Electronic Supplementary Material

for

Psychophysical study of the moon illusion on paintings and landscape photos

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Theories of the Moon Illusion

Apparent distance theory

To explain the moon illusion, the most widespread explanation is the apparent distance theory, which assumes that the angular diameter of the lunar disc is always perceived to be the same (0.5^o), independently of its position in the sky. The basis of this theory, called also as 'oblate (or elliptic) sky-dome theory', originates from Ibn al-Haytham (Alhazen, Abu Ali Muhammad ibn al-Hassan ibn al-Hasham al-Basri, Basra: 965 - Cairo: 1040, Arab physicist and mathematician) whose explanation sounded: The Moon on the horizon is believed by most people farther than when it is higher in the sky-dome, thus on the horizon the apparent diameter of the lunar disc (with a constant real diameter of 0.5^o) increases significantly. According to the Emmert's law (Robinson 1998), the perceived size of objects generating the same retinal image size (namely, objects with the same angular diameter) is proportional to their distance, that is, the further an object, the larger its perceived size.

If this theory were true, an observer could say: "the Moon on the horizon seems farther than on the zenith". However, most observers describe the moon illusion as: "the Moon on the horizon looks bigger and closer than on the zenith." This contradiction is the size-distance paradox. On the basis of this paradox, the apparent distance theory is not widely accepted as a convincing explanation for the moon illusion (Wade 1998).

Further-larger-nearer theory

To resolve the size-distance paradox, the further-larger-nearer theory was formulated, which is based on the distinction between subconscious and conscious apparent distances (Robinson 1998, Ross and Plug 2002). According to this theory, the observer first perceives the Moon to be larger based on the subconscious distance, but then consciously infers its smaller distance from the larger size. A serious flaw of this theory is that a larger Moon size would mean a larger angular diameter, which is, however, practically constant in the sky. Thus, this theory cannot resolve the size-distance paradox, thus cannot serve as an explanation for the moon illusion either.

Angular size-contrast theory

The popular angular size-contrast theory (Robinson 1998, Ross and Plug 2002) tries to explain the cause of the moon illusion by the contrast of angular diameters: Landmarks visible near the Moon on the horizon (e.g. distant buildings, mountains, trees) usually have an angular diameter of less than 0.5^o, which is the size of the lunar disc. In contrast, near the zenith of the cloudless sky the Moon is alone, so there is nothing to compare with. Alternately, if the Moon near the zenith is surrounded by clouds covering a much larger spatial angle than 0.5^o, the Moon looks much smaller than the clouds. Here one could naively conclude that compared to the Moon on the zenith, the Moon on the horizon will appear larger, but this would be logically flawed, as the two separate true statements do not result in this. Perhaps the best-known example of angular contrast is the Ebbinghaus illusion (Roberts *et al*. 2005). According to another interpretation, the larger or smaller spatial objects (such as clouds, objects, plants) surrounding the Moon are distance cues (Ross and Plug 2002). Hence, the angular size-contrast theory takes the illusion of the change in angular diameter into consideration, too. This theory is considered promising even if not fully explained (Ross and Plug 2002).

Ponzo illusion

It is a common habit to explain the moon illusion by the Ponzo illusion (Ponzo 1911, Kaufman *et al*. 2007). In this illusion, two horizontal bars or circles of equal size are displayed on the top and the bottom of the picture between train-tracks-like converging lines. The line pair produces a perspectivic sense, thus the observer perceives the bar/circle at the upper end of the line pair larger than the one at the lower end of the line pair, because according to the Emmert's law, the retinal image of two objects sensed/detected at different distances can only be the same, if the further object is larger than the nearer one (Robinson 1998). This theory is widely accepted (Ross and Plug 2002).

Oculomotor micropsia and macropsia

A recent theory hypothesizes that the moon illusion is the result of the oculomotor micropsia and macropsia (McCready 2007). Observations have shown that the perceived angular diameter of the lunar disc correlates with the changes in visual signals indicating distance, which is also explained by this theory. Both micropsia (perceiving an object smaller than its real size) and macropsia (perceiving an object larger than it is really) are caused by activity changes of the eye-moving muscles. In the case of micropsia, the eyes focus closer than the real (physical) distance of an object, thus the angular diameter of the observed object is smaller than the real one. When macropsia occurs, the opposite happens: the eyes focuse farther than the real object distance, so the angular diameter of the target is larger than the real one.

