the internal space that people recover represents these parameters. This implies that nearby points in the original parameter space are near in the mental space, and it is short step from this to saying that similarity is preserved between the two spaces. Such results are not surprising where the dimensions of variation in the objects are subjectively obvious (e.g., the length and orientation of line segments), and in such cases this correlation between parameter space and mental space is frequently found. But it is impressive with Edelman's stimuli, where the underlying dimensions of variation are far from obvious and interact in a complex way to produce the visual image.

Edelman moves from these results to a general theory of perception founded on similarity. He presents this as an alternative to a "reconstructionist" approach. The goal of perception is assumed to be preserving similarities between things in the environment, rather than building an internal representation of environmental structure. Edelman's target article is important and should act as a valuable stimulus for future research. We believe, however, that there are three difficulties with this viewpoint as a general program in perception.

(1) The notion of "distal" similarity seems ill-defined. Goodman (1972) pointed out that any two objects have infinitely many common and distinctive features, thus "objectively" everything is equally similar to everything else. Watanabe (1985b) illustrates that even choosing for a set of objects only those predicates that are extensionally distinct (which for a finite set of objects is a finite set of predicates) still leaves all between-object similarities equal, unless differential weights for predicates are introduced. This is not just a philosophical nicety. In Edelman's experiments, stimuli are generated artificially by varying a set of parameters; thus nearness in parameter space may be chosen as a reasonable measure of similarity.

But the natural world has not been generated by manipulating a small number of underlying parameters. Variation in natural objects can be considered along a limitless number of dimensions. By choosing (and assigning differential weights to) any subset of these dimensions, all manner of "distal" similarities can be generated. Objects may be compared by overall color, by outline shape using any number of shape representation systems, by nearness to the observer (or to Pluto!), by weight, by perimeter length, and so on, indefinitely. Moreover, any of these measurements can be combined in arbitrary ways (e.g., perimeter length times weight) to produce new measures that can be used to give new dimensions.

Any set of any dimensions seems equally good as a distal measure of similarity. It might be suggested, for example, that physics could supply constraints on what can count as an underlying dimension, but it should be clear that this still leaves an infinite number of possible dimensions along which objects in the environment might be assessed; moreover, it will rule out many psychologically critical dimensions (e.g., the dimensions that define facial structure) since these do not relate to physical quantities. In short, it does not make sense to say that two things are similar without specifying in what way they are similar (Goodman 1972); to specify this, however, requires a cognitive agent to *define* which dimensions of distal variation matter and which do not; then the relation between an "objective" distal similarity structure and the similarity structure in the internal space of an agent breaks down. This means the claim that the perceptual system preserves an objective distal similarity structure loses its sense. Edelman, rather than dealing with objective properties of the world, is dealing with *two different descriptions* or representations – an experimenter-intended one (the underlying parametrization) and one formed by participants (the internal similarity spaces).

The situation seems analogous to the general philosophical difficulty with the correspondence theory of truth: there is no "mind-independent" way to specify which *facts* the world consists of, so the claim that true statements correspond to these facts is circular. In exactly the same way, there is no "mind-independent" way to specify which are the *similarities* in the world, so the claim that

The notion of distal similarity is ill defined

Ulrike Hahn and Nick Chater

Department of Psychology, University of Warwick, Coventry CV7 4AL, United Kingdom. **u.hahn,n.chater@warwick.ac.uk**

Abstract: We argue that the notion of distal similarity on which Edelman's reconstruction of the process of perception and the nature of representation rests is ill defined. As a consequence, the mapping between world and description that is supposedly at stake is, in fact, a mapping between two different descriptions or "representations."

Edelman has shown experimentally that people can extract the underlying parameters used to generate a set of novel stimuli. From the results of multidimensional scaling, he conjectures that

similarities in mental space correspond to these external similarities is circular. But if there are no distal similarities, there can be no second-order isomorphism on which to build a theory of representation. The debate about the correspondence theory of truth as stated by us is a philosophical classic. The point we are making – that there is no "picture" relationship between statements and world – is widely accepted (see Strawson, Ayer, Wittgenstein II) even within logical positivism (for example, Neurath).

(2) Perception frequently appears to involve classifying very different patterns as similar. For example, the sequences 101010101010 and 010101010101 appear similar, even though they differ at each spatial location. Similarly, a photograph and its negative will be judged similar, even though they differ in every pixel value. Or again, different pictures of the same face, or different tokens of the same phoneme, will seem very similar, even if, under some obvious physical description, they appear completely different. The point is that the perceptual system identifies the common structure in both stimuli. How does this relate to Edelman's claim that distal structure is preserved in the internal representation of similarity? Using some obvious physical interpretation of the stimulus, the objects are very different, yet they are judged to be very similar, violating Edelman's theory. But using, instead, a perceptually appropriate description for measuring "distal" similarity (e.g., that the stimuli above are both examples of alternating patterns: descriptions in terms of the structure of a face or the identity of a phoneme), the similarities between the distal world and the mind are preserved, but only at the cost of circularity.

(3) Finally, we suggest that the reconstructive approach to perception may not be an *alternative* to Edelman's similarity-based view of perception. Instead, a reconstruction of the perceptual world may be required to explain why the similarities are judged as they are. For example, with Edelman's artificial figures, the parameters of variations may be of interest as part of a specification of the structure of those figures – indeed, only by attempting to reconstruct those figures does it seem possible to realize that there *are* only a small number of underlying parameters of variation (i.e., the recipe for reconstructing each figure is the same, apart from parametric variation). Thus, the parametrization used as a basis for internal similarity judgments may be *based on* the attempt to reconstruct the figure. For example, it is not clear why two pictures of the same face will be judged to be similar unless the same underlying 2/3D structure has been reconstructed (at least partially) for both. Thus, we would argue that the reconstructionist view of perception may be an important component in an account of similarity of relevance to Edelman's empirical results.