I am viewing a double eclipse of the sun. Traveling east is the heavenly body Far. Traveling west and nearer to me is the smaller body Near. Near is close enough to compensate exactly for its smaller size with respect to shadow formation. Near and Far look the same size from my vantage point. When Near falls exactly under the shadow of Far, it is as if one of these heavenly bodies had disappeared. Do I see Near or Far?

Figure 1

*I thank far-sighted members of colloquium audiences at Dartmouth College, the University of Connecticut, and the University of Delaware for their perceptive comments. I also received insightful counsel from Jonathan Adler, John Carroll, Fred Dretske, Julia Driver, Doug Ehring, Brian McLaughlin, David Robb, Walter Sinnott-Armstrong, Gerald Vision, and Denis Walsh.

Common sense answers that I see Near rather than Far: Near is an opaque body that completely blocks my view of Far. Since I see something, I see Near.

I. THE CAUSAL THEORY CORRECTLY PRECLUDES NEAR

According to the causal theory of perception, S sees object O just when there is an appropriate causal connection between S and O. ‘Appropriate’ has proven difficult to spell out. But the theory entails a necessary condition that clearly precludes the possibility that I see Near: S sees O only if O is a cause of what I see. Near is totally within the shadow cast by Far. An object that is completely enveloped in a perfectly dark shadow cannot be seen. A cat silhouetted against the moon can be seen by virtue of the light it blocks. But since Far is preventing any light from striking Near, Near is not casting a shadow. Near is causally idle and therefore invisible. If light were being reflected by Near into my eyes, Near would preempt Far; and I would see Near. But since I am actually seeing by virtue of partial light blockage, it is Far that preempts Near.

H. P. Grice\(^1\) motivated the causal theory of perception with a thought experiment. Suppose I believe I am facing an unoccluded pillar. Unbeknownst to me, there is a mirror that is reflecting the image of the pillar to my rear. On the opposite side of the mirror there is a pillar, indeed one that would look just like the one in the mirror. If the mirror were removed, there would be no phenomenological difference. Under these conditions, common sense correctly says I see the mirror and not the occluded pillar. The reason is that the occluded pillar plays no causal role in what I see.

Or suppose that there are two identical coins in my line of sight, one behind the other. If the front coin is rolled away, the scene will look the same. Nevertheless, I do not see the rear coin because it makes no actual difference to what I see. The reason why I see only the objects facing me is that only they are in a position to transmit light into my eyes. More generally, the perceiver’s field of vision is widely agreed to comprise the front surfaces of those opaque bodies lying within a conical region radiating outward from the perceiver’s open eyes. The causal theory of perception provides a natural explanation of why my field of vision is structured as it is.

Alvin Goldman\(^2\) uses satisfaction of this environmental relation between perceiver and perceived as one of three defeasible factors in determining whether an object is seen. His second factor is the exis-

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tence of a physical mechanism. By this Goldman means a causal pathway by which the object transfers energy to the perceiver. His last factor is counterfactual dependency: Would the scene have looked different had the object not been there? Each of these factors has some say but none has a veto. Consequently, there will be hard cases. Goldman considers Jaegwon Kim’s example of an astronomer looking at a black hole through a telescope. The astronomer sees the black hole by virtue of its contrast with the background star light. According to Goldman, the black hole is in the perceiver’s field of vision and satisfies the counterfactual dependency condition but violates the physical mechanism condition.

To save the causal theory, Goldman claims that ‘cause’ is ambiguous between a counterfactual-dependency sense and a physical-mechanism sense. Since parallelism and occasionalism deliver counterfactual dependency without causation, this ambiguity defense fails. For good or ill, the causal theory unequivocally condemns idle objects to invisibility. If God made an astronomer have hallucinations of a black hole that reliably track the black hole, the astronomer would not see the black hole.

Since black holes violate just one of Goldman’s conditions, he (correctly) acquiesces to the intuition that the astronomer sees the black hole. It is striking that Far violates all three of Goldman’s conditions. The environmental relation is unsatisfied because Near is in front of Far. The counterfactual dependency condition is violated because I would notice no change in the scene if Far were not present. And the physical mechanism condition is violated because Goldman requires that the physical mechanism involve an energy transfer from the object to its perceiver.

Although Near satisfies the environmental condition, Near violates Goldman’s other two conditions. Near transfers no energy to me. And if Near were absent, the scene would be indistinguishable. Hence, Goldman is committed to saying that I see neither Near nor Far.

I have future comments on each of Goldman’s factors of perception. But here is an immediate remark about the environmental relation. The relativity of ‘occlude’ forces a corresponding relativization of our field of vision. Consider two dark nebulae that exactly overlap in the manner of Near and Far. A dark nebula is a dense cloud of interstellar dust. Dark nebulae do not transmit light in the optical region of the spectrum. Yet they are conspicuous in any photograph of the Milky Way because of their contrast with ambient starlight. The twist is that “dark” nebulae glow brightly in the infrared because interstellar dust efficiently absorbs optical and ultraviolet radiation. An
astronomer peering through an infrared telescope can see the near nebula. But an astronomer using an optical telescope cannot. Relative to infrared observation, the near nebula occludes the far nebula. But the reverse holds for optical observation. The infrared astronomer has a classical field of vision in which he sees the fronts of objects. The optical astronomer has a back-lit field of vision in which one of the objects is visible by its backside.

The correct solution to the eclipse riddle is that I see Far. This answer follows as a bold consequence of the causal theory of perception, given natural background assumptions. ‘I see Far’ will seem bizarre as long as we persist in modeling all vision on seeing objects that transmit light (by reflection, refraction, or emission). We must be careful not to prejudice the explanation of our field of vision by overlooking alternate lighting conditions. In particular, when objects are back-lit and are seen by virtue of their silhouettes, the principles of occlusion are reversed. In back-lit conditions, I can hide a small suitcase by placing a large suitcase behind it. The reversal runs deeper: we see the backs of back-lit objects. Although this thesis seems like parapsychology, my premises are drawn from the reigning orthodoxy. I am a conservative rather than a radical.

