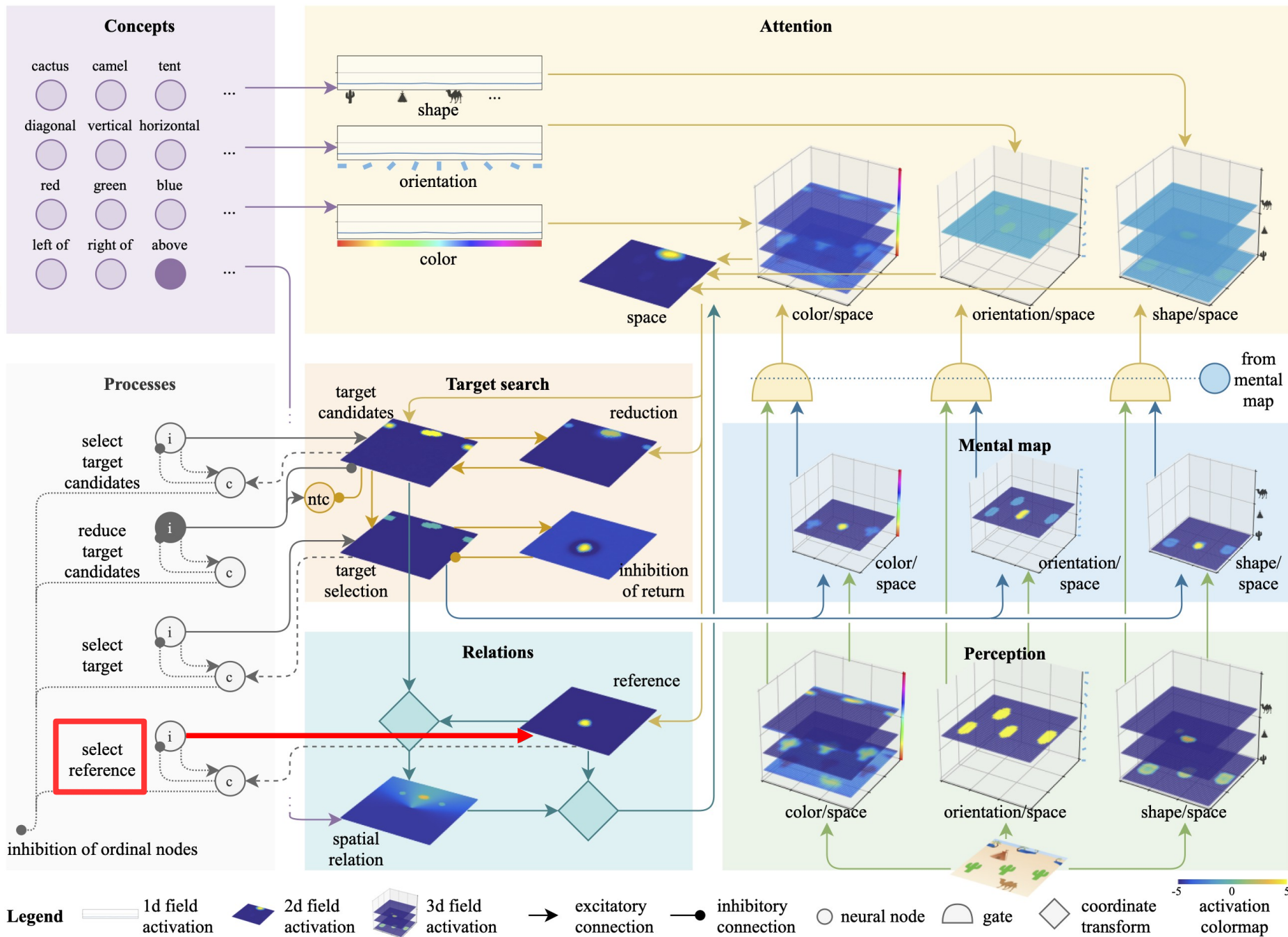
1. select target candidates cactus
2. select reference tent
3. eliminate target candidates below
4. select reference camel
5. eliminate target candidates above
6. select target
7. select target candidates blue
8. select reference cactus from mental map
9. eliminate target candidates above
10. select target



There's a cactus below the tent and above the camel. Find the blue object above that cactus.

language pre-processing

1. select target candidates
cactus
2. select reference
tent
3. eliminate target candidates
below
4. select reference
camel
5. eliminate target candidates
above
6. select target
7. select target candidates
blue
8. select reference
cactus from mental map
9. eliminate target candidates
above
10. select target



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