



**Figure 5.11** Most of the preattentive examples given here can be accounted for by the processing characteristics of neurons in the primary visual cortex.

mark on a map as being of type A, it should be differentiated from all other marks in a preattentive way. There have been literally hundreds of experiments to test whether various kinds of features are processed preattentively. Figure 5.11 illustrates a few of the results. Orientation, size, basic shape, convexity, concavity, and an added box around an object are all preattentively processed. However, the junction of two lines is not preattentively processed; neither is the parallelism of pairs of lines, so it is more difficult to find the targets in the last two boxes in Figure 5.11.

The features that are preattentively processed can be organized into a number of categories based on form, color, motion, and spatial position.

- Line orientation
- Line length
- Line width

- Size
- Curvature
- Spatial grouping
- Blur
- Added marks
- Numerosity (one, two, or three objects)
- Color
  - Intensity
- Hue
  - Intensity
- Motion
  - Flicker
  - Direction of motion
- Spatial position
  - Two-dimensional position
  - Stereoscopic depth
- Convex/concave shape from shading

Originally, studying preattentive features was thought to be a way of measuring the primitives of early visual processing (Treisman & Gormican, 1988). The list given above, however, is considerably longer than the one that resulted from neuropsychological studies. Still, in most of these instances, the target is different from the surrounding nontargets in terms of the basic channels introduced earlier (color, size, contrast, orientation).

There is a risk of misinterpreting the findings of psychophysical studies and proposing a new kind of detector for every distinct shape. To take a single example, curved lines can be preattentively distinguished from straight lines. Despite this, it may be a mistake to think that there are curved line detectors in early vision. It may simply be the case that cells responsive to long, straight-line segments will not be strongly excited by the curved lines. Of course, it may actually be that early vision curvature detectors do exist; it is just that the evidence must be carefully weighed. It is not a good idea to propose a new class of detector for everything that exhibits the popout effect. The scientific principle of finding the most parsimonious explanation, known as Occam's razor, applies here.

It is also important to note that not all preattentive effects are equally strong. There are degrees of popout. In general the strongest effects are based on color, orientation, size,