Ernst Gombrich and the concept of 'ill-defined area': perception and filling-in[1]

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Introduction: on imagery

In *Art & Illusion: A Study in the Psychology of Pictorial Representation* (1960), Ernst Gombrich (1909–2001) formulates a series of concepts and descriptors to shed light on the ontology of images and the way viewers perceive them.[2] This essay examines three of Gombrich's ideas: 'the beholder's share', the 'ill-defined area' (or the 'etcetera principle'), and the 'egg shape formula'. It does so by updating his insights in accordance with contemporary research in the fields of experimental psychology and cognitive neuroscience. One of Gombrich's main concerns, as expressed in these three notions, was the relationship between the material (or physical) image and the mental image, and how viewers reconstruct the material images in front of them in their minds.

The connection between material and mental images finds its origin in ancient Greek philosophy. Ancient Greek thinkers primarily used two terms to refer to images: *eidolon* (image, or mental image) and *eikon* (image, likeness, or reflection).[3] However, there were other words in use related to the concept of imagery, including *phantasia* (imagination, or impression) and *phantasma* (appearance, mental image, or reflection).[4]

In the *Sophist*, Plato uses the concept of the image in two different senses: 'likeness' (*eikon*) and 'appearance' (*phantasma*).[5] In a dialogue between the Stranger and Theaetetus, Plato states:

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[1] I presented an abridged version of this paper at the conference *The Influence of the Vienna School of Art History III: Origins, Modifications and Influences of Its Theoretical Concepts*, Institute of Art History, Czech Academy of Sciences, Prague, Czech Republic, 19–20 April 2023. In this venue, I benefited greatly from the fruitful discussion that followed my presentation. I would also like to express my gratitude to Professor David Freedberg (Columbia University, New York) for his helpful comments on an early version of this text. This article has the support of CHAM (NOVA FCSH / UAc), through the strategic project sponsored by FCT (UIDB/04666/2020).

[2] Ernst Gombrich, *Art & Illusion: A Study in the Psychology of Pictorial Representation*, London: Phaidon, 2014.

[3] See Francis Edwards Peters, *Greek Philosophical Terms: A Historical Lexicon*, New York, NY: New York University Press, 1967, 45–46 and 51.

[4] See Peters, *Greek Philosophical Terms*, 156.

[5] Plato, *Sophist* in *Theaetetus. Sophist*, trans. by Harold North Fowler, Cambridge, MA, and London: Harvard University Press, 1921, 259–459.

> Str. So the artists abandon the truth and give their figures not the actual proportions but those which seem to be beautiful, do they not?
>
> Theaet. Certainly.
>
> Str. That, then, which is other, but like, we may fairly call a *likeness* [*eikona*], may we not?
>
> Theaet. Yes.
>
> Str. And the part of imitation which is concerned with such things, is to be called, as we called it before, likeness-making?
>
> Theaet. It is to be so called.[6] (236a–b)

In this passage, Plato conceives of the (artistic) image as a 'likeness' (*eikona*): an imitation, but not a faithful copy, of a model. Plato also refers to the concept of the image with the word 'appearance' (*phantasma*), meaning a fantastical artwork:

> Str. Now then, what shall we call that which appears, because it is seen from an unfavourable position, to be like the beautiful, but which would not even be likely to resemble that which it claims to be like, if a person were able to see such large works adequately? Shall we not call it, since it appears, but is not like, an *appearance* [*phantasma*]?
>
> Theaet. Certainly.
>
> Str. And this is very common in painting and in all imitation?
>
> Theaet. Of course.
>
> Str. And to the art which produces *appearance* [*phantasma*], but not *likeness* [*eikona*], the most correct name we could give would be 'fantastic art', would it not?
>
> Theaet. By all means.
>
> Str. These, then, are the two forms of the image-making art that I meant, the likeness-making and the fantastic.[7] (236b–c)

Thus, Plato uses *phantasma* to refer to a work of art created with the artist's imagination, rather than as a careful imitation of reality.

In another passage of the *Sophist*, Plato grapples with the ontological nature of the image. In his attempt to define the person who makes fantastic images, Plato states:

> Str. And so, if we say he has an art, as it were, of making *appearances* [*phantastiken*], he will easily take advantage of our poverty of terms to make a counter attack, twisting our words to the opposite meaning; when we call him an image-maker, he will ask us what we mean by 'image' [*eidolon*], exactly. So, Theaetetus, we must see what reply is to be made to the young man's question.

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[6] Plato, *Sophist*, 335. Emphasis added.

[7] Plato, *Sophist*, 335–37. Emphasis added.

> Theaet. Obviously, we shall reply that we mean the *images* [*eidola*] in water and in mirrors, and those in paintings, too, and sculptures, and all the other things of the same sort.[8] (239c–d)

Tellingly, Plato includes sights as diverse as reflections in water and mirrors (optical images) and scenes in paintings and sculptures (material images) in his formulation of the 'image'.

In *The Republic*, Plato further expands his concept of imagery: 'by *images* [*eikonas*] I mean firstly shadows, the *reflections* [*phantasmata*] in water and in those surfaces which are solid, smooth and shiny, and everything like this, if you get my meaning' (509d–510a).[9] He therefore includes not only reflections and works of art, but also immaterial images such as shadows, in his rubric of imagery.

Plato likewise deals with mental imagery in his texts. For example, in the *Theaetetus*, he compares pictorial memories with impressions in a wax tablet:

> Soc. Please assume, then, for the sake of argument, that there is in our souls a block of wax, in one case larger, in another smaller, in one case the wax is purer, in another more impure and harder, in some cases softer, and in some in proper quality.
>
> Theaet. I assume all that.
>
> Soc. Let us, then, say that this is the gift of Memory, the mother of the Muses, and that whenever we wish to remember anything we see or hear or think of in our own minds, we hold this wax under the perceptions and thoughts and imprint them upon it, just as we make impressions from seal rings; and whatever is imprinted we remember and know as long as its *image* [*eidolon*] lasts, but whatever is rubbed out or cannot be imprinted we forget and do not know.[10] (191c–e)

Therefore, Plato acknowledges that the human mind is filled with images, insofar as when people remember, think, or perceive, they do so by means of mental pictures.

Plato reiterates this idea in a passage from the *Philebus*, in which Socrates uses the metaphor of the painter who illustrates words that are read or heard in human souls:

> Soc. Memory unites with the senses, and they and the feelings which are connected with them seem to me almost to write words in our souls; and when the feeling in question writes the truth, true opinions and true statements are produced in us; but when the writer within us writes falsehoods, the resulting opinions and statements are the opposite of true.
>
> Pro. That is my view completely, and I accept it as stated.

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[8] Plato, *Sophist*, 347. Emphasis added.

[9] Plato, *Republic*, trans. and ed. by Chris Emlyn-Jones and William Preddy, 2 vols, Cambridge, MA, and London: Harvard University Press, 2013, II, 97. Emphasis added.

[10] Plato, *Theaetetus* in *Theaetetus. Sophist*, trans. by Harold North Fowler, Cambridge, MA, and London: Harvard University Press, 1921, (1–257) 185–87. Emphasis added.

> Soc. Then accept also the presence of another workman in our souls at such a time.
>
> Pro. What workman?
>
> Soc. A painter, who paints in our souls *pictures* [*eikonas*] to illustrate the words which the writer has written.
>
> Pro. But how do we say he does this, and when?
>
> Soc. When a man receives from sight or some other sense the opinions and utterances of the moment and afterwards beholds in his own mind the *images* [*eikonas*] of those opinions and utterances. That happens to us often enough, does it not?[11] (39a–c)

Closely related to Plato's concept of the memory image is Aristotle's use of the terms *eidolon* and *phantasma* (that is, mental image), according to the cases. In *On the Soul*, Aristotle compares sight with imagination: 'Since sight is the chief sense, the name *imagination* [*phantasia*] is derived from light [*phaos*], because without light it is impossible to see' (429a).[12] Then, he collocates imagination (*phantasia*) in an intermediary state between perceiving (*aisthesis*) and thinking (*noesis*):

> for *imagination* [*phantasia*] is different from both perception and thought; imagination always implies perception, and is itself implied by judgement. But clearly imagination and judgement are different modes of thought. For the former is an affection which lies in our power whenever we choose (for it is possible to call up *mental pictures* [*eidolopoiountes*], as those do who employ images in arranging their ideas under a mnemonic system).[13] (427b–429a)

Therefore, *eidolon* can be defined as 'mental image'. However, according to Aristotle, the term *phantasma* can also mean 'mental image', as the following passage suggests: 'Now for the thinking soul *images* [*phantasmata*] take the place of direct perceptions; and when it asserts or denies that they are good or bad, it avoids or pursues them. Hence the soul never thinks without a *mental image* [*phantasmatos*]' (431a).[14]

In line with the philosophical tradition established by Socrates, Plato, and Aristotle, David Hume interrogated the essence of material and mental images. In his *Enquiry Concerning Human Understanding*, he states:

> nothing can ever be present to the mind but an image or perception, and that the senses are only the inlets, through which these images are conveyed, without being able to produce any immediate intercourse between the mind and the object. The table, which we see, seems to diminish, as we remove

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[11] Plato, *Philebus*, trans. by Harold North Fowler, in *Statesman. Philebus. Ion*, trans. by Harold North Fowler and W. R. M. Lamb, Cambridge, MA, and London: Harvard University Press, 1925, (197–399) 299–301. Emphasis added.

