Letter

Action beyond our grasp

In his recent paper, Carey reviews a broad range of experiments on how illusions influence grasping[1]. Most studies report that illusions affect the perception of size more than they affect the maximum grip aperture. On the basis of this, Carey claims that most of the experimental evidence is in line with the two-visual-systems model of Milner and Goodale[2]. The underlying assumption is that grip aperture is based on a *visual* estimate of the object's size.

We have questioned whether the consistently observed linear relationship between object size and grip aperture signifies that a visual estimate of object *size* is used to control the aperture of the hand in grasping[3]. In our view, the information that is used is a perceptual estimate of two positions on the objects' surface. According to this view, a critical experimental test for the two-visual-systems hypothesis in grasping is a comparison of the illusory effects on grip scaling with the effects on perceived *positions*. As far as we know, this has never been studied. A second possibility is to compare perceptual size estimation with motor tasks that must use size, such as lifting the object. This has been done, and in line with our expectations, the illusion does affect the forces used to grip[4] and lift[5] the object in such experiments.

The above might seem only a matter of terminology, because the size of an object is physically indistinguishable from the difference between the two positions on its surface. However, the brain uses different information processing to obtain such physically related spatial attributes[6]. The representations of such attributes are therefore not necessarily consistent with each other. Our claim is that many illusions induce such inconsistencies, affecting one spatial attribute (e.g. object size) without affecting physically related ones (e.g. positions on the object's surface). Such inconsistencies can be found between various other pairs of attributes of spatial perception (e.g. velocity and position[7]).

We illustrate our argument with an example of a size illusion. In Fig. 1, the vertical lines and the points of the arrows appear to be exactly aligned (which they are). The central vertical line in (b) appears to divide the horizontal line in two equal parts (which it does). Nevertheless, the central arrow in (a) seems to bisect the upper horizontal line in two unequal parts (which it doesn't). Thus, the arrows influence the perceived extent of the two upper line segments, without influencing the perceived positions of their end-points relative to positions on the lower line[8].

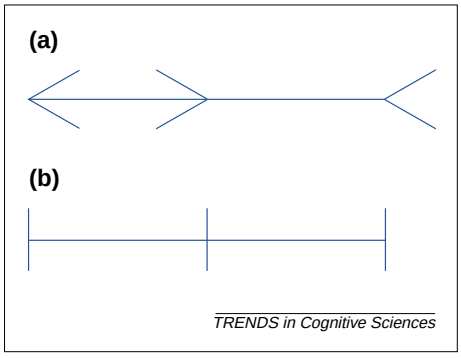

Fig. 1. The Brentano version of the Müller–Lyer illusion is an example of the inconsistent perception of physically related spatial attributes such as extent and positions. The alignment of the points of the arrows in (a) with the vertical lines in (b) is based on the perceived positions of the line intersections, whereas the bisection of the horizontal lines is based on the perceived extent of the line segments.

Which of the physically related attributes is used in a task depends on which attribute gives the most direct (and thus reliable) information for performing (the relevant aspect of) the task, independent of whether the task can be classified as an action or not. In the above example, the extent of the two line segments is used for the bisecting tasks, but the alignment is based on the relative positions of two intersections. Both of these attributes are relative (allocentric) measures. Our argument is therefore more general than the distinction between 'absolute' and 'relative', made by Vishton *et al.*[9]

Still limiting ourselves to the Müller–Lyer illusion, we can explain the results of various pointing studies. When making pointing movements between the end-points of the illusion, subjects could use either position or extent to plan their movement. If they fixate the target position, they have more direct information on the (egocentric) location of the target than if they fixate the initial position. So, we should expect the illusion to have less effect in the former case, which indeed has been found[10]. For pointing movements that start outside the Müller–Lyer figure, information about extent is irrelevant for the task if the target position is fixated. According to our reasoning, such movements should be totally immune to the illusion, which, again, is what has been reported[8].

If one realizes that various attributes of space are not necessarily represented in a consistent way, one can interpret many other experiments on illusions without the need to assume that perception and action are differentially susceptible to visual illusions. Whether an illusion affects (aspects of) the execution of a task does not depend on whether the task is perceptual or motor, but on which spatial attributes are used in (those aspects of) the task.

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