

Gestalts of thought*

Barbara Tversky

Perceptual organizing principles: Grouping

Gestalt psychology is by now a given, recognized by the public at large, accepted by the scientific community, immortalized in dictionaries as “the whole is more than the sum of the parts.” The Gestalt approach developed to describe certain compelling phenomena of the experience of perception that are not easily explained by qualities of the stimuli nor of the internal processing of them. Most prominent among them is grouping. The mind groups visual objects, on almost any basis it can find, by similarity of shape, of color, of size, of angle, or if the objects are uniform, by proximity. The penchant for grouping is so strong that the mind groups and regroups fields of uniform objects. That is, the mind finds groupings even when there is no perceptual basis for them, to the delight of artists and their audiences. It is not only visual objects that get grouped; sound objects are also grouped, as an essential component of auditory scene analysis and appreciation of music (Bregman 1990). Grouping occurs not just in perception, but also in action; problem solvers use gestures to organize imaginary individuals into imaginary groups (Kessell & Tversky 2005).

Grouping, and other perceptual organizing principles, are processes applied to stimuli in the world. But what about stimuli in the mind, mental objects? Many mental processes, notably, mental rotation, seem to derive from perceptual ones (e. g., Shepard & Podgorny 1978). If the processes occur in the mind, then the objects on which they act can also be mental objects, rather than objects in the world (Finke, Pinker, & Farah 1989). So it is not unreasonable to propose that grouping and other perceptual organizing principles are general processes of the mind, not limited to perception.

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Why Group?

Why does the mind group? The most obvious answer is that the mind groups to simplify. The world is nothing if not complex. Grouping objects, putting them in distinct piles, frees the mind to attend to a smaller number of things rather than to each individual. Grouping reduces the number of things that need to be kept in mind. The mind treats the individuals of a group as equivalent, and different from the individuals of other groups. But what of the groups? The mind seems to go yet another step, to assume that groups based on one feature, often a perceptually salient one, share other features, features that may not be perceptual at all. Grouping is effective on one condition: that the feature or features that link the groups do more than that, they also predict or correlate with other features. Perhaps this is part of what is meant by “the whole is greater than the sum of the parts.”

These claims – that grouping is a general mental process and that grouping by one feature is used to predict other, correlated features – need support. To do that, we first consider another enduring contribution of the Gestalt tradition, the study of perceptual illusions.

Errors as clues

From the Gestaltists, psychologists learned that insight into normal perception could come from the study of perception seemingly gone wrong, from compelling and systematic errors of perception. Visual illusions, systematic errors, constrain theories. They also serve as visual jokes, and provide captivating coffee table books. Unlike magic, perceptual errors occur for the simplest stimuli and the simplest judgments. The same line is perceived as longer when oriented vertically than when oriented horizontally, the Top Hat illusion. The same line is perceived as longer when bounded by inward pointing arrowheads than when bounded by outward pointing arrowheads. An oblique straight line looks crooked when interrupted by two parallel vertical lines. Now for grouping, and its’ implications: Two dots that form part of the contour of the same figure are judged closer than two dots, actually closer, that form parts of contours of separate figures (Coren & Girgus 1980). This example also demonstrates the inferences the mind makes about grouped objects, that individuals within the same group are relatively closer than individuals in different groups. Localizing these errors at a specific level of information processing has proved impossible. Surprisingly, the same errors seem to occur at many levels of information processing (Coren & Girgus 1978).

The robustness and ubiquity of perceptual organizing principles suggest that they serve perception. One presumed function of perceptual organization is the establishment of figures, collections of parts that are integral, form wholes. The

test of a whole is another Gestalt organizing principle, common fate. The parts that form an integral whole move together, as a unit (cf. Spelke, Vishton, & von Hofsten 1995). Thus one part predicts another. This is the added value of grouping, one feature predicts another. Might the same organization principles occur in memory, on mental objects? And might the same added value, predictability, result?