[12] Aristotle, *On the Soul* in *On the Soul. Parva naturalia. On Breath*, trans. by W. S. Hett, Cambridge, MA, and London: Harvard University Press, 1957, (1–203) 163. Emphasis added.

[13] Aristotle, *On the Soul*, 157. Emphasis added.

[14] Aristotle, *On the Soul*, 177. Emphasis added.

> farther from it: but the real table, which exists independent of us, suffers no alteration: it was, therefore, nothing but its image, which was present to the mind. These are the obvious dictates of reason; and no man, who reflects, ever doubted, that the existences, which we consider, when we say, this house and that tree, are nothing but perceptions in the mind, and fleeting copies or representations of other existences, which remain uniform and independent.[15] (152)

By assuming that observed objects are present in human minds by means of imagery, Hume places physical images in direct relation with mental images. In this sense, the one cannot exist without the other, as the world cannot be directly perceived.

In *The Blue and Brown Books*, Ludwig Wittgenstein echoes Hume, pointing out the relationship between mental and physical images: 'Mental images of colours, shapes, sounds, etc., etc., which play a role in communication by means of language we put in the same category with patches of color actually seen, sounds heard'.[16] To Wittgenstein, mental images are closely related to the senses, since they arise in human minds whenever they see, hear, read, etc.: 'in some cases saying, hearing, or reading a sentence brings images before our mind's eye, images which more or less strictly correspond to the sentence, and which are therefore, in a sense, translations of this sentence into a pictorial language'.[17]

The problem of imagery has also been addressed in experimental psychology and cognitive neuroscience. For example, Stephen Kosslyn, Marlene Behrmann, and Marc Jeannerod define mental imagery in the following passage:

> Visual mental imagery is 'seeing' in the absence of the appropriate immediate sensory input, auditory mental imagery is 'hearing' in the absence of the immediate sensory input, and so on. Imagery is distinct from perception, which is the registration of physically present stimuli.[18]

More recently, Joel Pearson and his colleagues confirmed this definition: 'We use the term "mental imagery" to refer to representations […] of sensory information without a direct external stimulus'.[19] Bence Nanay expanded on these formulations with more precise information: 'mental imagery is perceptual processing (that is, processing in the early sensory cortices, V1, V2, V4/V8, MT) that is not triggered directly by sensory input'.[20] Along these lines, mental imagery refers to a wide

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[15] David Hume, *An Enquiry Concerning Human Understanding and Other Writings*, ed. by Stephen Buckle, Cambridge: Cambridge University Press, 2007, 133–34.

[16] Ludwig Wittgenstein, *The Blue and Brown Books: Preliminary Studies for the 'Philosophical Investigation'*, ed. by Rush Rhees, Oxford: Blackwell, 1958, 89.

[17] Wittgenstein, *The Blue and Brown Books*, 36.

[18] Stephen M. Kosslyn, Marlene Behrmann and Marc Jeannerod, 'The Cognitive Neuroscience of Mental Imagery', *Neuropsychologia*, 33: 11, 1995, (1335–44) 1335.

[19] Joel Pearson *et al.*, 'Mental Imagery: Functional Mechanisms and Clinical Applications', *Trends in Cognitive Sciences*, 19: 10, 2015, (590–602) 590.

[20] Bence Nanay, 'Unconscious Mental Imagery', *Philosophical Transactions Royal Society B*, 376, 2021, (1–9) 1.

variety of different phenomena, both conscious and unconscious, such as 'filling-in' the blind spot, modal and amodal completion, and some perceptual expectations.

The relationships between physical and mental images and between perception and imagination form the basis of Gombrich's concept of 'ill-defined area', which I analyse from an experimental aesthetic perspective. I argue that in observing an image containing an 'ill-defined area' (in other words, an incomplete image), the beholder's mind completes the missing part(s) through the activation of determinate neurons. The task of these neurons is to fill the gaps in such an image. What follows, I assert, is a mental image of the now complete figure.

1. The Concept of 'Ill-Defined Area'

One of the most significant achievements of Gombrich's study of images is the idea of 'the beholder's share' as formulated in *Art & Illusion*. Using this term, he sought to explain how beholders deal with images. He argued that the beholder is called upon to (mentally) re-create an observed image in order to make sense of it. Gombrich thus describes 'the beholder's share in the readings of images' as 'his capacity […] to collaborate with the artist and to transform a piece of coloured canvas into a likeness of the visible world'.[21] Intertwined with the notion of 'the beholder's share' is that of the 'mental set', that is, the

> state of readiness to start projecting, to thrust out the tentacles of phantom colours and phantom images which always flicker around our perceptions. And what we call 'reading' an image may perhaps be better described as testing it for its potentialities.[22]

Partially visible figures and unfinished artworks are particularly pertinent examples of images in which the 'state of readiness to start projecting' and the collaboration between the maker and the viewer are critical.[23] The beholder must mentally formulate the work to complete it in his or her mind – in other words, to grasp its content and meaning.[24]

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[21] Gombrich, *Art & Illusion*, 246.

[22] Gombrich, *Art & Illusion*, 190.

[23] For more on the phenomenon of the unfinished in art, see Fabio Tononi, 'The Problem of the Unfinished and the Shaping of the Canon of Finiteness in the Italian Renaissance', *The Edgar Wind Journal*, 1, 2021, 86–127; Tononi, 'Aesthetic Response to the Unfinished: Empathy, Imagination and Imitation Learning', *Aisthesis: Pratiche, linguaggi e saperi dell'estetico*, 13: 1, 2020, 135–53; Kelly Baum *et al.*, eds, *Unfinished: Thoughts Left Visible*, New York, NY: The Metropolitan Museum of Art, 2016; and Nico van Hout, *The Unfinished Painting*, Antwerp: Ludion, 2012.

[24] See Tononi, 'Aby Warburg and Edgar Wind on the Biology of Images: Empathy, Collective Memory, and the Engram' in *Edgar Wind: Art and Embodiment*, ed. by Jaynie Anderson, Bernardino Branca and Fabio Tononi, Oxford: Peter Lang, forthcoming; Tononi, 'Worringer, Dewey, Goodman, and the Concept of Aesthetic Experience: A Biological Perspective', *ITINERA: Rivista di filosofia e teoria delle arti*, 23, 2022, 303–28; Tononi, 'The *Night* of Michelangelo: Animism, Empathy, and Imagination', *Journal of Comparative Literature and Aesthetics*, 45: 4, 2022, 27–41; Tononi, 'Aby Warburg, Edgar Wind, and the Concept of

Certain image types have posed a long-standing perceptual problem, wherein beholders mentally fill in figures and forms left incomplete (whether intentionally or otherwise) by the artist. The two types of incomplete imagery at the centre of this study are (*i*) representations of human figures with body parts that have either been hidden behind other objects or rendered absent to convey a sense of realism (e.g. perspective); and (*ii*) human figures that, for various reasons, have been depicted without faces. The images in question have what Gombrich termed an 'ill-defined area', which stimulates the observer's participation.[25] The way in which the beholder, in a neurological sense, deals with this 'ill-defined area', is the subject of the present work.

To explain the concept of 'ill-defined area', Gombrich examines a common phenomenon that occurs in two-dimensional art as well as lived experience: the representation of, and response to, figures that are not entirely visible. This lack of visibility is usually due to one of the following reasons: (*i*) the incompleteness of the figures, (*ii*) the introduction of perspective in art, and (*iii*) the 'necessary incompleteness of all two-dimensional representation', per Gombrich.[26] For these reasons, 'some part of the motif will always be hidden from us, and there will always be some overlap'.[27]

In the work known as the *Imagines*, Philostratus the Elder likewise describes the phenomenon of an 'ill-defined area' in painting.[28] Discussing the appearance of armed men surrounding the walls of Thebes, he states that

> some are seen in full figure, others with the legs hidden, others from the waist up, then only the busts of some, heads only, helmets only, and finally just spear-points. This, my boy, is perspective; since the problem is to deceive the eyes as they travel back along with the proper receding planes of the picture.[29] (I, 4.2)

Thus, any element contained in the painting, whether a part of the human body or an attribute of the soldier, is understood by the observer as a (ill-defined) man whose invisible parts must be imagined.

Kulturwissenschaft: Reflections on Imagery, Symbols, and Expression', *The Edgar Wind Journal*, 2, 2022, 38–74; Tononi, 'The Aesthetics of Freud: Movement, Embodiment and Imagination', *Reti, saperi, linguaggi: Italian Journal of Cognitive Sciences*, 8: 1, 2021, 125–54; Tononi, 'Intermediality and Immersion in Gaudenzio Ferrari's *Adoration of the Magi* in Chapel V of the Sacred Mountain of Varallo', *PsicoArt: Rivista di Arte e Psicologia*, 10, 2020, 1–18; and Tononi, 'Andrea Mantegna and the Iconography of Mourners: Aby Warburg's Notion of *Pathosformeln* and the Theory of Aesthetic Response', *IKON: Journal of Iconographic Studies*, 13, 2020, 79–94.

[25] Gombrich, *Art & Illusion*, 174.

[26] Gombrich, *Art & Illusion*, 176.

[27] Gombrich, *Art & Illusion*, 176.