II. SHADOW ARCHITECTURE

Any opaque object can be seen by virtue of its silhouette. The shade formed by a back-lit object is a volume that commences from the far side of the object. Call this initiating surface the silhouette. The shade extends from the silhouette in accordance with principles of projective geometry. The shadow can be truncated only by light. Intervening opaque objects do not stop the shadow. After all, the shadow is a privation of light rather than a positive force. Hence, it does not need to penetrate objects to reach the opposite side. Nevertheless, the shadow is sensitive to whether the object contains light. Consider a silhouetted safe that contains a flare. If the flare is burning, then the near wall of the box blocks light and so casts the shadow at the base of the safe.

The dark area on the initial surface of an intermediate object is called a “cast shadow” by architects. They call the shade between the beginning and end of the shadow “the invisible shadow” (though they admit it can be seen when the air is dusty).

3 The representational sense of ‘silhouette’ is etymologically prior to its mereological sense. The notorious French controller general of finance, Etienne de Silhouette (1709-1767), had a hobby of cutting shadow portraits out of black paper. ‘Silhouette’ came to be applied to depictions of this sort and then later became applied to the causal basis of those depictions. Compare ‘silhouette’ with ‘pin-up’, which at first denoted only poster depictions of sexy women and then came to denote the subjects of those depictions.
Shadows are not mere absences of light. Shadows require light sources and transparent regions where light would have entered were it not for objects that block the source. A brick resting flat on the ground at high noon casts no shadow. If I lift the brick, it casts a shadow. But I have not discovered a pre-existing shadow.

Philosophers exacerbate the mystery of shadows by treating the shadow as if it consisted solely of the cast shadow. For instance, Avrum Stroll⁴ contrasts the three dimensionality of a physical object with the two dimensionality of shadows. Whereas two objects cannot be the same place at the same time, a two-dimensional shadow can be “located in the same portion of space that, say, a stretch of road is occupying. So shadows have an existence in space without displacing space” (ibid., p. 75). Stroll is led to wonder whether shadows violate John Locke’s⁵ principle that two things of the same kind cannot be in the same place at the same time. If two people cast shadows that exactly overlap, why must there be one shadow rather than two (ibid., p. 72)?

⁵ Locke states the principle in Essay concerning Human Understanding, Essay II, chapter 27, section 1.
Puzzlement is diminished by the architect’s conception of the cast shadow as a surface of a three-dimensional volume. The two dimensionality of the cast shadow is due to its status as a surface rather than its status as a shadowy thing. Hence the cast shadow has no special property of being in space without displacing space. If an interloper walks exactly into my invisible shadow, then he does not cast a shadow. To cast a shadow, he must block light.

With the help of separate light sources, two coins can causally overdetermine the same cast shadow. If you glue penny A to the center of flashlight A and penny B to the center of flashlight B, then you can position the pair of flashlights so that penny A and penny B cast the same shadow against a wall. The symmetry of the situation prevents either flashlight from preempting the other. Since each penny generates a distinct volume of shade, their shared cast shadow is like the shared section of two intersecting roads. It is also possible for the two pennies to share nearly all of their invisible shadows. Just point the two flashlights directly at each other.

The parasitic nature of shadows makes it natural to infer that “a shadow is sustained in existence by the continued existence of its originating source.” ⁶ But shadows can survive the destruction of their originators; consider a tree that is constantly illuminated as it petrifies into stone. The shadow begun by the tree is continued by the stone.

It is also possible for a shadow to persist without any sustaining object. Light travels at 299,792,458 meters per second in a vacuum. The moon is about 384,400,000 meters away from the earth. Hence, if the moon were instantly obliterated during a solar eclipse, its shadow would linger for over a second on the surface of the earth. If the moon were further away, its shadow could last several minutes. We can extrapolate to posthumous shadows that postdate their objects by millions of years. We can also speculate about an infinite past in which a shadow is sustained by a beginningless sequence of objects. As one object is destroyed, it is seamlessly replaced by an object of the same shape and size. Arguably, this shadow antedates any object in the sequence and so threatens the principle that every shadow is caused by an object.⁷

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⁷ Yet more speculative is Samuel Levey’s scenario involving an infinite sequence of walls where wall $n$ has a thickness $1/2^n$ meters. If the sun rises from the thin side, which wall casts the shadow at the base of the thickest wall? I suspect Levey’s scenario is either physically impossible or underspecified. What do the photons hit if there is no first wall to strike?
Do we see silhouetted objects that no longer exist? The answer is the same as the solution to the old riddle prompted by starlight that survives its star: Can we see stars that no longer exist? Yes, but we see them as they were, not as they are.

Since the silhouette of an object is part of the object, there can be cast shadows without silhouettes. Thus the leading edge of a shadow need not be a silhouette. (Since an uninterrupted shadow ends at a region of space instead of at the surface, it follows that some shadows have neither a silhouette nor a cast shadow.) When the object is destroyed, the leading edge of the dark three-dimensional volume races toward its opposite edge at the speed of light. Small volumes of shade appear to be destroyed at exactly the time that the object is destroyed. But, strictly speaking, shadows last longer than their destroyed objects.

The speed of light compels a surprising qualification to my answer to the eclipse riddle. Initially, Near blocks light because there will be photons trapped between Far and Near. Once Near absorbs these intermediate photons, it will no longer block any light and consequently become invisible. Only at that stage do we see Far.

Although cast shadows are displaced and usually distorted, silhouettes provide a visual match that is comparable to that achieved with transmitted light. Seeing a silhouette of an object counts as seeing the object itself. This principle is prehistoric and culturally universal. Silhouette portraits are the earliest and most universal genre of representational art. Some are found in prehistoric caves. There are ancient specimens from Egypt, China, and Greece. Intricate eighteenth-century silhouette portraits are housed in London’s National Portrait Gallery.

This simplest form of portraiture was a stepping stone to early photography. Instead of tracing a shadow by hand, John Herschel had nature fix the image with potassium ferricyanide in 1839. Botanists would place a plant directly on the photosensitive paper and shine a strong light on it. The blue and white image, a precursor of the blueprint, was sensitive to the varying opacity of the plant—unlike simple silhouettes. Cyanotype photographers were aware that the images were of the back sides of the plants; for they warn novices to turn the intricate features face down. Further piecemeal improvements in photochemistry and optics allowed the object’s image to be taken without direct contact with the photosensitive paper. Further improvements decreased exposure time, increased the durability of

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8 I owe this point to Laurie Paul. She notes that the qualification is not needed if Far is stationary.
the photograph, and formed a continuous developmental sequence leading up to modern photography.

