# •3• *How objects form groups*

## Objects and groups

In the lighting and heating control panels shown in Figure 1.8, objects were grouped explicitly, with boxes. Objects can also be grouped according to their appearance or spatial arrangement. Figure 3.1 shows a similar panel that has no explicit grouping cues. As you can see, though, the names and buttons still do form groups, even though there are no boxes. This means that when you are designing an interface, you cannot simply avoid the question of grouping objects, because if you don't try to design grouping into the interface, the user's perceptual processes will still try to impose a structure on the display - and it might not be the structure you want. In Figure 3.1, the room names and the buttons form vertical groups, similar in structure to the Heating panel. As we saw in Section 1, this might be good for turning all of the ventilation on or off, but not for controlling specific rooms.

The structure of the object representation that isn't explicitly there in the visual information is being added by the visual-to-object transformation, as described in section 2. In this section we will look at some of the principles that affect the way that this transformation process operates to create implicit structure. Many of these principles have been known for a long time, and you might know of them as 'Gestalt' rules.

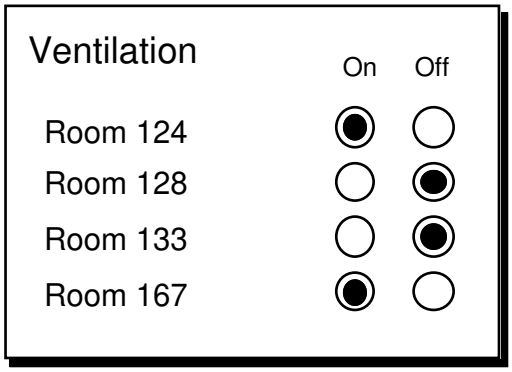



Fig 3.1: a control panel similar to the 'light' and 'heating' panels, but without explicit grouping cues

Figure 3.2 shows how four triangles can be grouped in different ways due to:

- proximity (being very near to each other)
- sharing a colour
- sharing a boundary
- sharing a junction.
- collocation (being superimposed or intersecting)

These are 'physical' relationships that can be derived from the visual information, and in some cases the groups that result appear more 'obvious' than the original triangles.

Visual information can affect the way that objects form groups

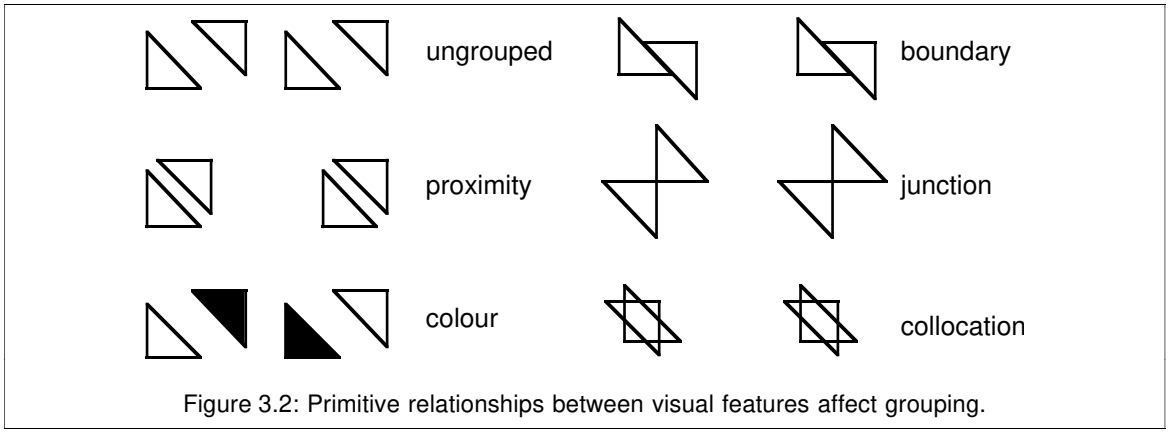
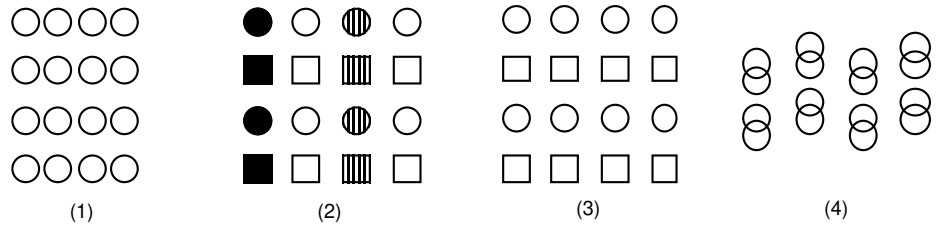



Figure 3.2: Primitive relationships between visual features affect grouping.