[28] Philostratus the Elder, *Imagines* in Philostratus the Elder, *Imagines*. Philostratus the Younger, *Imagines*. Callistratus, *Descriptions*, trans. by Arthur Fairbanks, Cambridge, MA, and London: William Heinemann and Harvard University Press, 1969, (2–271) 17.

[29] Philostratus the Elder, *Imagines*, 17.

As Gombrich observed, images of this kind are ubiquitous in the visual arts.[30] For example, a curious scene can be found at the centre of Giotto's *Last Judgement* in the Arena Chapel in Padua: a man is almost entirely hidden by the cross he carries, assisted by two angels at the top of the picture (Figure 1). The only visible parts of the man are two feet (and a portion of the legs), two hands, and some hair. Suppose I am shown this image and asked what it is. I would not say, 'There are two feet, two hands and some hair holding a cross', but rather, 'There is a man holding a cross'. Thus, the fact that the body is entirely missing, hidden behind the cross, does not prevent me from understanding, based on the visible parts of the figure, that what I am beholding is a human being.

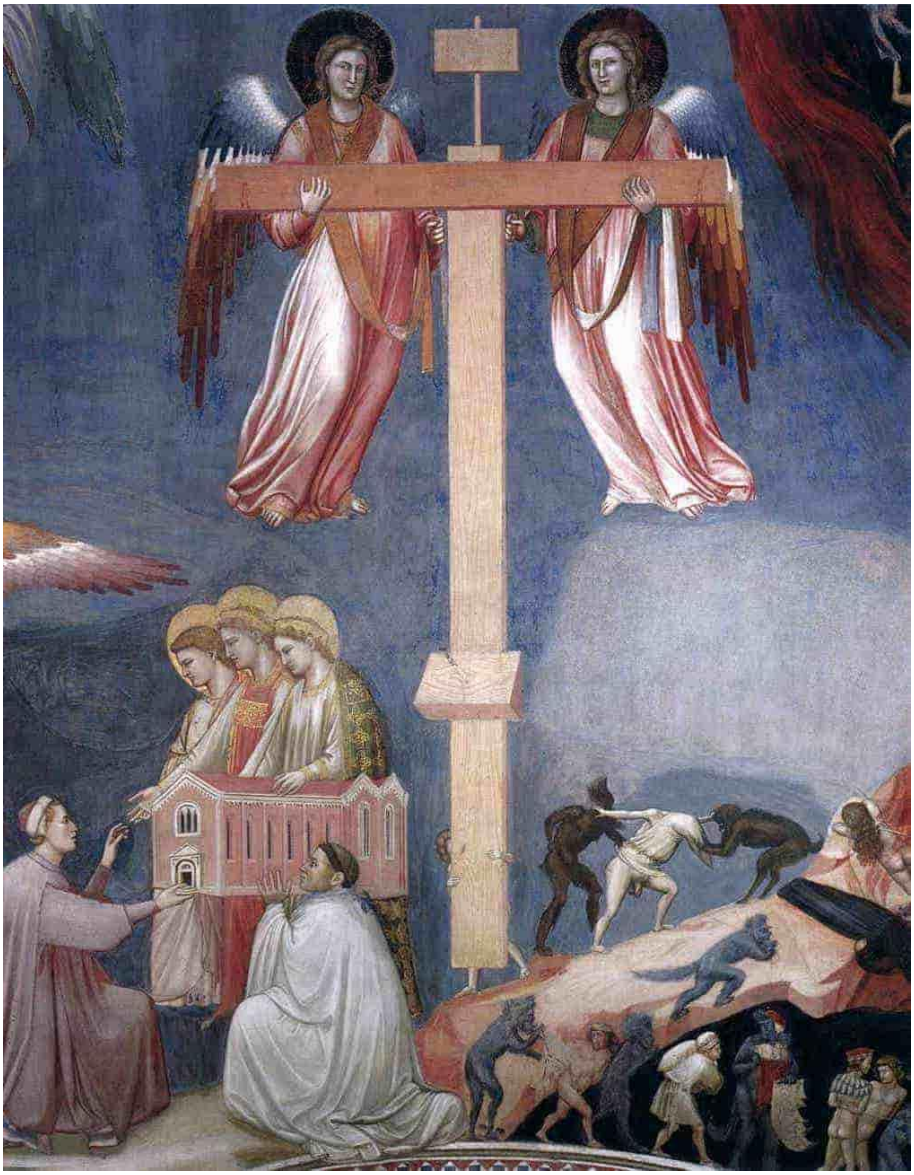

Figure 1. Giotto, *The Last Judgement* (detail), c. 1306. Fresco, 1000 x 840 cm. Padua: Arena Chapel. Image in Public Domain.

[30] Gombrich, *Art & Illusion*, 177–79.

There is a similar instance of an 'ill-defined area' in Hubert and Jan van Eyck's *Ghent Altarpiece*. This scene can be found at the top of the second interior panel from the right, in which a group of music-making angels with stringed instruments is gathered around a pipe organ, played by two seated angels, one shown full-length in the foreground and the other located behind the organ, only partially visible (Figure 2). It is the latter angel that drew Gombrich's attention:

> There is a glimpse of red and brown at the side of the organ, or rather behind it. You must know what organs are like to take the hint. It is the garment and hair of the angel working the bellows, which Jan van Eyck did not want to miss out.[31]

Figure 2. Hubert and Jan van Eyck, *Ghent Altarpiece* (detail), 1426–1432. Oil on panel, 258 x 375 cm. Ghent: Saint Bavo Cathedral. Image in Public Domain.

[31] Gombrich, *Art & Illusion*, 177.

Thus, to realise what these reds and browns stand for – in other words, to see this almost entirely hidden figure – the beholder must know how an organ operates. In this way, the viewer can complete, in his or her mind's eye, what (s)he barely glimpses.

The phenomenon of 'ill-defined area' can be found in many other multi-figure compositions. For instance, Donatello's *Herod's Banquet* (Figure 3) includes a figure – the man rushing out of the room on the right – whose presence in the relief is revealed only by his legs. Similarly, in Dürer's print of *The Prodigal Son* (Figure 4), the tail end of a bull on the lefthand side suggests that the animal has nearly exited the scene. All these devices testify to the desire of the artist to be a faithful imitator of reality. The artist's aim is substantially achieved in the incompleteness. It is in such cases that the contribution of the viewer to the construction of the image comes into play. To understand the picture, (s)he must rely on the power of his or her visual imagination (along with visual memory, visual experience, and background knowledge) to 'see' an entire figure where only a small portion of one appears.

Figure 3. Donatello, *Herod's Banquet*, 1423–1427. Bronze, 60 x 60 cm. Siena: Baptistry. Image in Public Domain.

A comparable phenomenon occurs in listening and reading. In *Talks to Teachers on Psychology; and to Students on Some of Life's Ideals*, William James writes:

> When we listen to a person speaking or read a page of print, much of what we think we see or hear is supplied from our memory. We overlook misprints, imagining the right letters, though we see the wrong ones; and

> how little we actually hear, when we listen to speech, we realise when we go to a foreign theatre; for there what troubles us is not so much that we cannot understand what the actors say as that we cannot hear their words. The fact is that we hear quite as little under similar conditions at home, only our mind, being fuller of English verbal associations, supplies the requisite material for comprehension upon a much slighter auditory hint.[32]

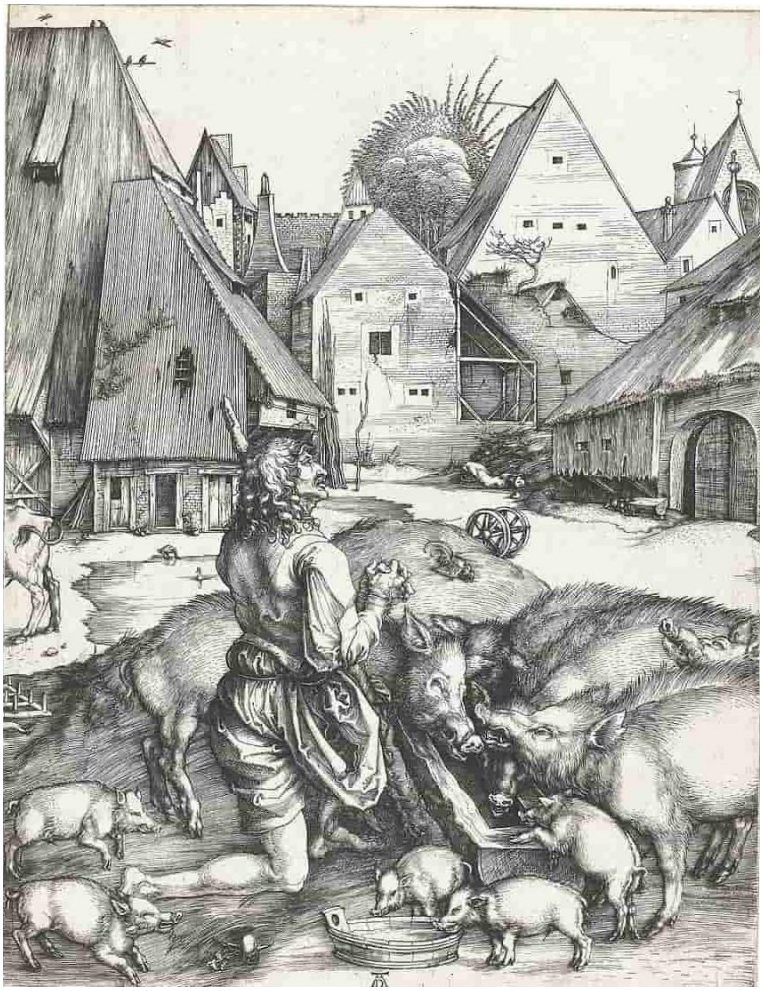

Figure 4. Albrecht Dürer, *The Prodigal Son Amid the Swine*, 1494–1498. Engraving, 24.7 x 19.1 cm. Amsterdam: Rijksmuseum. Image in Public Domain.