Night photography harks back to these roots. Nazi naval archives contain ominous silhouette photographs of targeted ships. Although New York City was out of range of Nazi bombers, cargo ships using New York harbor were in range of Nazi submarines. The cargo ships turned off their sea lights but were back-lit by the bright lights of Manhattan. (This explains why New York City had to be blacked out during World War II.) The Nazi archives also include silhouette photographs of the effects of cargo ships—their wakes, smoke, debris, and the like. These photographs of ship effects can be distinguished from the photographs of the ships themselves. Consider a submarine captain who first spots traces of a ship against the moonlight. Since the captain sees that a ship is in the vicinity, he follows its trail until, finally, he sees the ship itself profiled against the moonlight.

Purely contrastive seeing is not an ability peculiar to homo sapiens. Aquatic predators frequently hunt from below. Light enters water from above, so prey are back-lit. A shark that approaches a school of anchovies from the side will be dazzled by the light reflected by the anchovies’s scales as the school sharply pivots in unison. Some sharks counter by driving the school toward the surface and then lunging in from below. The sharks see the anchovy silhouettes. They also see the anchovies.

One rationale for counting the sighting of a silhouette as a sighting of the object might be that the visual match is sufficiently good—or as good as obtained during nocturnal conditions when we see only in black and white. This fidelity explains why silhouettes are so widely used as iconographic symbols.

As in the case of seeing transmitted objects, the good visual match holds only as a general trend. The silhouette of a pile of junk does not look much like a pile of junk. But if I see a silhouette of a pile of junk, I see a pile of junk. Interviewers preserve the anonymity of informants by televising them in silhouette. Viewers see the informant but cannot identify him on the basis of what they see.

Under some conditions, a cast shadow provides just as strong a visual match as the silhouette. Early silhouette portraitists traced the sitter’s shadow as it was cast against white paper. Casting a shadow on a cloud with a powerful search light makes it seem as if one is seeing an object back-lit from the sky above. Hence the “bat signal” from the Batman comic strip is called a silhouette.

An object’s genuine silhouette has a more robust resemblance to the object than the object’s cast shadow. The cast shadow is only comparable to the corresponding silhouette under a narrow set of conditions—
and only if we ignore the spatial displacement. Causal theorists reject
the hypothesis that seeing is a matter of having experiences that resemble
the scene. Resemblance is neither a necessary nor a sufficient condition
for seeing. Causal theorists agree that there is generally a good visual
match, but seek to explain that fidelity in terms of causal connections between visual experience and the scene. Why do silhouettes generally provide a better match than cast shadows? Why do I see an object by seeing its silhouette but not by seeing its cast shadow?

Note that I am using ‘see’ in Fred Dretske’s9 sense of nonepistemic seeing. Whereas seeing that a is F entails belief that a is F, nonepistemic seeing lacks belief content (ibid., p. 88). When cave men witnessed a solar eclipse, they saw the moon even if they had no beliefs about what they were seeing.

Or consider the original situation in which I am in doubt about whether I am seeing Near or Far. Given my lack of belief, I cannot be said to see that the silhouetted object is Near or see that the silhouetted object is Far; for I lack the belief that the object is Near and lack the belief that the object is Far.

III. CAUSAL PROCESSES AND PSEUDO-PROCESSES

Wesley Salmon10 draws a distinction that helps the causal theorist explain why seeing the silhouette of an object is seeing the object but seeing its cast shadow is merely seeing an effect of the object. When a blimp casts a shadow that races along the ground, the moving shadow has persistence conditions that are entirely parasitic on the blimp and the sun. I can predict where the shadow will move by keeping my eyes on the ground and tracking the shadow’s speed and direction. But the stages of the shadow’s movements are not related as cause and effect. Rather, they relate to the stages of the blimp’s movements. Elliott Sober11 diagrams the causal structure by using \( \rightarrow \) to represent causal connections and broken arrows as the absence of a causal connection (ibid., p. 303):

\[
\begin{align*}
\text{causal process} & \quad C1 \rightarrow C2 \rightarrow C3 \rightarrow C4 \rightarrow C5 \\
\text{pseudo-process} & \quad P1 \rightarrow P2 \rightarrow P3 \rightarrow P4
\end{align*}
\]

9 Seeing and Knowing (Chicago: University Press, 1969), p. 88. Do not picture nonepistemic seeing as restricted to agnostic viewing. Nonepistemic seeing is compatible with being heavily opinionated about what one is seeing. Dretske’s point is that this sense of ‘see’ does not entail any beliefs.


If I watch the moving shadow cast by the blimp, then I see a pseudo-process governed by the blimp’s movement. But if I watch the silhouette of the blimp, I see a causal process. The same point holds if the blimp is stationary.

If the blimp collides with a skyscraper and is destroyed, the shadow is terminated. If only the shadow meets the skyscraper, the shadow is momentarily deformed but then, after passing the skyscraper, continues on exactly as before, carrying no trace of its encounter with skyscraper. I can enlarge the cast shadow by inserting a flag into the perimeter of the invisible shadow as the cast shadow passes in front of me. But this alteration does not persist after the shadow passes the flag. Putting a flag on the blimp does result in a lasting change. I can mark the blimp but cannot mark the shadow.

A given process, whether it be causal or pseudo, has a certain degree of uniformity—we may say, somewhat loosely, that it exhibits a certain structure. The difference between a causal process and a pseudo-process, I am suggesting, is that the causal process transmits its own structure, while the pseudo-process does not. The distinction between processes that do and those that do not transmit their own structure is revealed by the mark criterion. If a process—a causal process—is transmitting its own structure, then it will be capable of transmitting certain modifications in that structure.\(^{12}\)

The silhouette of the blimp is a causal process because it satisfies the mark criterion. A change of the silhouette is inherited by future stages of the silhouette.

Since an intrinsic change in the silhouette constitutes an intrinsic change in the object, the silhouette is part of the object. A silhouette, in this mereological sense, is not a depiction because it exists independently of any intention to represent the object.

The moon is like the blimp during a solar eclipse. The silhouette of the moon is a causal process. If the silhouette is changed by a meteor collision, then the silhouette retains that disfigurement. The shadow cast by the moon is a pseudo-process, however. As it races along the surface of the earth, local interventions have no effect on future stages.

