

# Gestalt-induced disappearances of visual objects

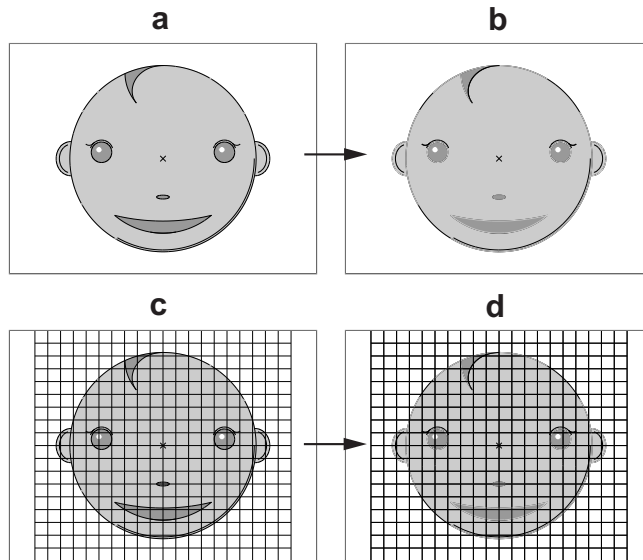
Masataka SUZUKI

## Abstract

Illusions serve as a powerful window into neuroscience, and have pointed towards new experimental techniques. Here, I introduce a set of new optical illusions, in all of which partial deletions of the visual object lead to an immediate disappearance of its whole. Critically, the stimuli were elaborated to violate Gestalt principles for *grouping or figure and (-) ground segregation* embedded in the original images, suggesting that various disappearance phenomena are common evidence showing that the object is perceptually organized as one undecomposable, higher-ordered unit in the visual system.

The first visual target was a human baby's face (**Fig. 1a**), in which many facial objects were represented to involve Gestalt principles of *grouping* (i.e., *closure*, *good continuation*, and *parallelism*)<sup>1,2</sup> or *figure-ground segregation*<sup>2</sup> in their geometry. During fixation on a central cross, a set of line segments composing each object was partially erased simultaneously (**Fig. 1b**) (**Demonstration 1**, <http://www.kinjo-u.ac.jp/mszk-demo/>). Then, the observers reported the first impressions of the residual image (**Methods**). Surprisingly, they reported that the residual image almost disappeared immediately after the partial erasure and then reappeared a few seconds later. The same tests were repeated when a grid was superimposed on the face (**Fig. 1c, d**) (**Demonstration 2**). Similarly, the face disappeared immediately after the partial erasure, leaving the visibility of grid lines intact, suggesting the selective disappearance of all objects composing the face. The reasons are considered in terms of the simultaneous violation of Gestalt principles embedded in the geometry of facial objects as follows.

The face contour is depicted as a circle, composed of six curved line segments with six intermittent missing parts (**Fig. 1a**). Erasure of three line segments led to an instantaneous disappearance of not only the remaining three line segments but also of the surface enclosed, which was filled-in with a background surface (**Fig. 1b**). According to the *closure* principle, these curved line segments, if each of them next to each other does have continuity, group together in order for the contour to be closed, and for the inner surface to be segregated from the background. It appears, therefore, that the partial erasure of the composite line segments made the



**Figure 1**

**Physical image of baby's face before (a, c) and after (b, d) removal of composite line segments (Demonstrations 1, 2).** (a) Original image of the baby's face. The boundary contour of the face is composed of six curved line segments, while that for the lumped hair, ears, eyes, nose, and mouth are depicted as solid line contours. Surfaces of these objects are filled with different shades of gray. Each object is composed of characteristic geometries of line segments within itself or in relationship with neighboring parts of the different objects. These are explained in terms of Gestalt principles of *grouping* and *segregation*. For details, see text. (b) Residual image after removal of line segments in the original image of a. For details, see text. (c) Original image of the baby's face with a grid. (d) Residual image after removal of line segments in the original image of c. In d, the deleted line segments are the same as those in b.