Gombrich echoes James, when he observes how greatly

> our knowledge and expectations influence our hearing. You had to know what might be said in order to hear what was said. More exactly, you

[32] William James, *Talks to Teachers on Psychology; and to Students on Some of Life's Ideals*, London: Longmans & Co, 1899, 159.

> selected from your knowledge of possibilities certain word combinations and tried projecting them into the noises heard.[33]

The phenomena that these two passages describe, such as unheard words and misprints, can be grouped under the same class as 'ill-defined areas', as the mechanism involved in these kinds of perceptions is essentially the same: a neural filling-in.[34] In this sense, as Gombrich states:

> We see objects only from one side and have to guess, or imagine, what lies behind. We see only one aspect of an object, and it is not very hard to work out exactly what this aspect will be from any given point.[35]

Consequently, in perceiving 'ill-defined areas', viewers contribute to the making of the work of art with their memory, imagination, and creativity. In this way, the complete figure only exists in their minds, as a mental image, as originally conceived in the mind of the artist.

The concept of 'ill-defined area' can also be applied to the incomplete figures found in preparatory drawings. These figures are partially visible, not because they are in some way hidden, but because they have been left (most of the time deliberately) unfinished by their authors. The Florentine Renaissance concept of drawing is telling. The majority of Renaissance drawings served as preparatory sketches for much larger works, and they must be understood by the viewer within this context. These drawings present contrasting states of completion, as their primary function was to delineate ideas meant to be fully developed in another medium, such as painting or sculpture.

Many Renaissance drawings depict figures without faces, as in Leonardo da Vinci's *Study of a Bust of a Woman* (Figure 5). These images were not intended as representations of decapitated people, but as preliminary sketches to be fully realised at a later stage and in a different medium. As Gombrich states: 'When we look at a sketch […] we immediately take in the situation. We do not feel tempted for a moment to interpret its images literally'.[36] Rather, '[w]hat we read into these accidental shapes depends on our capacity to recognise in them things or images we find stored in our minds'.[37] For this reason, the beholder understands that in this type of drawing, 'the schema assumes the form of shorthand notations which the artist will expand and fill in when the time comes'.[38]

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[33] Gombrich, *Art & Illusion*, 171.

[34] See § 4.

[35] Gombrich, *Art & Illusion*, 211.

[36] Gombrich, *Art & Illusion*, 194.

[37] Gombrich, *Art & Illusion*, 155.

[38] Gombrich, *Art & Illusion*, 144.

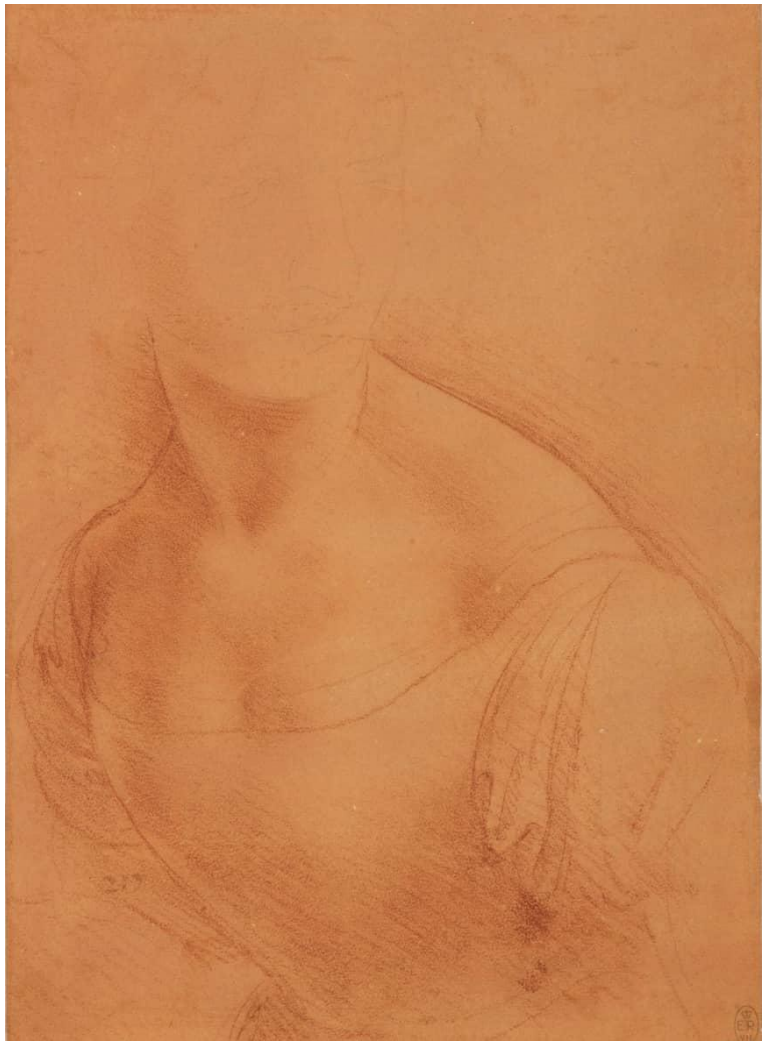

Figure 5. Leonardo da Vinci, *Study of a Bust of a Woman* (recto), c. 1500. Metalpoint and red chalk on pale red prepared paper, 22.1 x 15.9 cm. Windsor: Windsor Castle, Royal Collection Trust / © His Majesty King Charles III 2023.

In order to grasp the whole of an image from one of its parts, the perceiver must be equipped with a specific faculty, which Apollonius of Tyana describes in the following way: 'Those who view the works of painters need the imitative faculty, since no one will praise the picture of a horse or bull unless he has no idea of the creature represented' (II, 22.5).[39] Therefore, the imitative faculty – or projection, as Gombrich termed it – is what gives the beholder the gist of the (fragmentary) depicted scene.[40] In this way, the unfinished image 'can arouse the beholder's imagination', projecting on the blank screen 'what is not there'.[41] In other words, the memory and background knowledge that humans possess of the

[39] Philostratus, *Apollonius of Tyana, Volume I: Life of Apollonius of Tyana*, trans. and ed. by Christopher P. Jones, Cambridge, MA, and London: Harvard University Press, 2005, 185.
[40] See Gombrich, *Art & Illusion*, 155.
[41] Gombrich, *Art & Illusion*, 174.

structure and morphology of their own bodies allows them to recognise a man or a woman even when there are only vague suggestions of such figures in the picture.

The perception of images containing 'ill-defined areas' allows the viewer not only to stimulate his or her imagination but also to experience the process of creation.[42] The immediacy of preparatory drawings, characterised by a network of marks and empty spaces, causes the representation to take shape in the mind's eye of the beholder. It is in this sense that a link 'between the imagination of the artist and that of his public' is established.[43] Perception, as Gombrich suggests, 'is always an active process, conditioned by our expectations and adapted to situations'.[44]

2. Perceiving the 'Egg Shape Formula'

As to the representation of faceless figures, a question arises: how do beholders respond to this pattern? The answer to this question will help me fulfil my aim of examining the effects that 'acquired patterns or schemata have on the organisation of our perception'.[45] Gombrich designates this specific pattern (that of faceless figures) 'oval or egg shape' and considers it 'the most widespread and familiar of all the diagrammatic formulas taught in the Western tradition'.[46] The 'egg shape formula', in which the 'egg' stands for the head, is a drawing technique that assists the artist in constructing a face according to the laws of human proportions. In this regard, the eighteenth-century anatomist Pieter Camper explains that

> the portrait-painters of the present day, generally describe an oval upon their panel before the person to be painted sits to be drawn; make a cross in the oval, which they divide into the length of four noses, and the breadth of five eyes; and they paint the face according to these divisions to which it must be accommodated, let the proportions themselves be ever so much at variance.[47]

In Leonardo da Vinci's *Study of a Bust of a Woman*, viewers are confronted with the 'egg shape formula', with an (almost entire) oval contour occupying the space where the woman's face would be. As this drawing suggests, sometimes, in the design phase of the work, it was not necessary to define the face of the figure. Instead, it was more important to single out the format of the portrait (i.e. half-length, full figure, etc.), the position of the body and limbs, and the details of the folds of the drapery.

These representations inevitably exercise a particular effect on the perceiver, who can automatically imagine the presence of a face where there is none, probably because, as Gombrich states, 'we have come to accept certain forms in pictures as

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[42] For more on the pedagogical function of unfinished artworks, see Tononi, *Aesthetic Response to the Unfinished*.

[43] Gombrich, *Art & Illusion*, 163.

[44] Gombrich, *Art & Illusion*, 148.

[45] Gombrich, *Art & Illusion*, 144.