When we look at the Moon being on the horizon, our eyes focus to the optical infinity. This will cause macropsia, so the angular diameter of the lunar disc will be greater than the real 0.5^o. If we look at the Moon being near the zenith, our eyes cannot focus well on it, because there are usually too few distance cues (clouds) around it. Therefore, our eyes return to their resting state, meaning a target distance of about 1-2 meters. Due to the micropsia that occurs in this case, the Moon appears to be smaller than 0.5^o.

With this theory the following question arises: Why do observers say that the Moon on the horizon is not only bigger, but also closer? Here again, the distance cues provide an explanation: Most adults know that the size of the lunar disc is practically constant, thus if somebody perceives the Moon larger on the horizon, this is a strong signal, meaning that it is closer than near the zenith. If, on the other hand, an observer knows that the physical distance of the Moon from the Earth is practically constant in one day, then only the size of the Moon can change, and the perceived distance is the same on both the horizon and near the zenith. This theory can explain many aspects of the moon illusion.

Earlier Psychophysical Experiments Studying the Moon Illusion

1) Participants of the experiment of Holway and Boring (1940a,b) had to estimate the size of the full moon's disc projected by a mirror at different angular heights above the horizon with horizontal or elevated axis of their eyes in standing or lying attitude. The apparent moon size depended only on the elevation angle of the eye in the skull. If the participants looked under the Moon and only raised their ocular axis, the expected moon illusion occurred, and they perceived the Moon to be smaller than the one on the horizon. When their heads were raised and their ocular axis looked horizontally at the Moon, they saw the Moon similarly large as that on the horizon. In this experiment the magnitude of moon illusion was $Q = 1.8$.

2) Taylor and Boring (1942) conducted outdoor full moon experiments in which the test persons looked at the moon with two eyes or only one eye. The necessary prerequisite for a moon illusion of magnitude $Q = 1.6$ was to look with both eyes at the same time. However, this contradicted their earlier theory that the elevation angle of the ocular axis in the head causes the moon illusion.

3) Kaufman and Rock (1962a,b) and Rock and Kaufman (1962) studied the moon illusion in a planetarium. First, in complete darkness a white disc was projected to the zenith and horizon of the planetarium's dome. The size of these two discs perceived by the test persons was nearly the same, from which it was concluded that in darkness the moon illusion does not occur. They also used an optical device that projected the lunar disc into the infinity with a collimator (i.e. light beam parallelizer) lens. This variable-sized artificial lunar disc could be displayed on the real horizon or in the sky with a semipermeable mirror. The result of this experiment disproved the eye-axis-dependent moon illusion hypothesis of Taylor and Boring's (1942), because the size of the moon perceived by test persons was the same on the horizon and the zenith. The apparent distance of the horizon greatly influenced the magnitude of the moon illusion as the theory on the apparent distance of moon illusion assumes.

4) In his experiments, Roscoe (1985, 1989) applied and improved the lunar projection equipment used by Kaufman and Rock (1962a,b) and Rock and Kaufman (1962). He varied the distance and angular descent of landmarks relative to the horizon by partially obscuring the participants' field of view. He measured the change in eye focus of the test persons with a laser optometer. The size of the artificial lunar disc perceived by the test persons was highly dependent on the deviation from the poising eye focus.

5) Enright (1975, 1987, 1989a,b) improved the projection device of Kaufman and Rock (1962a,b) and Rock and Kaufman (1962) so that it became suitable for binocular observations. He examined not only the focal length of the eye, but also the role of pupil diameter and eye vergence (i.e., simultaneous movement of both ocular axes in opposite directions) in moon illusion by creating micropsy and macropsy. He measured a magnitude $Q = 1.2$ of the moon illusion, being the ratio of the diameters of the artificial lunar disc on the horizon and the zenith. When the apparent distance of the projected lunar disc was reduced from 3 km to 80 m, the test persons correctly felt that the disc was much closer, but there was only an 8 % increase in the perceived size of the disc, meaning $Q = 1.1$. He concluded that the moon illusion occurs not because of the conscious or subconscious size compensation due to distance, which conclusion, however, contradicts the apparent distance theory.

