Notes and Comment

Transformability and object identity

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A recent paper published in this journal (Warren, 1977) argued that two stimuli in apparent motion are perceived as a single object if and only if one is "ecologically transformable" into the other.

While no general criterion has been offered for testing the transformability of a given stimulus pair, it seems that under any reasonable criterion the reported data will *not* support the above claim.

One of the stimulus pairs used in Warren (1977) (Figure 1j) comprised a triangle and a square of about 0.5 deg of visual angle. Are they really "ecologically nontransformable" as claimed in Warren (1977)?

Since ecological transformations are those produced by the perspective projection of moving objects, two views that represent the same three-dimensional object before and after a slight movement should inevitably be considered ecologically transformable (this criterion is used in Warren (1977), e.g., in Figures 1h and 1i). Figures 1a and 1b show that the triangle-square pair meets the above requirement, hence the transition from one stimulus to the other is a valid "ecological transformation." The two figures depict two perspective views of the same three-dimensional object (a side view of this object is given in Figure 1c). The transition from Figure 1a to Figure 1b is caused by a rotation of the object by 5 deg about its vertical axis, accompanied by some translation in depth. Therefore, there is no reasonable criterion which accepts Figures 1h and 1i in Warren (1977) as transformable but renders Figure 1j nontransformable.

Two properties of the above example are worth mentioning. (1) A solid tetrahedron can replace the wireframe object in the example, in which case the projections will be filled triangle and square instead of the outlined ones. (2) By varying the object, the rotation required for the transition from Figure 1a to Figure 1b can be made arbitrarily small. For example, an object can be constructed such that a rotation by less than 1 deg will suffice to transform the triangle into a square. A final note: Figure 1b actually shows the two views at once: note the triangular shadow of the square figure.

I thank Kent Stevens for photographing the object.

Figure 1. Three perspective views of the same three-dimensional object, (a) the object viewed from 0 deg ("head on"), (b) the object viewed following a rotation by 5 deg about its vertical axis, (c) the object viewed following a rotation of about 90 deg ("side view").

The same transformability relation holds for the hexagon-triangle pair in Warren (1977), Figure 1k. An object does exist such that the two shapes are perspective views thereof, separated by a small movement of the object.

The distinction between valid and invalid ecological transformation was further attempted in Warren (1977) by contrasting a square changing into a trapezoid with a square changing into a rectangle. It was argued that only the first transformation is "ecologically valid," since a tilted rectangle really exhibits both horizontal contraction and line convergence (p. 267). But, since the square in the experiment extended only 0.5 deg of visual angle, the line convergence produced by the tilt is negligible: one side of the resulting trapezoid is shorter than the other by only *less than 1%*.¹ That is equivalent to a trapezoid with a long side of 10 mm and a short side of 9.9 mm viewed from a distance of about 100 cm. Such a "trapezoid" is certainly perceptually indistinguishable from a rectangle. A square-rectangle pair is actually a valid transformation of a small planar square in rotation, while the square-trapezoid used in Warren (1977) is not.

In conclusion, the classification of the stimuli in the experiment cannot be justified on the basis of their transformability, hence an explanation for the difference found between them has to be sought elsewhere.

A second comment concerns the generality of the reported findings. Apparent motion displays are influenced by several variables, among which are the stimuli shape and the timing parameters. It was

claimed that keeping the timing parameters constant (60-msec presentation time, 60-msec ISI) enabled the direct measurement of the shape influence alone. But this experimental procedure does not guarantee consistent results. It is perfectly conceivable that when two stimuli-pairs are compared, one will be judged as higher along a given scale using one set of timing parameters, but lower using another. This *is*, in fact, the case both for smoothness of motion ratings and for likelihood of perceived motion [for examples, see Kolers (1972), Figures 3.1 and 3.4]. Consequently, no general statement can be reliably made on the basis of a single set of timing parameters.

In summary: The perceptual identity of stimuli in apparent motion cannot be accounted for in terms of shape transformability. Whether or not identity can be predicted on the basis of shape alone, independent of timing characteristics, cannot be concluded without further experimentation.

REFERENCES

- KOLERS, P. A. *Aspects of motion perception*. Oxford: Pergamon, 1972.
 WARREN, H. W. Visual information for object identity in apparent movement. *Perception & Psychophysics*, 1977, **21**, 264-268.

NOTE

1. This holds true regardless of the original orientation of the viewed surface.

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