The shadow moves as quickly as the earth spins. In principle, a shadow can move faster than the speed of light. Suppose I held my thumb over a flashlight that could transmit light across vast distances. I wave the flashlight, sending the shadow of my thumb coursing through the heavens. The rate at which the cast shadow moves

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\(^{12}\) Salmon, p. 144.
increases geometrically with distance. At a large enough distance, my thumb's shadow is moving faster than the speed of light.

This is compatible with the special theory of relativity. The theory says only that no signal can travel faster than the speed of light. The shadow is not a signal because it cannot transmit information. My thumb's shadow when cast on surface A does not pass on any information from A to any subsequent location B. The shadow's features at B instead depend on the flashlight and my thumb.

The silhouette of my thumb can move only as fast as my thumb; for the silhouette of my thumb is where my thumb is. The persistence conditions of a silhouette make it a causal process. A process is a persistence of something—a wave, a table, and so on. Both the object and its silhouette are genuine causal processes.

Plato's allegory of the cave was inspired by the shadow plays of puppeteers. In the allegory, men are shackled together in a way that keeps them facing a cave wall. Behind and above them is a fire and a walled walkway. The barrier conceals servants who stroll by with figurines above their heads. These figurines cast shadows on the cave wall. This shadow play is the only reality for the prisoners who have never seen things under normal conditions. The prisoners consider the shadows as objects in their own right. They do not view them as signs of other objects. They do not know that the shadows are cast by figurines and so do not use the shadows to make inferences about those figurines. When the prisoners view the shadows in this fashion, they do not see the figurines. My explanation is that one can see only an object via a causal process emanating from that object. The prisoners do not see any objects even though they can predict the patterns of shadow play.

If a prisoner is turned toward the silhouettes of the figurines, then he sees the figurines—whether he recognizes them or not. Suppose the prisoner comes to have normal knowledge of the world but resumes his original station in front of the shadows. This prisoner knows that the figurines are casting the shadows. He can see that the present shadow is being cast by the horse figurine. Yet he no more sees the figurine than his ignorant companions. He sees exactly what his ignorant cavemates see. Since nonepistemic seeing has no belief content, what one sees cannot be increased by learning.

Astronomy teachers warn that staring at an eclipse causes irreversible eye damage. Galileo's telescope magnified this destructive

14 Salmon, p. 140.
power and contributed to his blindness. Hence teachers encourage students to view eclipses by means of pinhole cameras. The students can safely watch the shadow cast on the ground by the moon as it crosses in front of the sun. Teachers assure the students that they are seeing the moon eclipse the sun. But the students are actually like the enlightened cave prisoner who knows the shadow is cast by an object that is, sadly, out of view. Only a student who steals a glance at the silhouette in the sky sees the moon eclipsing the sun.

IV. SILHOUETTES AS ABSORPTION SURFACES

The silhouette is the surface of the object that makes it visible by virtue of the light that it blocks. Therefore, to see a silhouette of an object is to see a part of it. Seeing a relevant attached part of an object suffices for seeing the object simpliciter. The reason why we count seeing the silhouette of an object as seeing the object is that we are seeing a surface of the object.

Leonardo Da Vinci propounds a whittling objection to the assumption that the surface of an object is the outermost material part of an object. If the surface is the outermost part of the object, then how can it have any thickness? If it were one millimeter thick, then only the outermost 1/2 millimeter could be the outermost part of the object. That 1/2 millimeter could not be the outermost part because only its outer half could qualify as the outermost part of the object. That outer 1/4 millimeter can itself be halved. And so on. Consequently, surfaces have 0 thickness and thus cannot be a material part of the object. Da Vinci goes on to infer that the surface is a common boundary between an object and its environment.

The whittling argument illicitly manipulates the domain of discourse for the quantifier ‘outermost’. What counts as the parts of an object varies with purposes. Sometimes the parts include a coat of paint, the enamel, the peel, and so on. Sometimes not. The domain is nondissective; parts of the parts need not be in the domain of discourse. If I say that the surface of my couch is plaid, I am not refuted by the observation that none of the small parts of the surface is plaid. Da Vinci’s whittling argument can proceed only by shifts of context to smaller and smaller parts. Thus, the argument that material objects lack surfaces is much like Peter Unger’s argument that no material object is flat. Both of these arguments are refuted by the kind of contextual analysis David Lewis proposes in “Scorekeeping in a Language Game.”

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15 See Avrum Stroll, Surfaces (Minneapolis: Minnesota UP, 1988), pp. 40-46.
Like most philosophers and psychologists, I say that we see objects only by seeing their surfaces. Stroll\textsuperscript{18} cites Venus as a counterexample: we see Venus even though the surface of Venus is completely covered with clouds. I say that we see Venus only if we count the clouds of Venus as part of Venus. If we count Venusian clouds as not part of Venus, then we do not see Venus. The same holds for objects that are marked to make them visible. If I paint part of a perfectly transparent ball black, then I see the ball only if the paint is part of the ball.

Stroll denies that Jupiter has any surface at all since it is gaseous. Here, I concede that it is vague where the surface is. But the vagueness of the location is compatible with Jupiter having a genuine surface. Microphysicists regard the surfaces of all objects as vague.

Stroll rightly observes that philosophers and perceptual psychologists have done too little to defend their presupposition that all objects have surfaces. And he is right again about their lack of support for the presupposition that we see by virtue of these surfaces. But I think both presuppositions are correct. Therefore, I rely on both presuppositions when assimilating purely contrastive seeing to the case of seeing objects that transmit light. But I endorse Stroll’s objection to the assumption that we see by virtue of a single surface. Purely contrastive seeing shows that there are at least two types of surfaces that play a role in vision.

Surfaces have physical properties. In front-lit conditions, we see an object by virtue of the light transmitted by its front layer. In back-lit conditions, we see the object by virtue of light blocked by its back layer. A layer blocks by a different mechanism than it reflects. Consequently, the surface of a back-lit object consists of the portion of the object that is just enough to block the light. This absorptive surface must be distinguished from the reflective surface. We can represent the two surfaces of the far side of the moon like so: \textit{)).} The outer parenthesis is the surface relative to light reflection. The inner parenthesis is the surface relative to light absorption. An astronaut in orbit over the far side of the moon during a solar eclipse does not see the silhouette of the moon even though he sees the reflective surface of the far side of the moon. Viewers from earth are seeing the absorption surface.