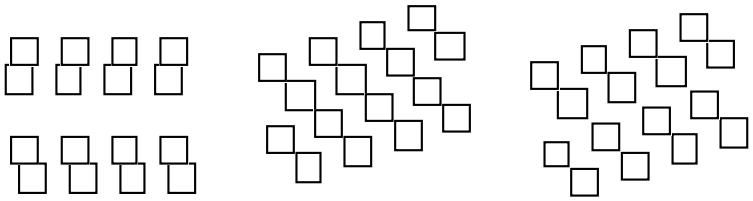
If you had to describe the 'junction' or 'collocation' parts of this figure, without having seen the rest of it, you would probably not make any mention of triangles. Instead of calling the junction group 'two triangles joined at one corner', you might call it 'an hour-glass' or 'a bow-tie'; and you might call the collocation group 'a six-pointed star, slanting backwards'. In both of these instances, you are describing the 'group' that is composed of the two triangles, and not the triangles themselves. We can take this point further still, because even in the 'ungrouped' instance, we perceive 'triangles', and not individual horizontal, vertical and oblique lines. In terms of the basic processes of visual perception, it is even arguable that we actually 'see' lines as 'end-points', 'corners' and 'middles' – but while this may be what we 'see' in our visual representations, it is clearly not what we 'perceive' with our object representations.

## Exercise Set 1

Draw structure diagrams for these sets of objects – start each with a group called 'set' at the top level of the structure and use up to four levels. Describe the visual attribute that 'causes' each group.



(1) (2) (3) (4)



(5) (6) (7)

## Psychological Subjects pop-out

One way to approach the problem of deciding when objects form groups and when they don't is to consider the phenomenon of 'pop-out'. This happens when there are several objects forming a group, and one object that doesn't join the group. In Figure 3.3, for example, there are three groups of circles. If you just look at the left hand group, all of the circles are exactly the same, and none of them stand out any more than the others. Because of their 'proximity', they are all members of the same group, and if we were to draw a structure diagram, each circle would be represented at the same 'level' of the structure as the others (shown in the left hand part of Figure 3.4).

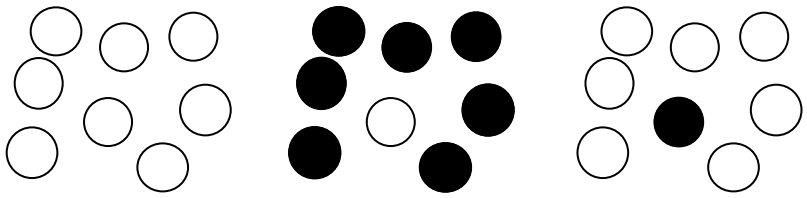


Figure 3.3: pop-out of the psychological subject

The central and right hand groups are different. In these groups all of the circles are the same size, but one of them is a different colour. You have no difficulty in noticing which one it is, because it seems to 'pop-out' from the others – and the structure diagrams for these two groups, shown in the central and right hand parts of Figure 3.4, represent this.

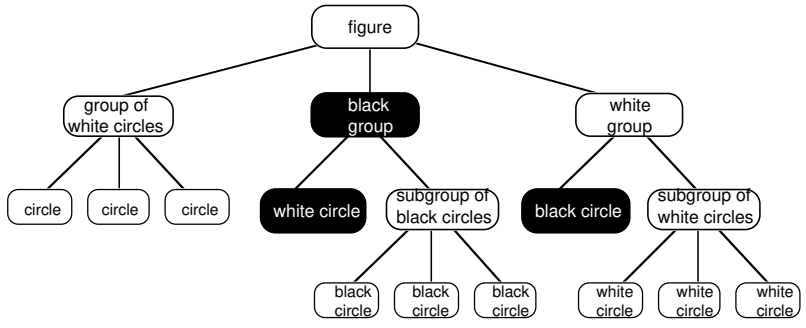



Figure 3.4: structure diagrams of Figure 3.3

The circles that share the same colour all form a subgroup, to which the different circle does not belong. Both the subgroup of similar circles and the different circle are part of a larger group, and so we see them as related, but when we focus on the whole group to see the objects that it is made up of, we perceive the single circle and the group of circles.