Grouping of remembered objects

Telling examples of grouping in memory come from research on cognitive maps (for reviews, see Tversky 1992, 1993, 2005a, 2005b). In a typical study, students are asked to make judgments about directions or distances between pairs of cities. When students in San Diego were asked to indicate the direction between San Diego, California and Reno, Nevada, most incorrectly indicated that Reno was east of San Diego (Stevens & Coupe 1978). Despite the fact that Reno is in Nevada and San Diego in California, neighboring states, Reno is in fact west of San Diego. The likely reason for this error is grouping. Instead of remembering the spatial relations among all cities, people remember the spatial relations among states. They group cities into states, and infer the directions of cities from the locations of states. Since California is generally west of Nevada, people incorrectly make the inference that San Diego, CA is west of Reno, NV.

Other studies suggest that people remember the relative locations of groups as more aligned than they actually are. When asked to judge the direction between Philadelphia and Rome, people incorrectly report that Philadelphia is north of Rome (Tversky 1981). The most likely cause of this error is also grouping. People mentally group the United States with Europe, and remember that Europe and the US are more directionally aligned, even though much of Europe is north of the US, more aligned with Canada, an error termed *alignment*. Although weather may be part of the error, it cannot be entirely responsible as the same grouping or alignment error occurs for North-South directions, where climate is not a factor. People group North and South America, that is, they think that South America is more directly south of North America than it actually is. Thus, they incorrectly report that Boston is east of Rio de Janeiro, when Rio is considerably east of Boston. These effects of perceptual grouping are evident in memory of artificial maps and of blobs, showing that they are broader than geography. Perceptual grouping is also apparent in judgments from perception as well as from memory. Grouping leads most participants to prefer incorrect maps of the world that have been altered in the direction of grouping to correct maps (Tversky 1981). People select a world map in which Europe and Africa have been moved south to be grouped with North and South America to the correct map; they also prefer a map in which

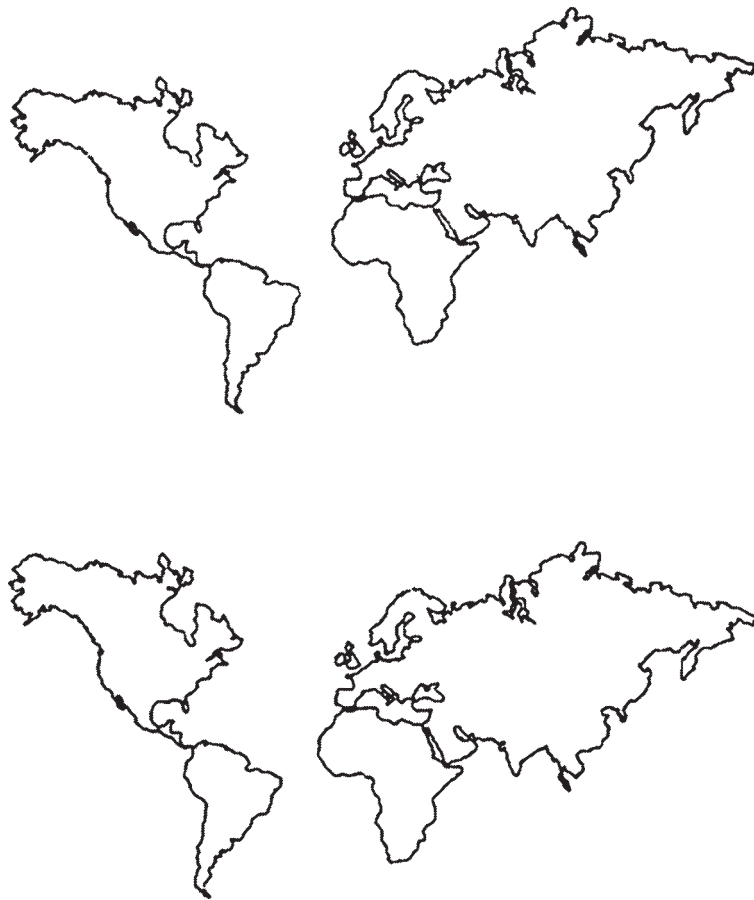


Figure 1. A significant majority of respondents incorrectly chose the lower map over the upper map. In the lower map, the Western hemisphere has been raised relative to the rest of the world so that the United States is more aligned with Europe and South America with Africa (after Tversky 1981).