[46] Gombrich, *Art & Illusion*, 144.

[47] Petrus Camper, *The Connexion between the Science of Anatomy and the Arts of Drawing, Painting, Statuary, etc.*, trans. by Thomas Cogan, London: Charles Dilly, 1794, 94.

representing heads'.[48] This is why, as Gombrich pointed out and as neuroscience research seems to verify,[49] the beholder is led to project a face onto a blank surface at the top of a faceless body; a face that (s)he finds stored in his or her memory.[50] The precondition for this mental completion is 'that the beholder must be left in no doubt about the way to close the gap'.[51]

Notably, Chinese art theorists have discussed the power that absence has on viewers of images. In the *Tao of Painting*, the Chinese-American painter and writer Mai-mai Sze argues that (strategic) absence emanates a force that the beholder captures as if it were a meaningful form:

> Figures, even though painted without eyes, must seem to look; without ears, must seem to listen [….] There are things which ten hundred brushstrokes cannot depict but which can be captured by a few simple strokes if they are right. That is truly giving expression to the invisible.[52]

As Sze observes, the beholder's imagination plays a significant role in the perception of, and response to, meaningful absences in the visual arts. Chinese art, with its characteristically abridged visual language, appeals to the observer's urge to mentally add what is not there (eyes, ears, faces, etc.) onto a blank 'screen'.

The passages so far mentioned suggest that viewers, in multiple time periods and cultures, possess the faculty to fill in 'ill-defined (familiar) areas'. This observation finds confirmation in the phenomenon of 'filling-in', which occurs at physiological blind spots. On a certain segment of the retina there are no light-sensitive receptors. This area is known as a blind spot, and is located medially to the right in the left eye and to the left in the right eye. People do not perceive this gap because the brain fills in the blank point based on information perceived in the surrounding areas. As Benedikt Ehinger and his colleagues demonstrate, 'information generated by the brain itself is sometimes treated as more reliable than sensory information from the outside world'.[53] Therefore, the blank surface of a face is as much a part of the image as the strokes of the pencil that define a body.

3. The Neural Correlate of Face Perception

A number of neuroscientific studies on face perception provide evidence that perceiving a face (both in real life and through depictions) or a body in which a face is apparently missing activates similar neural networks. This could imply that, in the second case, the beholder's visual imagination plays an important role. As

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[48] Gombrich, *Art & Illusion*, 148.

[49] See § 3.

[50] See Gombrich, *Art & Illusion*, 148.

[51] Gombrich, *Art & Illusion*, 174.

[52] Mai-mai Sze, *The Tao of Painting: A Study of the Ritual Disposition of Chinese Painting; with a Translation of the Chieh tzu yüan hua chuan; or, Mustard Seed Garden Manual of Painting, 1679–1701*, 2 vols, New York, NY: Pantheon Books, 1956, II, 250–51.

[53] See Benedikt V. Ehinger *et al.*, 'Humans Treat Unreliable Filled-in Percepts as More Real than Veridical Ones', *e-Life*, 6, 2017, (1–17) 2.

Gombrich writes: 'Where is his face? As soon as we ask, we notice we are scanning the poster, looking for indications where to anchor our projection'.[54]

Gombrich assigned a significant role to the face in perception, as if it were the most important part of the human body. More recent scientific evidence confirms his claim, indicating that 'faces are among the most important visual stimuli we perceive, informing us not only about a person's identity, but also about their mood, sex, age, and direction of gaze'.[55] Humans, while scanning a face, are able to detect this information within a fraction of a second, in a manner salient for everyday social interactions.

Nancy Kanwisher and her team of researchers discovered the existence of a face module in the human brain known as the fusiform face area (FFA).[56] Subsequent evidence from behavioural, neuropsychological, and neurophysiological investigations corroborates that humans have specialised cognitive and neural mechanisms dedicated to the perception of faces, which primarily converge in the FFA.[57] Significantly, in the FFA, faces are processed as a distinct object category. A similar form of brain activity occurs during the perception of other categories of objects. For instance, the observation of places triggers activity in a brain area called the parahippocampal area.[58] Seeing human bodies, or parts of them, excites the extrastriate cortex.[59] Reading words and letters activates the visual word form area.[60] Therefore, in most cases, a specific perception corresponds with a cortical area in the brain.

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[54] Gombrich, *Art & Illusion*, 197.

[55] Nancy Kanwisher and Galit Yovel, 'The Fusiform Face Area: A Cortical Region Specialized for the Perception of Faces', *Philosophical Transactions of the Royal Society of London B.*, 361: 1476, 2006, (2109–28) 2109.

[56] See Kanwisher *et al.*, 'The Fusiform Face Area: A Module in Human Extrastriate Cortex Specialized for Face Perception', *Journal of Neuroscience*, 17: 11, 1997, 4302–11. For a review of studies on face perception, see Kalanit Grill-Spector *et al.*, 'The Functional Neuroanatomy of Human Face Perception', *Annual Review of Vision Science*, 3, 2017, 167–96.

[57] See Winrich Freiwald, Bradley C. Duchaine and Yovel, 'Face Processing Systems: From Neurons to Real-World Social Perception', *Annual Review of Neuroscience*, 39, 2016, 325–46; Marlene Behrmann and David C. Plaut, 'Distributed Circuits, Not Circumscribed Centers, Mediate Visual Recognition', *Trends in Cognitive Sciences*, 17: 5, 2013, 210–19; David Pitcher *et al.*, 'Two Critical and Functionally Distinct Stages of Face and Body Perception', *Journal of Neuroscience*, 32: 45, 2012, 15877–85; and Elinor McKone *et al.*, 'A Critical Review of the Development of Face Recognition: Experience is Less Important than Previously Believed', *Cognitive Neuropsychology*, 29: 1-2, 2012, 1–39.

[58] See Russel Epstein *et al.*, 'The Parahippocampal Place Area: Recognition, Navigation, or Encoding?', *Neuron*, 23: 1, 1999, 115–25.

[59] See Paul E. Downing *et al.*, 'A Cortical Area Selective for Visual Processing of the Human Body', *Science*, 293, 2001, 2470–73.

[60] See Stanislas Dehaene *et al.*, 'The Neural Code for Written Words: A Proposal', *Trends in Cognitive Sciences*, 9: 7, 2005, 335–41; and Laurent Cohen *et al.*, 'The Visual Word Form Area: Spatial and Temporal Characterization of an Initial Stage of Reading in Normal Subjects and Posterior Split-Brain Patients', *Brain*, 123: 2, 2000, 291–307.

These studies unveil the complex neural mechanisms underlying the perception of faces, but what happens when the brain imagines faces? In other words, what is the neural substrate of the perception of the 'egg shape formula'? In *Emotions and the Body*, Beatrice de Gelder states: 'It is a reasonable supposition that the brain mentally completes the picture when we see a headless body or a bodiless head'.[61] Since people usually perceive faces and bodies together, it may be that, as de Gelder suggests, 'the perception of the face and body is closely linked and that they can quickly convey the same message in a very similar way'.[62] This consideration sustains the hypothesis according to which the observation of faceless bodies, such as the one depicted in Leonardo's *Study of a Bust of a Woman*, would lead the beholder to imagine the missing face, precisely because body and face are usually seen together. A similar hypothesis was already advanced by Gaetano Kanizsa, who, contrasting an incomplete figure of a complete human body with the complete figure of an amputated man, argued that only the former activates an amodal completion process.[63] At this point, the question remains: What stimulates the neural filling-in of what is missing?

In a fMRI study, Jia Liu, Alison Harris, and Nancy Kanwisher investigated the neural mechanisms underlying the perception of facial components and configurations.[64] They monitored the activity of three regions in the human ventral visual cortex that respond selectively to faces: the occipital face area (OFA), in the lateral inferior occipital gyri; the FFA, in the mid-fusiform gyrus; and a face-selective region in the posterior part of the superior temporal sulcus (STS). They examined the extent to which these areas respond to facial features such as the eyes, nose, and mouth, and the T-shaped spatial configuration of these parts. The working question of their study was: What aspects of the face stimulus do each of these three regions respond to? The T-shaped configuration of eyes, nose, and mouth, and/or the individual parts of faces (i.e. eyes, nose, and mouth)? Put differently, how is the response of each region affected by the presence or absence of different parts of the face?

They measured the fMRI responses to eight face stimuli in eight different configurations: (*i*) facial features in oval shape with hair on the top and sides; (*ii*) facial features without oval shape; (*iii*) facial features covered by black ovals in oval shape with hair on the top and sides; (*iv*) facial features covered by black ovals without oval shape; (*v*) facial features rearranged in an irregular way (the eyes in place of mouth and nose etc.) in oval shape with hair on the top and sides; (*vi*) facial features rearranged in an irregular way without oval shape; (*vii*) facial features covered by black ovals rearranged in an irregular way; and (*viii*) facial features covered by black ovals rearranged in an irregular way without oval shape. The

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[61] Beatrice de Gelder, *Emotions and the Body*, Oxford and New York, NY: Oxford University Press, 2015, 38.

[62] De Gelder, *Emotions and the Body*, 38–39.

[63] See Gaetano Kanizsa, *Organization in Vision: Essays in Gestalt Perception*, New York, NY: Praeger Press, 1979, 18–19. See also § 4.