Objects that are spatially close to a group, but not part of it, seem to '**pop-out**'

If we drew a transition path diagram for someone viewing the central group, we would show them attending to the Figure as a whole, with the central group as their psychological subject. This would be followed by a transition to its structure that made the white circle the psychological subject, and the subgroup of black circles its predicate. In this case, the effect of pop-out is so strong that it almost forces the viewer to make the white circle the subject as soon as they attend to the structure of the central group. Even if the viewer wants to look at one of the black circles, they have to attend momentarily to the white circle, and then make additional transitions to the subgroup, and then into its structure to find a black circle. It doesn't matter whether the odd-one-out is black or white: as long as it is different, it becomes the psychological subject and pops-out, simply *because* it is different. As with the triangles in Figure 3.2, there is nothing in the sensory information that explicitly tells us that the black circles in the central part of Figure 3.3 all form a group, to which the white circle does not belong. At a visual level, they are all just areas of varying colour. The structural information that relates them together as members or non-members of groups is added by the process that transforms the visual representation into an object representation.

If four of the circles in a group were black and four were white, then there would be two equally sized subgroups and neither would pop-out. If there were subgroups of five and three circles, the effect would not be as strong, but it is likely that the smaller subgroup would form the psychological subject, and the larger group would be its predicate. The visual-to-object transformation 'favours' the part of the visual scene that is different, and produces representations organised with them as the psychological subject.

In Figure 3.4 we have drawn the 'different' circle in each group in white text on a black background, to show that it pops-out. At the level above, we have indicated that the 'black' group pops-out in the same way, because it is different in 'colour' to the other two groups. When you look at the 'whole figure', the black group pops-out; but once you have attended to it, its white circle pops-out. Of course, it isn't just colour that can make things different to their neighbours. Figure 3.5 shows that pop-out can also happen for shapes.

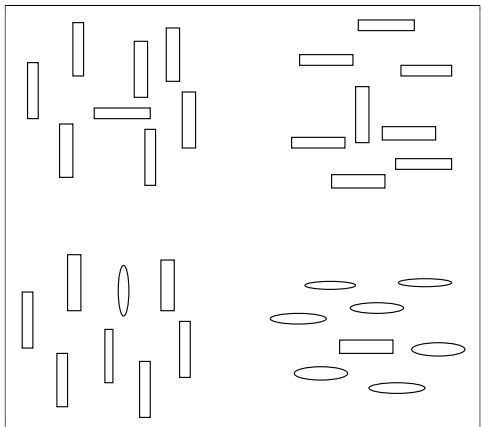


Figure 3.5: pop-out of shapes

Again, it doesn't matter why the shape is 'different'. You might say that the oblongs are all the same, and have just been rotated, but this is enough to make them different in the visual representation. As long as a shape is different, the visual-to-object transformation picks it out as the psychological subject, and the other objects form a group that becomes its predicate. If you think about looking for objects in the real world, this bias of perception makes sense: more often than not we are searching for objects against a background, looking for one particular object that is different to the rest of the scene. Whether it is a ripe red apple in a tree of green leaves and green apples, or an icon on a computer screen, it often has some visual feature that makes it stand out from the background.

The **pragmatic subject** is the object that will become the psychological subject when the structure of its group attended to, because of its visual features..

While higher mental processes could spend time and energy making transitions through a representation to locate the correct object, it is generally economical for the visual-to-object transformation to pick up the implicit information from the sensory data and to make the odd-one-out the one that gets attended to first. We make use of this tendency in the transition path diagrams, by drawing the psychological subject against a black background: it immediately pops-out from the diagram and orients you to the part of the Figure we are likely to be describing. We have also been using this convention in the structure diagrams, to indicate an object that pops-out to become the psychological subject. Unlike the transition path diagrams, which indicate the object that actually is the psychological subject at any moment, the structure diagrams aren't showing 'processing', but just the structure. The objects that pop-out aren't always psychological subjects, but will be if their level is attended to. To distinguish these 'potential' psychological subjects from 'actual' psychological subjects, we'll use the term 'pragmatic subject' – this means that the object can be expected to become the psychological subject for pragmatic reasons.

## Exercise Set 2

1. Draw transition path diagrams for Figure 3.3, showing the transitions that are needed to look at a white circle in each subgroup (you can base them on the structure diagrams from Figure 3.4).
2. Draw a structure diagram for Figure 3.5, indicating which object forms the pragmatic subject of each group.
3. Using this structure diagram, make transition path diagrams to show how a 'horizontal oblong' would be located in the first, second and fourth group (there isn't a horizontal oblong in the third group!)

