How can it be both abstract and perceptual?

Comment on

Hafri, A., & Firestone, C. (2021). The perception of relations. *Trends in Cognitive Sciences*

Jean-Rémy Hochmann^{1*} & Liuba Papeo^{1*}

¹ *Institute of Cognitive Sciences Marc Jeannerod –UMR5229, Centre National de la Recherche Scientifique (CNRS) and Université Claude Bernard Lyon 1, France*

*Corresponding authors:

Jean-Rémy Hochmann, Email: hochmann@isc.cnrs.fr ;

Liuba Papeo, Email: liuba.papeo@isc.cnrs.fr

In their provocative article *The perception of relations*, Hafri and Firestone (hereafter, H&F [1]) argue that the processing of abstract relations such as SUPPORT, FIT, CAUSE and even SOCIALLY INTERACT, displays key signatures of perception: those relations are extracted rapidly and spontaneously from visual input, cannot be ignored, and influence other perceptual processes. They conclude, not only that perception is involved in processing relations, but that perception represents abstract relations. The latter conclusion sounds –at least– ahead of its time.

Abstraction can be broadly defined as the property of a representation to generalize across different situations, domains and modalities. The opposition between perception and abstraction appears obvious. So, in what sense are perceptual representations of relations abstract?

Relations or perceptual correlates of relations?

In all the studies discussed in H&F, abstract relations are realized by, and extracted from, visual multiple-object scenes. The signatures of perception identified by H&F in the processing of visual relational stimuli (i.e., multiple-object scenes) may thus just reflect the encoding of visuo-spatial properties of the stimuli, which reliably correlate with abstract relations. Some of those properties are long since known. In the case of the relation CAUSE “perceived” in launching events, it is known since Michotte’s work in 1963 [2], that visual perception responds to the spatio-temporal continuity of the motion of two objects. In the case of the relation SOCIALLY INTERACT, current evidence shows that the visual system represents the difference between two seemingly interacting vs. non-interacting individuals [3]. But what the visual system encodes are visuo-spatial features such as physical proximity and facingness that reliably correlate with social interaction, rather than the social interaction itself (e.g., a fight, an argument, a dance, etc.).

Without spatio-temporal continuity or facingness, visual perception would not *see* CAUSE or SOCIALLY INTERACT. Given the current results, the signatures of perception identified by H&F reflect perception of visuo-spatial features that correlate with abstract relations, rather than representations of abstract relations themselves.

Abstraction by impoverishment

One possibility is that perception of relations as characterized above, gives rise to the illusion of abstraction, through a process that we call *abstraction by impoverishment*, in which a rich high-dimensional visual input is reduced to a low-dimensional representation. In this process, objects could be represented as object files, stripped of any perceptual feature [4]; likewise,

spatial relations of the kinds discussed in H&F could be represented by setting constraints on the relative positioning of two minimally defined object files in a mental model [see also 5]. Thus, the relation ON would be represented as one object file on top of another object file. If no additional featural information is specified for the object files, such representation can be generalized across various situations. Likewise, SOCIALLY INTERACT would be represented as two spatially close object files, adding two properties to each: category (body-shape) and direction (facing towards). Eventive relations would only require additional dynamic properties. More generally, all physical, eventive and social relations discussed in H&F could be reduced to mental models of two object files and basic featural, positional or dynamic properties. This type of representation remains perceptual, in this case visual, but is optimized for generalization across various situations, as long as they involve specific perceptual features. With this type of representation, however, generalization is limited. Launching events and entraining events, for instance, are two types of causal events with slightly different perceptual correlates. As a consequence of those differences, visual representations (isolated by retinotopic visual adaptation) elicited by launching events do not generalize to entraining events [6]. The representation of the abstract relation CAUSE that generalizes from launching to entraining is most likely to be non-perceptual.

In a long tradition of cognitive models [7], full abstraction is only achieved with non-perceptual (propositional) representations, where entities and relations are represented by discrete symbols that are combined in mental representations. In such format, the symbol that stands for a relation is entirely dissociated from perception and from the representations of the entities that participate in the relation, and can be used across conceptual domains and modalities.

In sum, we concur with H&F that perception is not just representation of a bag of objects and features. However, there is no empirical or logical argument to sustain that relations represented in visual perception are abstract. Current results at most suggest a mechanism that we call *abstraction by impoverishment*, where perceptual representations are stripped down until what remains is a skeleton of perceptual properties that are eventually correlated with abstract relations. As the case of causal launching and entraining demonstrate, the generalizability of these representations is too limited for them to be called “abstract”. Until proven otherwise (and this could be an exciting research program), relational representations in visual perception remain perceptual, built upon features such as object-shape, direction or acceleration, rather than upon abstract concepts such as CAUSE or SOCIALLY INTERACT.

Reference

1. Hafri, A., & Firestone, C. (2021). The perception of relations. *Trends in Cognitive Sciences*.
2. Michotte, A. E. (1963). *The perception of causality* (TR Miles, Trans.). London, England: Methuen & Co.
3. Papeo, L. (2020). Twos in human visual perception. *Cortex*, 132, 473-478.
4. Leslie, A. M., Xu, F., Tremoulet, P. D., & Scholl, B. J. (1998). Indexing and the object concept: developing what and where systems. *Trends in cognitive sciences*, 2(1), 10-18.
5. Summerfield, C., Luyckx, F., & Sheahan, H. (2020). Structure learning and the posterior parietal cortex. *Progress in neurobiology*, 184, 101717.
6. Kominsky, J. F., & Scholl, B. J. (2020). Retinotopic adaptation reveals distinct categories of causal perception. *Cognition*, 203, 104339.
7. Gentner, D. (1983). Structure-mapping: A theoretical framework for analogy. *Cognitive Science*, 7(2), 155-170.