[64] See Jia Liu, Alison Harris and Kanwisher, 'Perception of Face Parts and Face Configurations: An fMRI Study', *Journal of Cognitive Neuroscience*, 22: 1, 2009, 203–11.

choice to crop the face in a rectangular shape, showing only the central face region, is due to the interaction that may occur between the processing of the facial contour (i.e. hairline, chin, and ears) and the internal facial features.[65]

Data collected from this experiment indicate that FFA, OFA, and fSTS responses are significantly higher when real facial features, rather than black ovals, are present. One important finding from the experiment, which supports the argument of the present article, is that 'the FFA showed a significantly larger response to stimuli with face configurations regardless of whether face parts were present'.[66] This confirms my contention that the observation of a face's contour without internal features, in other words, the 'egg shape formula', activates the beholder's imagination to fill in the empty face. Furthermore, the FFA responds to face-like configurations of ovals. Liu, Harris, and Kanwisher note the fact that

> all three face-selective regions are sensitive to the external contours of faces suggests that this aspect of faces is also used for constructing the representation of faces at different stages of face processing. Indeed, when fine-grained details of the internal face features are missing, the coarse information of external features may help to detect faces among objects.[67]

Finally, the FFA, the OFA, and the fSTS are also active during the observation of absent parts of the face (though the activity of the three areas is lower than during the observation of visible face parts) albeit each with different degrees of intensity.[68] These results find confirmation in many other empirical studies, which show that, most of the time, incomplete faces are (amodally) completed by the human brain.[69]

Based on this evidence, it is possible to advance that the activation of the FFA, the OFA, and the fSTS during the observation of external features of the face (even when the internal parts are missing) may allow one to imagine a complete face. An analysis of the brain mechanisms underlying the so-called neural filling-in may help to further corroborate this thesis.

4. Incompleteness and Neural Filling-In

Neural filling-in is a perceptual phenomenon in which visual features such as colour, brightness, texture, and motion are perceived in certain areas of the visual

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[65] See also Pawan Sinha and Tomaso Poggio, 'I Think I Know that Face', *Nature*, 384, 1996, 404.

[66] Liu, Harris and Kanwisher, *Perception of Face Parts and Face Configurations*, 207.

[67] Liu, Harris and Kanwisher, *Perception of Face Parts and Face Configurations*, 209. See also David Cox, Ethan Meyers and Sinha, 'Contextually Evoked Object-Specific Responses in Human Visual Cortex', *Science*, 304: 5667, 2004, 115–17.

[68] See Liu, Harris and Kanwisher, *Perception of Face Parts and Face Configurations*, 206.

[69] See Juan Chen *et al.*, 'Cortical Dynamics Underlying Face Completion in Human Visual System', *Journal of Neuroscience*, 30: 49, 2010, 16692–98; Chen *et al.*, 'Time Course of Amodal Completion in Face Perception', *Vision Research*, 49: 7, 2009, 752–58; Alison Harris and Geoffrey Karl Aguirre, 'The Representation of Parts and Wholes in Face-Selective Cortex', *Journal of Cognitive Neuroscience*, 20: 5, 2008, 863–78; and Oliver J. Hulme and Semir Zeki, 'The Sightless View: Neural Correlates of Occluded Objects', *Cerebral Cortex*, 17: 5, 2006, 1197–205. See also Jordy Thielen *et al.*, 'Neuroimaging Findings on Amodal Completion: A Review', *i-Perception*, 10: 2, 2019, 1–25.

field, even though these features are not physically present.[70] Filling-in occurs in various situations and is an essential part of normal surface perception among humans. When a subject encounters an incomplete image, it is possible that his or her visual system simply ignores the lack of visual input; in this case, filling-in is a passive outcome. However, various psychophysical experiments show that some neural activity occurs during filling-in, particularly in the early visual cortical areas.[71]

Visual scientists employ the term *perceptual completion* to refer to scenarios in which subjects report that a form is present in a particular region of the visual field from which it is, in fact, absent. This is due to the unique morphology of the surrounding empty space. In neuroscience, this phenomenon is also called *neural filling-in*, referring to the mechanism activated in the brain in certain visual situations to fill in missing information. The neural mechanism supplies details to compensate for an absence, *filling-in* what is incomplete. Specific cells in the visual cortex thereby respond to discontinuities.[72] This response may be due to the presence of neurons that react more strongly to boundaries than to regions or surfaces.[73]

Scholars recognise a general division in the classification of perceptual completion: modal completion versus amodal completion. This division was proposed by Albert Michotte, Georges Thinés, and Geneviève Crabbé.[74] In modal

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[70] See Ehinger *et al.*, *Humans Treat Unreliable Filled-in Percepts as More Real than Veridical Ones*; Hidehiko Komatsu, 'The Neural Mechanisms of Perceptual Filling-In', *Nature Reviews Neuroscience*, 7, 2006, 220–31; Luiz Pessoa and Peter De Weerd, eds, *Filling-In: From Perceptual Completion to Cortical Reorganization*, Oxford: Oxford University Press, 2003; Vilayanur S. Ramachandran, Richard L. Gregory and W. Aiken, 'Perceptual Fading of Visual Texture Borders', *Vision Research*, 33: 5-6, 1993, 717–21; and Ramachandran and Gregory, 'Perceptual Filling in of Artificially Induced Scotomas in Human Vision', *Nature*, 350, 1991, 699–702.

[71] See Hanlin Tang *et al.*, 'Spatiotemporal Dynamics Underlying Object Completion in Human Ventral Visual Cortex', *Neuron*, 83: 3, 2014, 736–48; Andrea Perna *et al.*, 'Neuronal Mechanisms for Illusory Brightness Perception in Humans', *Neuron*, 47: 5, 2005, 645–51; Masayuki Matsumoto and Komatsu, 'Neural Responses in the Macaque V1 to Bar Stimuli with Various Lengths Presented on the Blind Spot', *Journal of Neurophysiology*, 93: 5, 2005, 2374–87; Komatsu, Masaharu Kinoshita and Ikuya Murakami, 'Neural Responses in the Retinotopic Representation of the Blind Spot in the Macaque V1 to Stimuli for Perceptual Filling-In', *The Journal of Neuroscience*, 20: 24, 2000, 9310–19; and Mario Fiorani *et al.*, 'Dynamic Surrounds of Receptive Fields in Primate Striate Cortex: A Physiological Basis for Perceptual Completion', *Proceedings of the National Academy of Sciences (USA)*, 89, 1992, 8547–51.

[72] See David H. Hubel and Torsten Wiesel, 'Receptive Fields and Functional Architecture of Monkey Striate Cortex', *Journal of Physiology*, 195, 1968, 215–43; and Hubel and Wiesel, 'Receptive Fields, Binocular Interaction and Functional Architecture in the Cat's Visual Cortex', *Journal of Physiology*, 160: 1, 1962, 106–54.

[73] See Pessoa, Evan Thompson and Alva Noë, 'Finding out about Filling-In: A Guide to Perceptual Completion for Visual Science and the Philosophy of Perception', *Behavioral and Brain Sciences*, 21: 6, 1998, (723–802) 724; and Alfred L. Yarbus, *Eye Movements and Vision*, Boston, MA: Springer, 1967.

[74] See Albert Michotte, Georges O. Thinés and Geneviève Crabbé, *Les complements amodaux des structures perceptives*, Louvain: Publications Universitaires de Louvain, 1964.

completion, the completed parts of the figure display the same attributes, or 'modes' (e.g. brightness), as the incomplete parts. The *Kanizsa triangle* (Figure 6) is an example of this phenomenon.[75] This image presents illusory contours and a brightening within the figure that leads the beholder to perceive a white triangle above three circles and the contour of a second triangle. In this sense, the illusory contours and the central brightening are modal in nature – that is, they are perceptually salient and appear to form a figure.

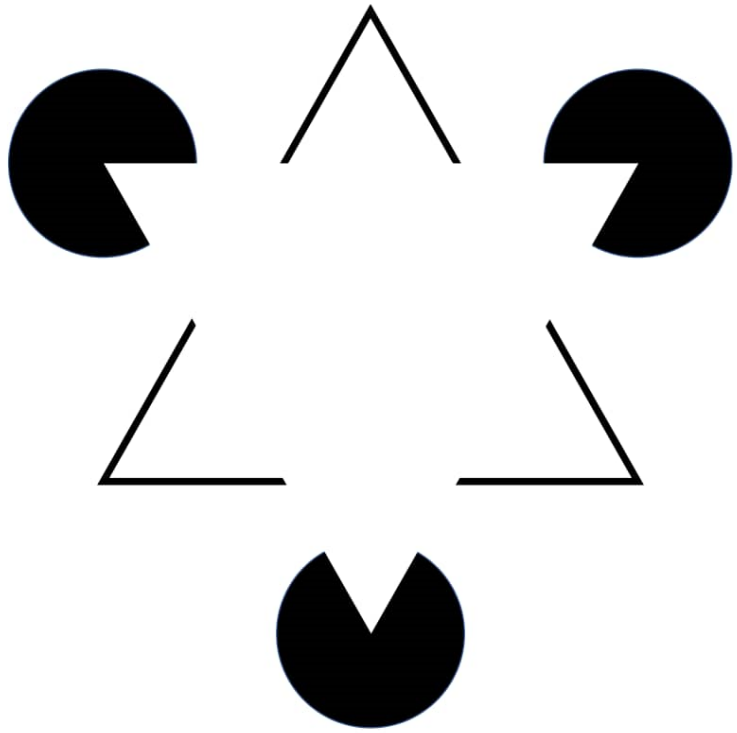

Figure 6. Gaetano Kanizsa, *Triangle*, 1955. Image in Public Domain.