More precisely, the viewers from earth are looking into a concave, bowl-shaped surface. It is indistinguishable from a dark disk just as the silhouette of a cube (viewed corner on) is indistinguishable from

\textsuperscript{18} \textit{Surfaces}, pp. 75-76.
the silhouette of a flat hexagram. But we are more apt to interpret the silhouette of the moon (in particular, the near side of the moon) three dimensionally as a convex surface. Hence the temptation to infer that the moon or sun has turned black. Most objects are convex rather than concave. Hence our strong preference for convexity could simply be due to the incorporation of an empirical regularity into our visual system.

Familiar seeing by transmitted light is surprisingly interpretative. The image of a square could be produced by an infinite variety of trapezoids or tilted rectangles. But silhouettes are much more interpretive because much less information is conveyed. Perceptual psychologists are impressed by how many of these physically possible interpretations never occur to the viewer. Usually, we promptly commit to a single interpretation. David Marr\(^{19}\) concludes that we disambiguate by hard-wired guidelines:

Somewhere, buried in the perceptual machinery that can interpret silhouettes as three-dimensional shapes, there must lie some source of additional information that constrains us to see silhouettes as we do.

Probably,...these constraints are general rather than particular and do not require a priori knowledge of the viewed shape (ibid., p. 219).

Marr articulates these assumptions as if the lines of sight emanate from an illumined object. If each point on the silhouette corresponds to one point on the viewed surface, we obtain a curve that serves as a contour generator. The three-dimensional shape of the object can be inferred, given Marr’s further pair of assumptions that nearby points on the contour of the image correspond to nearby points on the object and that all points on the contour generator lie in a single plane.

Thus, Marr underwrites our tendency to view the silhouette of the moon as convex with this rational reconstruction. If he is correct, our visual system violates the causal theory of perception. The system assumes, in effect, that we are seeing a part of the object that is causally idle, namely, the front surface of a silhouetted object. This hard-wired heresy might contribute to the counterintuitiveness of my thesis that we see the backs of silhouetted objects.

Regardless of whether I am laboring against a neurological illusion, my thesis that we see the (inner) far side of the moon during an eclipse is paradoxical. The general reason is that we tend to model vision on cases where we see objects by means of the light they transmit. This makes it seem like we are seeing through the 3,600 kilometers of solid rock between us and the far side.

\(^{19}\) Vision (San Francisco: Freeman, 1982).
To lessen the appearance of a miracle, some people suggest that I am only seeing the edge of the moon during a solar eclipse. The edge can block light, however, only if it is a physical object rather than an abstract mathematical limit. To be visible from earth, that edge would have to be many meters wide. If I can see the backside of this giant ring of matter, then I would still be seeing a surface that is behind several kilometers of solid rock! Reducing the quantitative scale of a miracle secures no advantage: “Don’t be so incredulous; Jesus only restored sight to one eye of the blind man.” Half a miracle is still a miracle.

Suppose a florescent balloon meanders in front of a solar eclipse. First the glowing balloon blocks our view of the bottom edge of the moon, then the middle of the moon. But if the balloon blocks our view of the middle of the moon, then we must have previously seen the middle of the moon. Therefore, we were not just seeing the edge of the moon during the solar eclipse.

Here is a summary of the basic argument for the thesis that I see the entire backside of silhouetted objects. When I see the silhouette of an object, I see the object. I see an object only if I see part of it. That part must cause my perception in an appropriate way. The only part that can play this causal role is the object’s absorption layer. Therefore, when I see a silhouetted object, I see its back surface.

V. CONFUSION ABOUT OCCLUSION

Objects that are seen at least partially in virtue of the light they transmit can be blocked from view by interrupting their transmission of light. But a perfectly dark object does not owe its visibility to the light it transmits. Hence, these nontransmitters are an exception to the principle that one can always conceal an object by interposing an opaque body. We do not need to see through the “blocking” object.

This point solves a puzzle about cast shadows. The first version was devised by Robert Fogelin around 1967 or 1968. It became a topic of lunchtime conversations with his colleagues at Yale University: Charles B. Daniels, Robert Stalnaker, Richmond Thomason, Samuel Todes, and Bas van Fraassen.20 The Yale puzzle and its solution were presented in detail by Todes and Daniels.21 But I shall present the

20 More oral history. My chief informant, Fogelin, was dissatisfied with a colleague’s analogy between ‘Only I can feel my pain’ and ‘Only I can cast my shadow’. Fogelin devised a complicated enigma involving infinitely many shadow casters. Fogelin is not sure whether the simplification to two shadow casters was his doing, the doing of another individual, or the product of the Yale collective consciousness.

simplified version van Fraassen mentions in *Laws and Symmetry*. Although ‘shadow’ is often used as a count noun, it should be read below as a mass noun (as in ‘How much shadow is there in the photograph?’):

I. If X casts any shadow, then some light is falling directly on X.
II. X cannot cast shadow through an opaque object.
III. All shadow is shadow of something (*ibid.*, p. 217).

Imagine a barn casting shadow on a sunny day. A bird flies between the barn and the shadow cast on the ground. The shadow directly beneath the bird cannot be cast by the bird (by virtue of I). Nor can it be cast by the barn (by virtue of II). But no third thing can cast the shadow. Hence, III is violated.

Principle II is true but insinuates that the only way that a shadow can appear on the far side of an intervening object is by penetration. It discourages us from considering the alternative that the shadow appears on the far side by default. Nothing aside from the original blockage of light is needed to place shadow there.

It is true that (unreflected) light can appear on the far side of an intervening object only by penetrating it. But opaque bodies do not block shadows. Nor do they let shadows pass through. It is also a mistake to picture a transparent pane of glass as letting a shadow pass through. The glass only lets light pass through. But this does not mean that glass blocks darkness. Talk of blocking or transmitting shadows is a symptom of the fallacy of reification.

A linguistic philosopher might be tempted to trace the reification to the fact that ‘shadow’ is a mass noun even though it has no mass. I suspect a stronger influence, however, is the representational economy of treating shade as if it were colored light. This fiction lets us effortlessly extend the projective geometry that is used to depict illuminated objects to the depiction of shadows. Artists sometimes draw with white chalk on dark paper. They represent shadows with undrawn regions. This omisssive method of representing shadows echoes scientific reality. We normally use light paper, however. To depict a dark area, we must shade in with a pencil or some dark substance. This practice abets the reification of shadows.