## Pop-out of groups

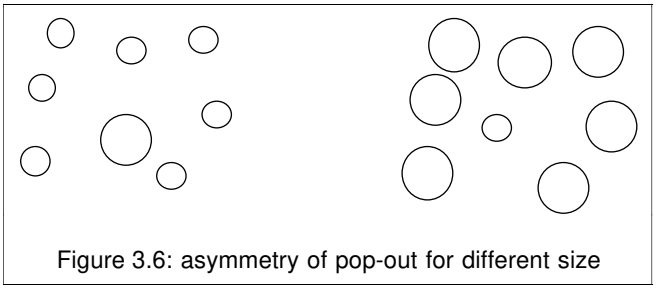


Figure 3.6: asymmetry of pop-out for different size

Colour and orientation aren't the only sensory cues that the visual-to-object transformation can use to pick out part of a scene as a pragmatic subject. Other attributes can also be used – but in a different way. In the two arrays in Figure 3.6, the size of the circles is varied.

Although it is still easy to find the small circle among the big ones, it is not quite as easy as finding the big circle amongst the small ones. The big circle amongst the little circles is the pragmatic subject of its array, but the group of big circles is the pragmatic subject of the other array (Figure 3.7). To make the small circle the psychological subject, a transition from the group is needed. While colour and orientation were symmetrical (black and white being equally able to pop-out) and it was an object's 'difference' that was the cue, here the attribute is 'asymmetrical', and the visual-to-object transformation always favours the larger-sized objects.

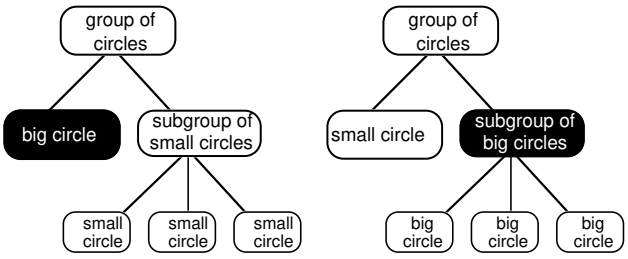



Figure 3.7: structure diagrams for Figure 3.6

The same asymmetry can be seen with the length of lines in Figure 3.8. The reason for this asymmetry is that the size of a visual object is related to its closeness to us – in general, the larger an item is, the nearer it is. The visual-to-object transformation is now choosing the closer object as more likely to be of interest, and so makes it the pragmatic subject. Again, this seems to make sense in terms of the real world: if you are in a tree picking apples, the ones that are visually larger are more likely to be within reach than the ones that are visually smaller. The same rule of thumb applies to contrast and brightness, since as things get closer to us they reflect more light, and are less obscured by anything that is in the air.

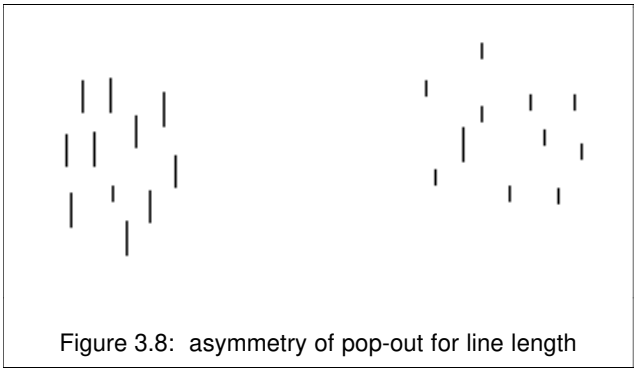


Figure 3.8: asymmetry of pop-out for line length

In many situations computer interface designs can take advantage of this bias towards difference and nearness. Like the white-on-black convention that we have adopted for representing the psychological and pragmatic subject, words and icons that are 'selected' usually become highlighted in some way, partly to provide feedback about the selection, but also to make sure that the user is actually attending to the part of the display that they have acted on.

Objects or groups that are larger or brighter appear **nearer** and can be pragmatic subjects.

Options on menus and in dialogues that are unavailable are shown 'greyed out' by reducing their contrast – this indicates their unavailability, and also makes them less likely to be attended to, since they will no longer form part of the group that is the psychological subject when the menu or dialogue is viewed. In Figure 3.9, for example, a set of commands that operate on Tables in a word-processor are greyed out when the user has selected an ordinary paragraph of text – the

other paragraph formatting commands are still black, and so they form a pragmatic subject that immediately grabs the user's attention.

