

Hybrid Representation of Spatial Descriptions

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Comprehension of Spatial Descriptions

Recipients of spatial descriptions have to draw on conceptual knowledge to arrive at integrated semantic interpretations. For example, the abstract spatial description *A above B*, *C next to B* is consistent with both of the following schematic spatial layouts.



Conceptual knowledge helps in choosing the adequate interpretation. In discourse, B could be a flower and C could be a human. If A is a bee, then the corresponding spatial situation is more similar to the first schematic layout. A recipient should verify *C next to A* (human next to bee) as consistent with the initial spatial description. In contrast, if A is the moon, then *C next to A* should be judged as inconsistent with the initial spatial description. As the example illustrates, the spatial relations that are implicitly conveyed in spatial descriptions are dependent on conceptual knowledge (Morrow & Clark, 1989).

The computational requirements of an integrated interpretation of spatial descriptions are better met by analog representations than by propositional representations (Larkin & Simon, 1987; Lindsay, 1988). Therefore, recipients of spatial descriptions who have to verify spatial expressions against an integrated representation of spatial descriptions are expected to construct a mental model of the described spatial layout in addition to a propositional representation. Those verification tasks should induce a hybrid representation.

Rule-Based vs. Model-Based Verification

Some verification tasks may be solved based on rule knowledge about spatial prepositions without referring to an analog representation (Pribbenow, 1991). For example, to verify that *B below A* is consistent with the above initial description it is sufficient to apply rule knowledge about opposite prepositions: *B below A* can be easily inferred from *A above B*.

The construction of an integrated spatial mental model requires effort. Thus, it is expected that if verification tasks can be solved rule-based, recipients will do so. Those tasks should not induce a hybrid representation. Consequently, experimental results indicating an integrated mental model should be less probable after such verifications.

An experiment was designed to test the following predictions concerning the allocation of cognitive resources: Rule-based verification tasks do not regularly induce model construction. In contrast, for model-based verification tasks a mental model of the described spatial layout has to be constructed. Once constructed, a mental model is available for further model-based verifications.

Thirty-two participants read 16 sequences of three sentences (interspersed with nonspatial or partially spatial filler sequences): Each sequence started with a spatial description involving three entities. Then two spatial sentences had to be verified with respect to the description. In half of the sequences a rule-based verification was followed by a model-based verification. In the other half of sequences both verifications were of the model-based type.

Consistent with expectations, the first model-based verifications took 400 ms longer than the rule-based verifications. More important, the same second model-based verifications took 1 s less after model-based verifications than after rule-based verifications. This confirms that models had to be constructed for the first model-based verifications which were then available for second model-based verifications. After rule-based first verifications, models had to be constructed for second model-based verifications.

The results indicate that the representation of spatial descriptions is hybrid and sensitive to task-demands. Analog mental models are sometimes necessary as integrated representations of the described spatial layout. Their construction requires effort. If a propositional representation is sufficient as for rule-based verification tasks in the present experiment, the construction of mental models is avoided.

References

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