South America has been brought westward so that it is more grouped with North America to the correct map (Tversky 1981).

Grouping is revealed in times to make spatial judgments as well as errors of judgments of direction. People are faster to judge which of a pair of cities is farther east or farther north when the cities are located in different states or countries than when they are in the same state or country, even if farther (Maki 1981; Wilton 1979).

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Grouping by abstract features

These results and others like them establish that grouping can occur for remembered objects just as it occurs for perceived objects. The mind goes yet another step. The mind can create objects it has never perceived, and organize them. What's more, the mind can group imagined objects by conceptual features as well as perceptual ones. Again, the literature on distortions in cognitive maps provides examples. One project had two steps: first, to establish conceptual groupings, a number of residents of Ann Arbor were given the names of a set of buildings in the city and asked to divide them into University or commercial buildings. Next, a second group of residents was asked to estimate distances between pairs of buildings. The distances between buildings in the same conceptual group were underestimated relative to the distances between buildings between conceptual groups (Hirtle & Jonides 1985).

Grouping may underlie landmark errors, in which participants judge an ordinary building to be closer to a landmark than the landmark to the ordinary building (e. g., Sadalla, Burroughs, & Staplin 1980; McNamara & Diwadkar 1997). Cognitively, landmarks define neighborhoods; for example, when asked where they live, most people answer in terms of the closest landmark that they believe

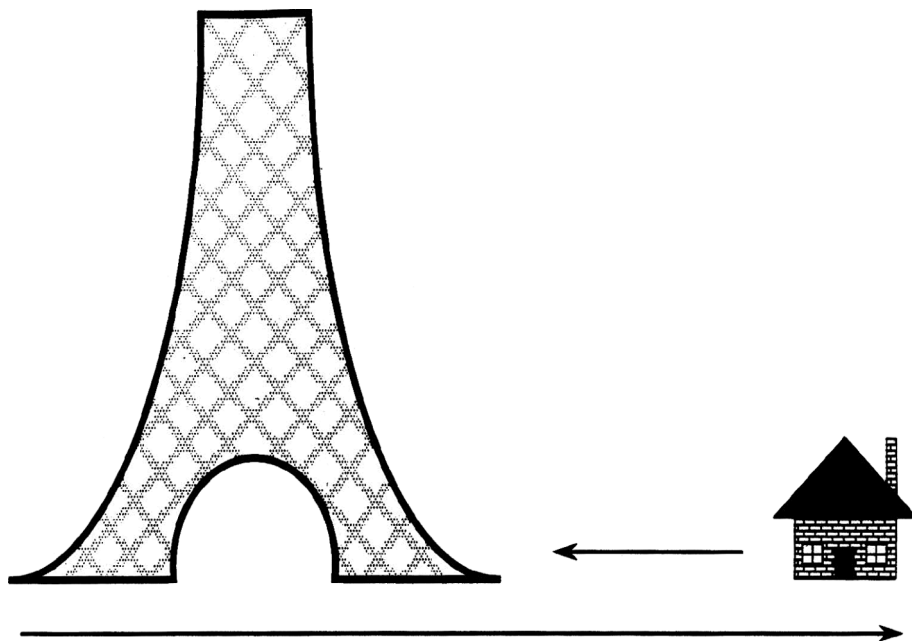


Figure 2. Landmark Effect. Respondents report that the distance from an ordinary building to a landmark is smaller than the distance from a landmark to an ordinary building.

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their questioner will know (Shanon 1983). An ordinary building does not define a neighborhood. Thus, when asked the distance from Jacques' house to the Eiffel tower, respondents will group Jacques' house with the Eiffel Tower, in the same neighborhood. However, when asked how far the Eiffel Tower is from Jacques' house, respondents will not group the Eiffel Tower with Jacques' house; they will be in two separate groups, hence perceived to be farther than if they were in the same group. More broadly, landmarks, like prototypes, define or stand for categories (A. Tversky & Gati 1978); ordinary instances just stand for themselves.