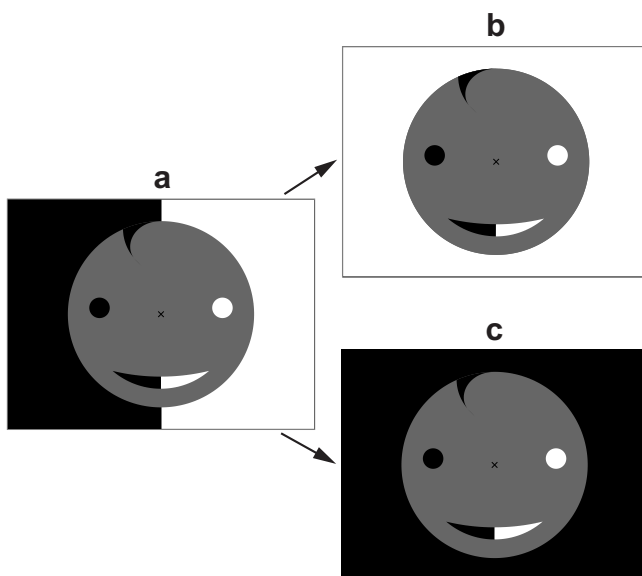
*closure* ineffective, leading to the disappearance of not only the residual line segments composing the face contour, but also the corresponding surface enclosed. The latter effect is thought of as the metaphor of a dam<sup>3</sup>. This is because, when the line contour surrounding one object is erased, the filling-in process occurs rapidly, like water gushing in through a broken dam, leading to the disappearance of the corresponding surface. Interestingly, this scheme proceeded leaving all objects *inside* of the face contour (i.e., hair, eyes, nose, and mouth) intact (**Demonstration 3**), as they had their own dams to prevent the filling-in. For all of these facial objects to disappear, therefore, their boundary contours were erased in synchrony with the erasure of the face contour (**Demonstration 4**).

In the hair near the top of the head, we see a deformed gray triangular surface surrounded by three curved line segments, one of which is a part of the face contour and the other two are inside of the face (**Fig. 1a**). In the latter, one touches the face contour continuously, while the

other one does so discontinuously. Erasure of the face line contour induced the disappearance of the former, but not of the latter, suggesting that the former was grouped together with the face contour, while the latter was independent of this grouping. This contrast reflects the *good continuation* principle, which refers to a tendency to group lines or curves that follow an established direction over those defined by sharp changes in direction. Thanks to this effect, the disappearance of the triangular surface arising due to the violation of the *closure* effect, was achieved by erasing only two line segments, one for the face line contour and the other one that abuts the face line contour (**Fig. 1b**).

In the same manner, the disappearance of an eyelid expanded to the eyelash, as expected from their continuous linkage (**Fig. 1a**). The eyelid itself was also induced to disappear by erasing the line contour of the eye. This is attributable to the violation of *parallelism*, which states that lines in parallel to each other are grouped together as one object. Accordingly, contour erasure for the eye induced the disappearance of the eyelid and eyelash (**Fig. 1b**). Other parallel line segments are seen in the relationship between the line contour of the left cheek and lower portion of the face contour, and between the two line segments forming the helix of an auricle (**Fig. 1a**). Erasure of the face line contour induced the disappearance of the line segment of the cheek (**Fig. 1b**). Also, simultaneous erasure of the face line contour and outer contour of the helix induced the disappearance of not only the inner contour of the helix, but of the surface of the auricle. The former and latter might be attributable to the violation of the *parallelism* and *closure* effects, respectively.

In Fig. 2a, we see a gray face mask (figure) on top of the ground (black and white surfaces), which is visible through the eyes, mouth, and lumped hair near the top of the head. When the black surface outside of the face contour was erased alone (**Fig. 2b**) (**Demonstration 5**), the residual black surfaces of the right eye, right half of the mouth, and lumped hair all disappeared and were filled-in with the gray surfaces, with less of an effect on the visibility of the left eye and left half of the mouth. Similarly, the erasure of the white surface outside of the face contour induced the disappearance of the left eye and left half of the mouth, leaving the visibility of other surfaces intact (**Fig. 2c**) (**Demonstration 6**). These strongly suggest context-dependency of the phenomena on how each of the black or white surfaces was perceptually grouped as one object<sup>4</sup>. In either of the black or white surfaces, the *similarity* of the colors or *closure* (or *co-linearity*) among their outer contours, including those appearing in the mouth, would lead to the grouping of corresponding surfaces as one object, a black or white rectangle. To facilitate this, the apparent presence of the figure (face mask) is negligible<sup>5</sup>, in that the contour separating the figure and ground belongs to the figure<sup>6</sup>. For example, the right vertical edges of the black surface outside of the face are abutting the top and bottom edges of the face contour, and the inside edge of the mouth is abutting the upper and lower lips. In all of these abutting regions, the contours form *T-junctions*<sup>7</sup>, which can be depth cues to interpret that the contours forming the 'roof' belong to the face mask, while those forming the 'stem' belong to the rectangular surfaces, both leading to the



**Figure 2**

**Partial erasure effect on surface view comprised of spatially separated parts (Demonstration 5, 6).** (a) Original image of overlapping surfaces. One for the gray face mask represented with the eyes, mouth, and lumped hair, while the other two both seem to be grouped as a black or white rectangle behind the face mask. It appears that parts of the rectangles are viewed through the hair, and holes representing the eyes and mouth. (b, c) Residual images when the black or white surface outside of the face contour in a is removed (changed into white or black) alone, in b or c, respectively, leaving the surface color of the lumped hair, eyes, and mouth intact.

segregation of the figure (face mask) from the ground (rectangles). Based on these informative clues, we interpret the two rectangular surfaces as being behind the face mask.