Darkness is an absence of light, not a substantive force that can be stopped with shields. Once the light has been stopped, nothing further needs to be done to ensure darkness. This asymmetry of manipulation is a general difference between properties and their

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23 Todes and Daniels, p. 90.
privations. A homeowner who insulates his house cannot literally keep the cold out; he can only keep the heat in. Cold is the privation of heat and hence is not a substance that can be directly manipulated.

Cold spots, shadows, and holes are not objects. Therefore, they do not challenge the principle that perceivers must have a causal connection with the seen objects. To see a hole is to see a perforated object. It is not the same as seeing that the object is perforated because one might mistakenly believe that one of the perforations is a spot of dark paint. We nonepistemically see holes. But this just amounts to nonepistemically seeing an object that has a certain shape. When I see a dark doorway, I see a holed wall. Behind every privation is a substance that suffers the privation.

VI. DARK OBJECTS MUST EFFECT CONTRASTS

W. R. Brain regards perception of perfectly dark objects as a counterexample to the causal theory of perception. But the causal theory correctly insists that we need light to see—if not light transmitted by the object, then light transmitted by the object's immediate surroundings.

Suppose my only source of light is a window that has two shutters. When the left shutter is closed, I see it by virtue of how its right side is outlined against the remaining light. When both shutters are closed, I see neither shutter.

The main reason for saying that the overshadowed smaller suitcase is invisible is that the smaller suitcase does not causally contribute to what is seen. The overshadowed suitcase also violates the requirement that $S$ nonepistemically sees $O$ only if $O$ “is visually differentiated from its immediate environment by $S$.” Consider a white moth on a white tree trunk. The white moth causes part of what I see, although not in a way that enables me to discern its outline. I am looking at the moth but I am seeing it.

Now consider a perfectly dark moth on a perfectly dark tree trunk. This case differs from the cases involving back-lit occlusions. The dark moth does not have a silhouette. The scene is front lit. Indeed, I am shining a strong light right on the moth. The moth is absorbing

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24 The temptation to reify holes can be strengthened with seductive arguments. These sophisms are beautifully illustrated and lovingly examined in Roberto Casati and Achille Varzi’s *Holes and Other Superficialities* (Cambridge: MIT, 1994).


all the photons that land on it and hence is playing a causal role in what I am seeing. For instance, if the dark moth is atop a white spot, the moth prevents me from seeing that white spot. Thus, the dark moth satisfies the causal theorist’s necessary condition for seeing. The moth is not an idler like Near.

When the dark moth is on a white tree trunk, the moth is seen by the contrast it creates via its light absorption. Absorption is a well-understood physical mechanism as evident from black-body research in physics. True, the white bark of the tree also contributes by reflecting light. But seen objects need not make the entire causal contribution.

Transmission of light is not a sufficient condition for being seen. The stars shine as brightly during the day as at night. If you put the halves of a ping-pong ball over your eyes, you do not see any objects. Transmitters rely just as much on contrast as dark objects. Human beings have exquisite contrast sensitivity that strains the capabilities of electronic display devices, such as television and computer graphics displays. People can detect a change of modulation of less than one percent across a border. This extreme sensitivity to differences in light intensity explains how the “darkness” of an object can itself be a pure contrast effect. Sunspots look dark solely because they are relatively cool spots on the sun. They would shine brightly if they could be removed from the even hotter photosphere of sun. The universality of this reliance on contrast explains why any object can be camouflaged by muting its contrast with its surroundings. Seen objects normally make a holistic contribution to the scene. They are visible by virtue of the differences that they make with their surroundings. The differences can be achieved by going up or down the scale of light intensity—including all the way down to zero.

The contrast between the silhouette and its background is muted by semi-opaque intermediates, such as window curtains. Since our eyelids are only semi-opaque, it is possible to see some objects with our eyes closed. Close your eyes and position a bright light bulb so close to them that you can feel the bulb’s heat. Now wave a pen just in front of your eyelids. (Contrast sensitivity is enhanced by movement.) Seeing the pen’s diffuse silhouette may make you receptive to the hypothesis that purely contrast seeing is biologically prior (phylogenetically and perhaps ontogenetically) to seeing objects by their transmitted light.

All evolutionary accounts start with a proto-eye that is merely sensitive to the presence of light and then develops into a detector of passing shadows. The first seen objects should have been silhouetted figures. Only later would we expect objects to be seen by virtue of the light they transmit. Instead of being a marginal form of vision, purely contrastive seeing is the primal form of seeing. Stereotypical seeing is an elaboration of this more basic ability.

Black holes amass the immediate surroundings that make themselves discernible. The textbook scenario features a black hole that develops from a large star in a binary star system. The larger star has been pulling matter from the smaller star. After the large star accumulates a critical amount of matter, it collapses into a black hole. Since the black hole has the same mass as it had when a large star, it continues to pull matter from its partner star. Since this new matter conserves angular momentum, it forms an accretion disk that revolves around the black hole. The matter from the inner part of the disk accelerates up to nearly the speed of light. The friction creates tremendous heat which in turn emits X-rays. Hence the black hole makes itself visible by piecing together an environment for itself.

Goldman rightly denies that there is a “transfer of energy or force” from the black hole to the observer (ibid., p. 282). But he wrongly denies that there is a physical mechanism by which the black hole makes itself seen. The black hole causes other things to transfer energy to observers. During World War II bombing raids, high-flying bombers could see the silhouettes of low-flying bombers below: 🇺🇸. The low bombers were back-lit from enemy searchlights. The low-flying bombers were not directly transferring energy into the eyes of high-flying observers. But the low-flying bombers were still causing themselves to be visible by rousing the enemy below.

Dark objects are a varied lot. Nevertheless, neither the overshadowed suitcase nor the overshadowed heavenly body, Near, satisfy the causal requirement. True, I would see Near if Far vanished. But I see in virtue of actual causation, not hypothetical causation. Recall Harry Frankfurt’s29 counterexample to the principle that I am responsible only if I could have done otherwise. An evil scientist has rigged up a device that will make me do an evil deed if and only if I fail to do it by my own accord. I do the evil deed, so the device does nothing. I am responsible for the evil deed even though I could not have done otherwise.