Common fate as grouping

Viewed abstractly, common fate can be seen as a corollary of grouping. An entity can be grouped with a large enclosing entity, a reference frame. Once separate things are grouped, they are seen as behaving together, for example, moving together or sharing a common orientation. Common fate biases can also be found in memory as well as perception. Objects induce their own frames of reference. The axis of elongation is viewed as a primary axis and the axis perpendicular to it as a secondary axis, forming an object-centered reference frame. When the reference frame of an object is not aligned with the reference frame of the surround, the two frames of reference are remembered as more closely aligned than they actually

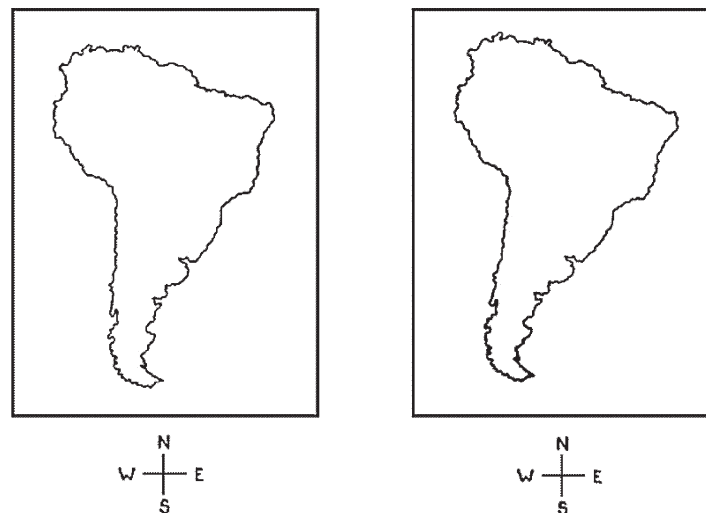


Figure 3. Respondents were asked to place a cutout of South America in a frame. They oriented South America more upright, as in the left-hand part of the figure, than it actually is, as in the right-hand part of the figure (after Tversky 1981).

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are, an error termed *rotation* (Tversky 1981). This kind of biased reasoning leads students to upright South America when asked to place it in a NS-EW reference frame. It also leads them to report that Berkeley is east of Stanford when it is west of Stanford, because the Bay Area does not run as north-south as many think. As for alignment, rotation errors occur for artificial maps and cities as well as actual ones, and for memory for blobs as well as geographic entities, implying that it is a general bias.

Grouping in abstract domains

It's time to review. We began with a key contribution of Gestalt psychology, that phenomenologically, perception is organized in ways that cannot be reduced to properties of sensations. Primary among the organization processes is grouping, forming clusters of individuals based on similarity, proximity or other properties. We then speculated that the function of grouping was to simplify, to reduce the number of things that need attention. But to be useful, the grouping needs to be meaningful, that is, the groups need to share properties other than those on which the grouping was based. The mind goes, as Bruner put it, "beyond the information given" (Bruner 1957). Whether or not the groups share other properties, the mind seems to make that leap for perception and memory, or that is what the data reviewed suggest. That inference is what seems to underlie "the whole is greater than the parts."

Levels of gestalt phenomena: From perception to imagination

Phenomenological experience, like perception, occurs at many levels; at each level, experience is related to information given, though it is not reducible to it, ideas developed more fully by Albertazzi (2004). We may perceive amorphous figures on paper as blobs and phenomenologically experience the blobs as grouped. At another level, we interpret the blobs as countries on a map, and phenomenologically experience them as grouped. At yet another level, we retrieve the countries in memory, and experience them as grouped again. These observations about perception hold also for abstract domains (nor are they new, e.g., Bruner 1957; Rosch 1978). The mind can do the same entirely in memory and entirely on abstract concepts. The mind can form groups that never actually appeared together, and form them on abstract features, for example, the scattered members of a political party or a religion or a generation. Although the groupings may be suggested by the features of the stimuli, the mind goes beyond, inferring more features shared within groups and differing between groups. People perceive members of the same group,

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social or political, to be more similar than members of different groups, even on attributes not used to form the groups (e.g., Quattrone 1986). At each level, new groupings, new organizations, can emerge. These seemingly inevitable groupings the mind imposes inevitably both allow inferences and entail error; the mind leaps to assume that groups share more features than those that establish the groups and in so doing, the mind ignores differences within groups and exaggerates those between.

Note

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