On the other hand, amodal completion refers to the phenomenon that occurs when the brain completes a figure, or an object, that is not entirely visible because it is partly covered by something else.[76] Thus, amodal completion denotes the

[75] See Kanizsa, *Organization in Vision*; and Kanizsa, 'Margini quasi-percettivi in campi con stimolazione omogenea', *Rivista di Psicologia*, 49, 1955, 7–30.

[76] See Walter Gerbino, 'Amodal Completion Revisited', *i-Perception*, 11: 4, 2020, 1–26; Nanay and Grace Helton, 'Amodal Completion and Knowledge', *Analysis*, 79: 3, 2019, 415–23; Nanay, 'The Importance of Amodal Completion in Everyday Perception', *i-Perception*, 9: 4, 2018, 1–16; Robert Eamon Briscoe, 'Superimposed Mental Imagery: On the Uses of Make-Perceive' in

perception of parts of figures or objects, insofar as they lack certain visible attributes. For instance, consider four discs partially occluded by four rectangles (Figure 7). Although the discs are partly hidden, they are easily recognisable and are perceived to be 'underneath' the rectangles. In this sense, the parts of the circles occluded by the rectangles are said to be amodally present.

Therefore, modal completion refers to the mental filling-in of the foreground, whereas amodal completion refers to the mental completion of the background, that is, of partly hidden figures or objects. Given this distinction, it is possible to address the following question: What is the neural mechanism of filling-in? Two lines of evidence – neurophysiological data and psychophysical research on the similarities between real and illusory contours – suggest the existence of a neural mechanism responsible for illusory contour completion. Regarding neurophysiological data, Esther Peterhans and Rudiger von der Heydt have found evidence from single-cell recordings suggesting neural correlates of illusory contours in area V2 of the macaque monkey.[77] Almost half of the cells they examined responded to edge-induced illusory contours and line-induced illusory contours.[78] Although directly linking single-cell activities to perceptual phenomena remains problematic, the data collected by Peterhans and Von der Heydt suggests that the perception of illusory boundaries involves neural filling-in of a presence, rather than ignoring an absence. Gregory Lesher describes these findings as the discovery of 'illusory contour cells'.[79] However, Von der Heydt, Peterhans, and Baumgartner adopt the more cautious

Perceptual Imagination and Perceptual Memory, ed. by Fiona Macpherson and Fabian Dorsch, Oxford: Oxford University Press, 2018, 161–85; Xuyan Yun, Simon J. Hazenberg and Rob Van Lier, 'Temporal Properties of Amodal Completion: Influences of Knowledge', *Vision Research*, 145, 2018, 21–30; Siyi Chen, Hermann J. Müller and Markus Conci, 'Amodal Completion in Visual Working Memory', *Journal of Experimental Psychology*, 42: 9, 2016, 1344–53; James Dadam *et al.*, 'Amodal Completion of Boundaries in Coloured Surfaces', *Psychologia*, 55, 2012, 227–54; Briscoe, 'Mental Imagery and the Varieties of Amodal Perception', *Pacific Philosophical Quarterly*, 92: 2, 2011, 153–73; Nanay, 'Perception and Imagination: Amodal Perception as Mental Imagery', *Philosophical Studies*, 150, 2010, 239–54; Nanay, 'Amodal Perception: Access or Visualization?' in *Proceedings of The Second European Cognitive Science Conference*, ed. by Stella Vosniadou, Daniel Kayser and Athanassios Protopapas, Mahwah, NJ: Lawrence Erlbaum, 2007, 492–97; and Kanizsa and Gerbino, 'Amodal Completion: Seeing or Thinking?' in *Organization and Representation in Perception*, ed. by Jacob Beck, Hillsdale, NJ: Lawrence Erlbaum Associates, 1982, 167–90.

[77] See Esther Peterhans and Rüdiger von der Heydt, 'Mechanisms of Contour Perception in Monkey Visual Cortex. II. Contours Bridging Gaps', *Journal of Neuroscience*, 9: 5, 1989, 1749–63.

[78] See Peterhans and Von der Heydt, *Mechanisms of Contour Perception in Monkey Visual Cortex*. See also Von der Heydt and Peterhans, 'Mechanisms of Contour Perception in Monkey Visual Cortex. I. Lines of Pattern Discontinuity', *Journal of Neuroscience*, 9: 5, 1989, 1731–48; and Von der Heydt, Peterhans and G. Baumgartner, 'Illusory Contours and Cortical Neuron Responses', *Science*, 224: 4654, 1984, 1260–62.

[79] Gregory W. Lesher, 'Illusory Contours: Toward a Neurally Based Perceptual Theory', *Psychonomic Bulletin and Review*, 2, 1995, 279–321.

descriptor, 'illusory contour stimuli'.[80] They also borrow the term 'anomalous contours' from Kanizsa to define a stimulus property without reference to perception.[81]

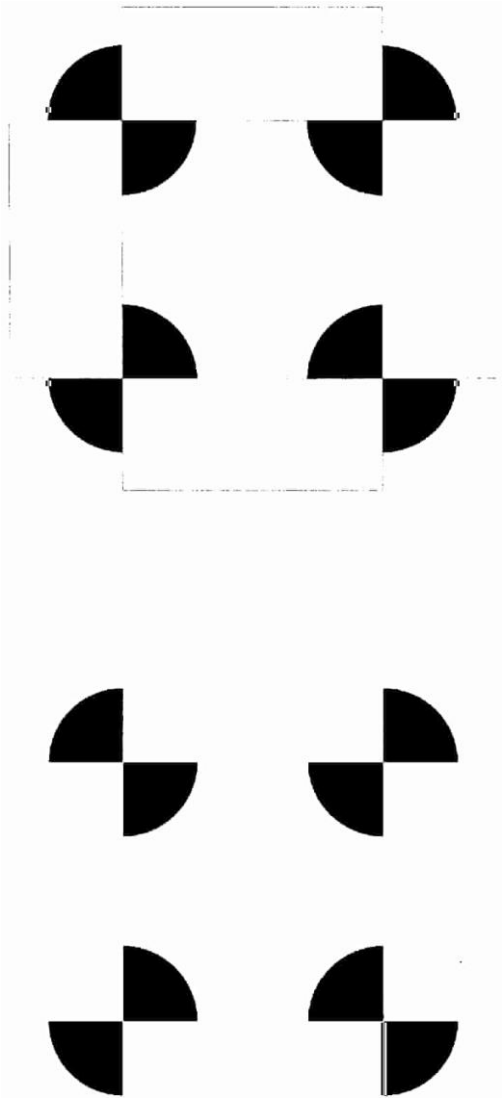

Figure 7. Luiz Pessoa, Evan Thompson and Alva Noë, *Four Disks Occluded by Four Rectangles* (top); *Four Disks Occluded by Four Illusory Rectangles* (bottom), 1998. In Pessoa, Thompson and Noë, *Finding out about Filling-In*, 729.

[80] See Von der Heydt, Peterhans and Baumgartner, *Illusory Contours and Cortical Neuron Responses*.

[81] See Kanizsa, *Organization in Vision*; and Kanizsa, *Margini quasi-percettivi in campi con stimolazione omogenea*.

Other psychophysical studies point to a common early treatment of both real and illusory contours by the visual system.[82] Andrew Smith and Ray Over have found evidence showing similarities between the two types of contours in the realm of motion aftereffects, tilt aftereffects, orientation discrimination, and orientation masking.[83] A tilt aftereffect, for example, occurs when a subject observes lines oriented counter clockwise from the vertical for a few seconds and is then exposed to an image showing vertical lines. In a persisting effect caused by the former image, the latter one will appear to him or her to be tilted clockwise. There is compelling evidence indicating that tilt aftereffects cross over between real and illusory contours.[84] Following this logic, adaptation with real lines can affect the perception of illusory contours. In this sense, the data reveals a functional equivalence between real and illusory contours in the operation of the visual system.[85] Thus, these results demonstrate that the perception of real and illusory contours share internal processes at an early level of the visual system.

Mario Fiorani and his colleagues have likewise provided evidence for the neural basis of perceptual filling-in that allows for completion of a visual image.[86] They propose that the existence of the neural filling-in mechanism is demonstrated by the 'completion neurons' firing in the visual blind spot. Ricardo Gattass and his collaborators also report that the same kind of neurons activate in response to completions behind occluders – that is, in cases of amodal completion.[87] Although more evidence is needed to discuss 'filling-in cells' – as Pessoa, Thompson, and Noë note[88] – neurons responding to filling-in phenomena are a likely candidate for its underlying mechanism.[89]

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[82] See Lesher, *Illusory Contours*; and Lothar Spillmann and Birgitta Dresp, 'Phenomena of Illusory Form: Can We Bridge the Gap Between Levels of Explanation?', *Perception*, 24, 1995, 1333–64.