6) In their experiment, Kaufman and Kaufman (2000) projected simultaneously two artificial lunar discs in the sky. On a screen placed under a black plate equipped with two lenses, two pairs of lunar disc were displayed at the same time, with two discs under one lens. A semi-transparent mirror with adjustable tilt angle was mounted above the plate, onto which the four lunar discs were projected. Looking through the mirror, the two-pair lunar discs fused binocularly, thus the test persons saw one pair of lunar discs in the sky. The apparent distance of one of the two lunar discs was adjustable,

while the other reference disc was always visible on the horizon. The test persons were able to change the apparent distance of the adjustable lunar disc by pressing a button. Their task was to try to set the left lunar disc to half the distance between the observer and the reference moon. The test persons perceived the lunar disc on the horizon more than four times farther than the one on the zenith. This result was considered as an evidence for the apparent distance theory of moon illusion.

According to the Emmert's law (Robinson 1998), objects with different distances from an observer but the same angular diameter are perceived with different sizes. In another experiment of Kaufman and Kaufman (2000) studying Emmert's law, test persons had to set the adjustable lunar disc to be half the size of the reference lunar disc. Then the perceived lunar size was not proportional to the perceived distance, so it was concluded that the Emmert's law is invalid for very long distances and thus cannot explain the moon illusion. Nevertheless, the apparent distance theory of moon illusion was also proved by this result. On average, the lunar disc on the horizon was 1.5 times farther away than that on the zenith when the test persons felt that its size had halved.

7) In his experiments, Suzuki (1984, 1991, 1998, 2007) further investigated the results of Taylor and Boring (1942), Kaufman and Rock (1962a,b), and Rock and Kaufman (1962). Suzuki (1984) attempted to reproduce the results of Kaufman and Rock (1962a,b), but he used the retinal afterimage of test persons instead of a projected lunar disc. The circular afterimage was triggered by a red-light stroboscope, and the test persons had to place this afterimage on the horizon or the zenith, where the apparent size of the afterimage disc was set on a tape measure. The result was consistent with that of Kaufman and Rock (1962a,b): the afterimage on the horizon appeared Q = 1.5 times larger than on the zenith. Contrary to the results of Kaufman and Rock (1962a,b), Suzuki (1984) found a positive correlation between the elevation angle of the ocular axis of the test persons and the ratio Q of the afterimage sizes on the horizon and the zenith.

Suzuki (1991) investigated the occurrence of moon illusion in complete darkness. According to Kaufman and Rock (1962a), the moon illusion practically does not occur in complete darkness. Suzuki (1991) projected two laser beams 3.5^{o} apart on a planetarium dome. The distance of these two light spots on the horizon and the zenith was estimated by 16 test persons. He performed this experiment (i) in complete darkness, (ii) with switched-on planetarium lamps, and (iii) when only the the horizon and stars were visible. With their eyes covered, test persons were escorted to the center of the planetarium in complete darkness, where only the two laser spots were seen with uncovered eyes. This experiment was performed first with all test persons, who perceived that the distance between the two spots was Q = 1.3 times larger on the horizon than at the zenith. In the illuminated planetarium, however, the moon illusion did not occur. Suzuki (1991) explained this as follows: The interior of an illuminated planetarium provided the test persons with sufficient visual signals to perceive distances and dimensions, thus they were able to accurately determine the distance between the two laser spots. Projecting the stars and the horizon onto the dark planetarium dome, the moon illusion reappeared, when the distance of the two spots on the horizon seemed to be Q = 1.2 times greater than that on the zenith.