Compare Frankfurt’s case with Lewis’s censor. The censor is a device that will make me have the visual experience of a scene if and only if I do not have the visual experience in another way. I am having a visual experience of the scene by opening my eyes and receiving reflected light waves in the normal way. Am I seeing the scene?

Lewis says I see if and only if “the scene before my eyes causes matching visual experience as part of a suitable pattern of counterfactual dependence” (ibid., p. 285). The censor illustrates a lack of suitable dependence:

The case is one of causal preemption. The scene before my eyes is the actual cause of my visual experience: the censor is an alternative potential cause of the same effect. The actual cause preempts the potential cause, stopping the alternative causal chain that would have otherwise gone to completion (ibid., pp. 285-86).

Substitute ‘Near’ for ‘the censor’. Although the censor is idle, its “idleness is an essential factor in the causal process by which matching visual experience is produced... We cannot uniformly ignore or hold fixed those causal factors which are absences of intervention” (ibid., p. 286). Lewis concludes that I do not see the scene.

Lewis’s verdict has been unpopular. His personal envoy, Bruce Le Catt has tinkered with the counterfactual dependency theory to illuminate the possibility of securing a better match with intuition. But these changes do not address the main problem: underweighting the importance of physical mechanisms. As Brian McLaughlin stresses, I see because the censor is an external fail-safe device that does not prevent me from exercising my capacity to see.

Let me turn the topic temporarily from nonepistemic seeing to perceptual knowledge. The eclipse riddle does not fit into the tradition of skeptical counterpossibilities. It is not like cases involving dreams, brains in vats, or fake barns. I have access to all the relevant facts. When I observe Near and Far approach and then intersect, I know they are behaving just as astronomers predicted many years ago. My situation differs from that of a passerby who had only heard of Near and just happens to look up at the moment of inter-

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section. He might be surprised to learn that the dark shape might be caused by Far. Not me; I have been preparing for the event for years and know all the empirically relevant facts.

The only threat to my perceptual knowledge of Far is conceptual unclarity. If I fail to believe that I am seeing Far, then I do not know that I am seeing Far. Astronomers saw dark nebulae long before they had perceptual knowledge that dark nebulae are clouds of interstellar dust. They had surprising difficulty excluding the possibility that the dark regions in the sky are tunnels through which we look out beyond the stars of the Milky Way into intergalactic space.

VII. CAUSE, RESEMBLANCE, AND VISUAL DETECTION
We are tempted to say we see Near because we seem to see its outline (and so appear to satisfy Dretske's condition of visual differentiation). The influence of the outline can be gauged by considering a scenario that increases the relative size of Far. The huge shadow would make Near invisible. Those tracking the movement of Near would say that they had lost sight of Near as it is submerged into the massive umbra of Far.

The extent of overshadowing is irrelevant to occlusion as long as the entire object is covered. But the size of the shadow is relevant to visual detection. A thief who hides in a shadow that perfectly coincides with his shape is not as well concealed as one who enjoys coverage by a massive shadow that is not congruent with his shape.

When Near and Far have their original dimensions, the trackers of Near would be able to see that Near is aligned with Far even though they cannot see Near. To see an object, the object must be causally responsible for the visual information. This requirement explains why I do not see Mario Andretti when looking at his identical twin Aldo Andretti. A photograph of Aldo Andretti is not a photograph of Mario Andretti, even if their resemblance is exact. The astronomers are seeing an object that has the same look as Near. This resemblance ensures that what they see gives them all the visual information about Near that would have been available had Near caused the image itself. Hence, the astronomers tracking Near are reliably guided by the resemblance just as a reporter tracking Mario Andretti is reliably guided by a photograph of his identical twin Aldo Andretti.

Visual detection does not suffice for seeing. Astronomers first visually detected planets outside our solar system by observing perturbations of stars through ground telescopes. Only later, with the help of the Hubble telescope, did they see a planet outside our solar system.
VIII. THE COLLAPSE OF THE COMPOSITE ANSWER

The Far answer is unaffected by the third possibility that I am seeing a composite object whose parts are Near and Far. This mereological sum, Near+Far, is arbitrary but no more arbitrary than scattered objects, such as constellations. We do speak of seeing the moon even when we do not see the far side of moon. Seeing a relevant, properly attached part of an object counts as seeing the object simpliciter. Seeing behaves just like most transitive verbs in this respect; to scratch a relevant attached part of an object is to scratch the object itself. Near is the front of Near+Far and Far is its back. If I see the front of Near+Far, then I see Near. But then the simple answer, that I see Near, would also be correct. The appeal to mereological sums would also be otiose if the simple ‘I see Far’ answer is correct. For if I see the back of Near+Far, I see Far. The composite answer is correct only if one of the simple answers is correct.

A polarizing light filter casts no shadow. But if a second filter of opposite polarity is placed beneath, then the pair jointly cast a shadow. Someone viewing an eclipse involving two such filters might qualify as seeing their mereological sum. Both the near filter and the far filter would each contribute to what is seen. In contrast, the heavenly body Near is completely idle. The same phenomenon arises for some objects that reflect light. Glass mirrors also polarize light. Hence glass mirrors darken when viewed through a polarizing filter even though everything else in the scene looks perfectly ordinary. The dark mirrors are visible by virtue of their contrast with their surroundings. But unlike Near, the mirrors causally contribute to the scene.

IX. VISUAL DIFFERENTIATION AND THE FAR SIDE

Picture Near and Far coming closer together until they fuse. I still see Far. This reinforces the point that we see the backs of back-lit dark objects. When the moon eclipses the sun, only the far side of the moon blocks the light. The front half is in the shade. Thus we see the far side of the moon during a solar eclipse.

True, little of the far side can be differentiated by purely contrastive seeing. Only the outer rim offers positive detail. The middle only supplies the negative information that there are no tunnels running completely through the moon. The silhouette of a fine mesh screen has a much higher proportion of positively detailed surface.

We distinguish between observing an effect of an object and seeing the object. The star Algol, in Perseus, has a companion star that is too dim to be seen. Since the plane on which these two stars revolve is ori-

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entirely during every revolution. Although the effect of Algol’s companion can be discerned by how it periodically dims Algol’s light, astronomers describe Algol’s companion as invisible. Astronomers cannot even discern its outline. The object must look some way to the perceiver.35

The analogy with Algol’s companion suggests that during a solar eclipse, we see an effect of the moon but not the moon. The distinction between seeing and seeing effects can also be drawn in another way that appears to yield the common-sense answer that we see the moon but not the far side of moon. “Seeing the search beam of a lighthouse may count as seeing the lighthouse and not as seeing the bulb inside the searchlight.”36 The suggestion is that the moon stands to its far side as the lighthouse stands to its bulb.