[83] See Andrew Smith and Ray Over, 'Motion Aftereffect with Subjective Contours', *Perception and Psychophysics*, 25: 2, 1979, 95–98; Smith and Over, 'Orientation Masking and the Tilt Illusion with Subjective Contours', *Perception*, 6: 4, 1977, 441–47; Smith and Over, 'Color-Selective Tilt Aftereffects with Subjective Contours', *Perception and Psychophysics*, 20: 4, 1976, 305–8; and Smith and Over, 'Tilt Aftereffects with Subjective Contours', *Nature*, 257, 1975, 581–82.

[84] See Mark A. Berkley, Bart Debruyn and Guy Orban, 'Illusory, Motion, and Luminance-Defined Contours Interact in the Human Visual System', *Vision Research*, 34: 2, 1994, 209–16; and Michael A. Paradiso, Shinsuke Shimojo and Ken Nakayama, 'Subjective Contours, Tilt-Aftereffects, and Visual Cortical Organization', *Vision Research*, 29: 9, 1989, 1205–13.

[85] See Table 1 of Lesher, *Illusory Contours*; and Spillmann and Dresp, *Phenomena of Illusory Form*, 1347.

[86] See Fiorani *et al.*, *Dynamic Surrounds of Receptive Fields in Primate Striate Cortex*.

[87] See Ricardo Gattass *et al.*, 'Visual Responses Outside the Classical Receptive Field in Primate Striate Cortex: A Possible Correlate of Perceptual Completion' in *The Visual System from Genesis to Maturity*, ed. by Roberto Lent, Boston, MA: Birkhäuser, 1992, 233–44.

[88] See Pessoa, Thompson and Noë, *Finding out about Filling-In*.

[89] See Ikuya Murakami, 'A Retinotopic Representation of Filling-In: Further Supporting Evidence', *Behavioral and Brain Sciences*, 21: 6, 1998, 765–66.

Pessoa, Thompson, and Noë remark that 'although the exact mechanisms of neural filling-in are unknown, what we do know suggests that they occur early in the process of vision'.[90] Furthermore, their data indicates that 'the perceptual completion of boundaries in illusory contours occurs as early as V2'.[91] From these considerations, it is possible to deduce that, as these authors state, the perception of objects is determined not only by visual processing but also by expectations formed through prior interactions with similar objects.[92] This seems to be confirmed by the morphologies of, and responses to, the partly hidden figures and unfinished images discussed in this paper, in which a part of the body speaks for the whole.

Conclusion

Existing empirical studies may shed some light on the way beholders respond to incomplete figures – or 'etcetera principle', as Gombrich defined it – such as those analysed in this paper.[93] I propose that the completion that may take place in the observer's brain during the observation of figures representing human bodies with missing faces is modal in nature, as images completed modally present illusory contours. In most cases, the illusory contours of a face or limb are perceptually salient and appear to complete an unfinished figure. The so-called *Hidden Dalmatian Dog Illusion* (Figure 8), which shows a series of Dalmatian spots without contours, might be used as an instructive example of this phenomenon. Once the viewer recognises the 'dog', (s)he can perceive its (illusory) contours. As Nanay states, 'before you get to see the dog, you do not see these illusory contours – you see them only once you see the dog in the picture'.[94]

On the other hand, I argue that amodal completion may occur during the contemplation of partly hidden figures, as amodal completion typically takes place when the beholder's mind completes a figure that is covered by another figure or object. This may occur, for instance, during the observation of the man partly hidden behind the cross in Giotto's *Last Judgement*. In this case, the concealed parts of the man's body are said to be amodally present. Amodal completion also refers to the perception of figures that lack some visible attributes but remain easily recognisable by the viewer.

[90] Pessoa, Thompson and Noë, 'Filling-In is for Finding Out', *Behavioral and Brain Sciences*, 21: 6, 1998, (781–96) 786.

[91] Pessoa, Thompson and Noë, *Filling-In is for Finding Out*. See also Hanlin Tang and Gabriel Kreiman, 'Recognition of Occluded Objects' in *Computational and Cognitive Neuroscience of Vision*, ed. by Qi Zhao, Singapore: Springer, 2017, 41–58.

[92] See Pessoa, Thompson and Noë, *Finding out about Filling-In*, 754.

[93] Gombrich, *Art & Illusion*, 184–86.

[94] Nanay, *Aesthetics as Philosophy of Perception*, Oxford: Oxford University Press, 2016, 53.

Figure 8. *Hidden Dalmatian Dog Illusion*. Image in Public Domain.

Perceiving these types of incomplete figures is a matter of contour completion or surface completion. In contour completion, collinear lines, edges, or fragments are perceptually grouped together by the visual system.[95] However, the phenomenon of contour completion may vary from case to case. In some instances, an illusory line may emerge perceptually, as between the two collinear edges in the so-called Kanizsa square (Figure 9); whereas in other cases, less is visible to the naked eye. The 'joining together' mechanism that underlies contour completion can be measured between any type of collinear line and edge, which means that they can be perceptually aligned.[96] Scientific data reveals that the visual system 'expects' something to appear within gaps between collinear fragments, and that it is ready to fill in the missing information. For example, long-range interactions between orientation selective neurons in the visual cortex provide a convincing neurophysiological explanation of contour completion across spatial gaps.[97]

[95] See Dresp, 'Area, Surface, and Contour: Psychophysical Correlates of Three Classes of Pictorial Completion', *Behavioral and Brain Sciences*, 21: 6, 1998, 755–56.

[96] See Christian Wehrhahn and Dresp, 'Detection Facilitation by Collinear Stimuli in Humans: Dependence on Strength and Sign of Contrast', *Vision Research*, 38: 3, 1998, 423–28; Cong Yu and Dennis M. Levi, 'Spatial Facilitation Predicted with End-Stopped Spatial Filters', *Vision Research*, 37: 22, 1997, 3117–27; and Dresp and Stephen Grossberg, 'Contour Integration Across Polarities and Spatial Gaps: From Contrast Filtering to Bipole Cooperation', *Vision Research*, 37: 7, 1997, 913–24.

[97] See Charles D. Gilbert and Wiesel, 'The Influence of Contextual Stimuli on the Orientation Selectivity of Cells in the Primary Visual Cortex of the Cat', *Vision Research*, 30: 11, 1990, 1689–701.

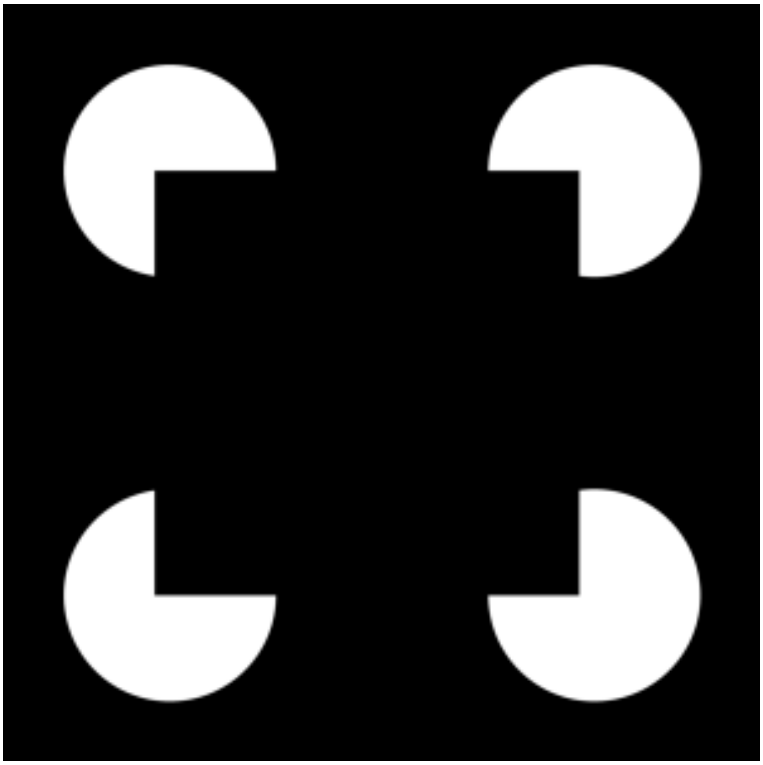

Figure 9. Gaetano Kanizsa, *Square*. Image in Public Domain.

By contrast, in surface completion, fragments of real or apparent contours give rise to perceptual closure and allow the completed regions to emerge as figures from the ground.[98] The *Kanizsa triangle* is an example of this phenomenon. Perceptually closed surfaces usually show phenomenal properties of figural relief or depth or have illusory contours. As Stanley Coren, Clare Porac, and Leonard Theodor have shown, the expectations of subjects significantly influence the perception of the shape at the centre of the *Kanizsa triangle* made up by illusory contours.[99]

Based on the above findings, it is possible to conclude that neural filling-in gives rise to a mental image, that is, an image of a complete figure as suggested by the morphology of the incomplete figure. Such an image can only exist in the mind's eye of the viewer. This explains, in experimental aesthetic terms, Gombrich's concept of 'the beholder's share' and the neurological mechanism underlying the perception of images containing 'ill-defined areas'.

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[98] See Kurt Koffka, *Principles of Gestalt Psychology*, New York, NY: Harcourt, Brace and Company, 1935.

[99] See Stanley Coren, Clare Porac and Leonard H. Theodor, 'The Effects of Perceptual Set on the Shape and Apparent Depth of Subjective Contours', *Perception and Psychophysics*, 39, 1986, 327–733.

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