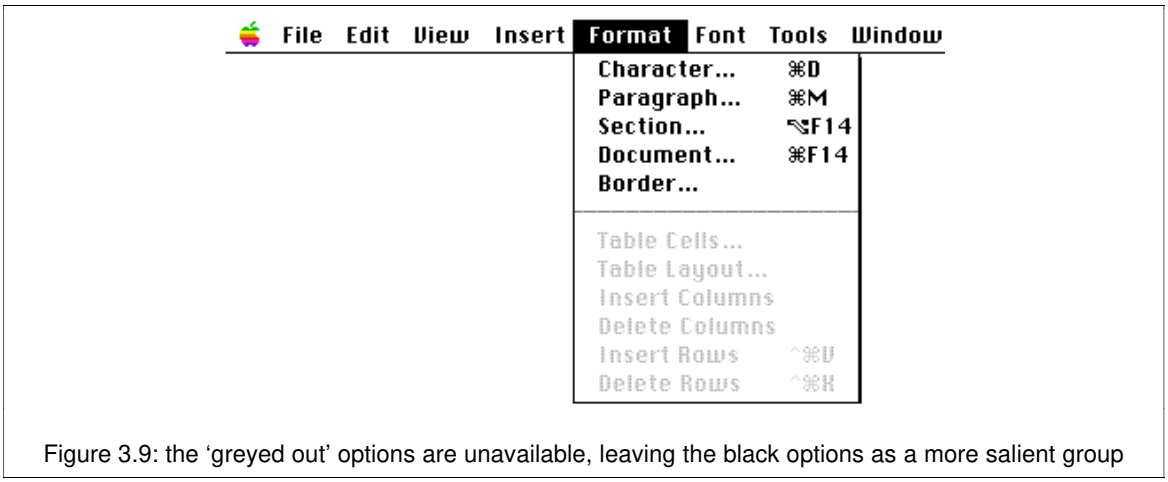



Figure 3.9: the 'greyed out' options are unavailable, leaving the black options as a more salient group

Use of these attributes can also help people to discriminate objects by guiding their attention to the part of its structure that distinguishes it from other objects. Figure 3.10 contains an array of four abstract icons, each of which is made of a diagonal cross and an upright cross. In (a) both crosses are shown by lightly dashed lines, but in the others one of the crosses is drawn as a bold, solid outline. Looking at each icon in turn it is clear that these changes affect the way that they are interpreted.

The icon (a) could be seen as two dashed crosses superimposed on one another at an angle, as four dashed lines, or as an eight pointed star. To its right, icon (b) has one dashed cross and one solid diagonal cross – the size of this cross makes it more salient, as it forms the pragmatic subject and the dashed upright cross becomes its predicate. The next icon, (c) has the same visual structure, but has been turned through 45°. This change in orientation is sufficient to render this solid, upright cross as an object that is different to the solid, diagonal cross of (b). Finally icon (d) has a large black diagonal cross – again the size of the diagonal cross makes it the pragmatic subject of this icon, but its colour also makes the icon that it belongs to likely to form the pragmatic subject of the whole array.

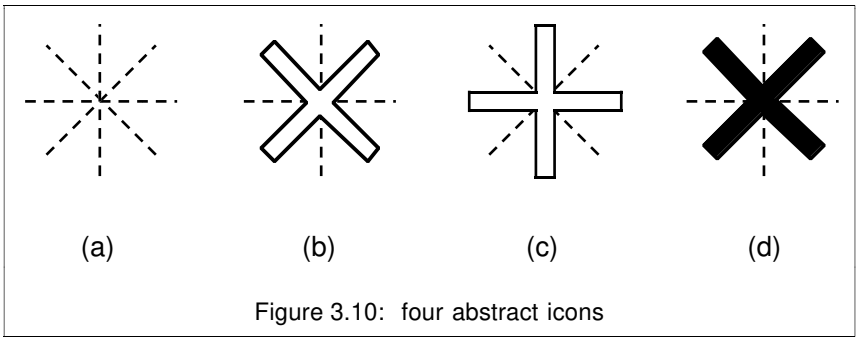



Figure 3.10: four abstract icons

If this array is attended to, it is probable that (d) may be the pragmatic subject, as its black solid cross is both 'nearer' than the thinner dashed crosses and 'different' to the solid, white crosses. The nature of the group of crosses that is icon (d) is defined predominantly by the nature of its pragmatic subject – because if it is looked at, the pragmatic subject is the first part of its structure that will be attended to.

The 'appearance' of an object is determined by its pragmatic subject

## Exercise Set 3

1. Draw transition path diagrams for the location of a big circle and a small circle in each part of Figure 3.6.
2. Draw structure diagrams for both parts of Figure 3.8, and transition path diagrams for the location of a small and a large line in each part.
3. Draw structure diagrams for each of the icons in Figure 3.10.
4. Draw transition path diagrams for Figure 3.10, showing the transitions necessary to attend to the diagonal crosses of each icon. Which cross is hardest to attend to?