The far side is not as obscured as the bulb, however. Aristotle argued that earth must be round because it always casts a round shadow on the moon during lunar eclipses. We have doubts about whether we see the earth this way because its shadow is displaced; the earth’s shadow is on the surface of the moon but the earth is not. Similar reservations affect seeing objects by mirror reflection. But during a solar eclipse, the silhouette of the moon is not displaced. The information we get from the moon’s silhouette is normally “discounted” by our ample background knowledge of the moon. The empirical content of the silhouetted moon is salient, however, when the observers have unusual background beliefs. Suppose we are worried that the moon was struck by a giant meteor during the daytime when it is invisible. Instead of waiting until night to find out, we fortunately have the opportunity to check the moon’s condition by observing an afternoon eclipse: “What a relief! There the moon is, right on schedule, just where it belongs, entirely intact. The meteor must have missed!”

Actually, the detail from the far side during an eclipse can be greater than that offered by the moon’s reflected light during a hazy evening. In an 1836 eclipse, Francis Baily noticed some bead-like features along one side of the moon. “Baily’s beads” are the peaks of mountains that lie along the profile of the moon. If the moon revolved with respect to Baily and if the eclipse lasted long enough to complete one revolution, Baily could have surveyed all of the moon’s peaks. But the moon always presents the same side to us. Why? Because the near side bulges about .5 kilometers and so is pulled more strongly by the earth’s gravity. If a meteor had knocked off this bulgy

35 Dretske, p. 20.
excess, the moon might have been sent spinning fast enough to make silhouette astronomy informative.

Granted, even Baily’s hypothetical survey hardly compares to the rich visual information relayed by the spacecraft, Luna III, in 1959. But even the proud Soviet astronomers granted that, under certain conditions, we very dimly see a portion of the “dark” side of the moon by earthlight (a phenomenon popularly known as “the old moon in the new moon’s arms”).

When I see the moon in normal conditions at night, I see the moon by virtue of seeing its front. Sticklers deny that I see the moon; I see only the front surface. The same sticklers would say that on my account, we do not see the moon when it eclipses the sun; we see only the back surface. I admire the insight and attention to detail that motivates the stickler. But I am not a stickler. I say we see the moon during normal conditions at night and that we see the moon during an eclipse. But I need insist only that the stickler’s standards be applied uniformly to both cases.

Suppose Near and Far have the same intrinsic diameter. Since Far is further away, it then only prevents light from striking the middle of Near. The stickler will say that I see a “doughnut” composed of an outer ring of Near and an inner core of Far. It is doubtful, however, that I see Far in this circumstance. I cannot differentiate Far from its immediate environment. Do I see a little star if it is stationed in front of the sun? If the two are equally luminescent, I cannot differentiate the little star from its immediate environment. Suppose a wall has beige wallpaper. If someone neatly pastes a patch of leftover beige wallpaper on the wall, do I see it? Following Dretske (op. cit., p. 23), I answer no.

I can clearly discern the outline of Near. True, I do not see its center because it is blocked by Far. But the block is not the sort that makes a difference to the visual match with the scene; if Far were absent, the scene would look the same. Since I am a nonstickler, I say that in that circumstance, I see Near because I see a relevant, attached part of it.

Parallel, duplicate blockers are unexpectedly common in our carpentered world of rectangular volumes. Consider a silhouetted box. Although its front side has the same dimensions as its back side, the front side is farther from the light source. Hence the shadow generated by the back side fails to include the outermost edge of the front. Consequently, perimeter of the silhouette is actually caused by the front side of the box. The stickler concludes we see a rectangular doughnut. But since the outline of the back side is invisible, the back side fails to satisfy the visual differentiation condition. I conclude we see the front of the silhouetted box. (More precisely, the relevant ab-
sorption layer starts from the inside of the front side.) Boxy shapes are rare in nature. Nevertheless, they constitute an important exception to the rule that we see the backs of silhouetted objects.

If I am standing with my nose against a concrete wall, then I see the wall or at least a portion of it. Yet I am not visually differentiating the wall from its immediate environment. Dretske treats this anomaly as a limiting case (op. cit., p. 26). He reasons that since there is no immediate environment, the requirement of visual differentiation does not apply. Interestingly, there is no parallel anomaly for the visual differentiation requirement in the case of purely contrastive seeing. If I am hurtling toward the moon during a solar eclipse, the black disk grows bigger and bigger, and then eventually overflows my visual field. There is only darkness. I know the moon is directly ahead of me. But I do not see it. For I need light to see.

X. THE CAUSAL THEORY’S RECOVERY OF PRIMAL VISION

I now summarize my main theses. Instead of adjusting principles to fit the intuition that I see Near, we ought to disown this piece of common sense as the effect of an over-generalization. The causal theory of perception unexpectedly but correctly rules out the possibility that we see Near. Its support for Far forces us to recognize that, typically, we see the backs of dark, back-lit objects, not their fronts. So ‘occlude’ must be relativized. That forces a corresponding relativization of ‘field of vision’. Thus the causal theory of perception brings an ancient species of seeing to the surface. Purely contrastive seeing is a living fossil that has everyday seeing as a descendent. Some minor adjustments are needed to accommodate this recovered form of seeing. Our conception of the physical mechanisms that support vision must be broadened to encompass the various kinds of visible dark objects. To include back-lit objects, we must allow partial light blockage to count. Objects are not seen simply by virtue of a contrast with their environment. They must cause the contrast. That is the difference between Near and Far.

Intersecting eclipses can form from a fortuitous convergence of heavenly bodies. But they also form in a cyclical fashion. As the moon orbits earth, the earth eclipses the sun. The scene would be reminiscent of the famous photograph “Earthrise” taken from the vantage point of the moon. Now take a giant step back from moon by imagining how the scene looks to an astronaut in a high orbit around the moon. The earth is then aligned with the moon and the astronaut has both of them in his line of sight. Near is the moon. Far is the earth.

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