A series of demonstrations show that the partial removal of an object leads to the immediate disappearances of residual parts of the same object, suggesting that the phenomena are object-based in all cases. The residual parts (or surface) are spatially separated from the erased parts by an open space (Figs. 1) or by occlusion (Fig. 2), while their spatial relationships have characteristic properties in terms of Gestalt principles of perceptual organization, i.e., *grouping or figure-ground segregation*, respectively. In modern neuroscience, a substantial body of evidence suggests that the conscious perception of objects depends on rapid bottom-up, implicit processes which seem to follow Gestalt principles for *groupings and segregations*<sup>2,8</sup>, whilst top-down cognitive guidance based on image contexts elaborates this bottom-up sequence from its beginning to the end<sup>9-11</sup>. Once these integrative processes are completed, the objects would be perceptually organized as one undecomposable, higher-ordered perceptual unit that we are aware of<sup>12</sup>. The unitary, higher-ordered representation of the object might be the basis of disintegration, causing the

disappearance of the image as a whole<sup>13,14</sup>. A series of demonstrations are regarded as explicit evidence to show that in perceptual space, the object is organized as such that it is not the sum of its parts<sup>15</sup>.

## Methods

The visual targets were displayed on a color monitor (EIZO S2431W,  $1,920 \times 1,200$  pixels, W  $518.4 \times$  H  $324.0$  mm) driven by a DELL Workstation (T-1700), at a refresh rate of 60 Hz. In all tasks, the image consisted of a common circle, with a diameter subtending 10.5 degrees from a central fixation point. Details of all image configurations in all demonstrations are described in the text or corresponding figure caption. All aspects of the demonstration, including stimulus generation and presentation, were carried out within the MATLAB programming environment (version 7.7) using in-house software.

The observer's head was immobilized with a chinrest located 45 cm from the computer screen. The standard procedure was the same across all image conditions. After fixating on a central cross, the observer pressed a key when viewing images on the monitor. Three seconds later, some of the line segments, dots, or areas making up the object image were partially erased. Even after the erasure, the observers were asked to maintain fixation on the central cross for 3 s without blinking. After this, the observers gave verbal reports of their impressions of the residual images. During this period, the residual images were replaced with a gray surface over the screen for 3 s. This sequence was repeated multiple times, while observers reported that the disappearance phenomena were confirmed within a few trials across all image conditions.

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**Demonstrations** (<http://www.kinjo-u.ac.jp/mszk-demo/>)

### **Gestalt-induced disappearances of visual objects**

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This demo shows several kinds of phenomena of "visual disappearance" in which visual images created using Gestalt principles for *grouping and segregation* disappear as if erased in front of the observers' eyes. It is implemented to show the complete and incomplete image successively, which are presented for 3 s each. This sequence is repeated multiple times with an inter-trial resting period of 3 s. During this period, the stimulus image is replaced with a gray surface. The incompleteness means that Gestalt properties embedded in the original images are exacerbated by erasing some of their parts (see text for details). When one of the links is clicked, the demonstration will begin. The standard procedure is the same across all demonstrations. Try to fixate on a central cross when the original image is presented. Three seconds later, line segments, or areas composing the original image will be partially erased for 3 s. During both periods, maintain fixation on the same central cross without moving the eyes and blinking. Another important point is not to attend on specific parts or areas of the objects, but on the image as a whole. For improved results, head movement should be minimized, and, if possible, the head should be immobilized with a chinrest. These are very important in order to finish the task successively. When viewing images with a smaller screen than that I used (W 518.4 × H 324.0 mm), the viewing distance should be shortened.

Click here

**Demonstration 1**, baby face (**Fig.1a→1b**)

**Demonstration 2**, baby face with a grid (**Fig. 1c→1d**)

**Demonstration 3**, baby face (closure and surface, **a→b**, see below)

**Demonstration 4**, baby face (closure and surface, **a→c**, see below)

**Demonstration 5**, Figure & Ground (**Fig. 2a→2b**)

**Demonstration 6**, Figure & Ground (**Fig. 2a→2c**)

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**Demonstrations 3 & 4**