In his another experiment, Suzuki (1998) examined the results of Taylor and Boring (1942) for one-eye and two-eye observations. This experiment was performed in a planetarium, where the test persons had to estimate the distance between two light spots projected 2^{o} apart on the dome. The participants were divided into two groups: the members of the first group observed the spots with one eye (monocular) first, while those of the second group with two eyes (binocular) first, and then vice versa. The moon illusion always occurred for binocular observations, when the distance between the spots corresponding to the lunar disc was felt to be Q = 1.2 times (binocular) and Q = 1.4 times (monocular) larger than the real distance. In the case of one-eyed observations, the moon illusion occurred only, if they were preceded by a two-eyed observation. However, the magnitude of the apparent size increase was still smaller than that for two-eyed observations: Q = 1.3 (binocular) and Q = 1.2 (monocular). Examining the elevation angle of the ocular axis in the skull, the apparent size increase for upward and horizontal direction of view was Q = 1.1 and Q = 1.2 for the two binocular observations, while no such effect occurred for monocular observations.

8) Ross and Cowie (2010) studied the moon illusion in children (4-12 years) and adults (circa 21 years). The test persons had to draw the full Moon on a landscape printed on A4 sheets: first on the horizon, and then higher in the sky on another but a same-looking sheet. They found that apart from 4-year-old children, in older persons the moon illusion has already been developed; and older persons have drawn the full Moon on the horizon Q = 1.5 times larger than the one higher in the sky. This experiment was similar to our psychophysical experiments.

Supplementary Table S1: Data of paintings (1-70: depicting a Moon, 71-100: displaying a Sun) used in experiments 1 and 2, and the chosen reference objects with their assumed linear size in meters.

No.	**year**	**painter**	**title of painting**	**source**	**reference object with its assumed size (m)**
1	1885	Edward Bannister	Moonlight marine	Virginia Museum of Fine Arts	length of the ship in the distance (35 m)
2	1865	Frederic Edwin Church	Moonrise	Hudson River Museum	tree on the coast (5 m)
3	1834	Thomas Cole	Moonlight	arthive.com	man sitting closer on the left (1.62 m)
4	1838	Thomas Cole	Tower with moonlight	oceansbridge.com	sitting man in red (1.62 m)
5	1866	George Inness	Winter moonlight	Hudson River Museum	walking man (1.62 m)
6	1882	Arkhip Kuindzhi	Night on the Dnieper	Wikimedia	window height of the right hut (0.5 m)
7	1609	Adam Elsheimer	The flight into Egypt	Wikimedia	man standing in the middle (1.62 m)
8	1808	Pierre-Paul Prud'hon	Justice and divine vengeance pursuing crime	Wikimedia	man on the left (1.62 m)
9	1886	Henri Rousseau	A carnival evening	Wikimedia	man on the left (1.62 m)
10	1897	Henri Rousseau	The sleeping gypsy	Wikimedia	woman laying down (1.5 m)
11	2000	Klaus Zambiasi	Chalet with moon	pitturiamo.com	window in the middle (0.5 m)
12	1880	John Atkinson Grimshaw	Nightfall down the Thames	Wikimedia	man on the left side of the boat (1.62 m)
13	1883	Ralph Albert Blakelock	Moonlight	Wikimedia	large tree on the right side (15 m)
14	1886	Ralph Albert Blakelock	Moonlight on the brook	Wikimedia	tree on the left (15 m)
15	1885	Ralph Albert Blakelock	Moonlight	Amazon CloudFront	child in front of the tent on the left (1.3 m)
16	1888	Ralph Albert Blakelock	Moonlight	Wikimedia	tree on the right (15 m)
17	18??	Ralph Albert Blakelock	Moonlight	Christie’s	tree on the left (7 m)
18	18??	Ralph Albert Blakelock	Landscape at moonlight	Christie’s	tree on the left (9 m)
19	1907	Henri Rousseau	The snake charmer	Wikimedia	woman with a flute (1.5 m)
20	1910	Henri Rousseau	The dream	Wikimedia	woman lying down on the left (1.5 m)
21	1821	Fyodor Alekseyev	Nocturnal landscape with fishermen	Wikimedia	man on the left (1.62 m)
22	1636	Adriean Brouwer	Dune landscape by moonlight	Wikimedia	first man from the left (1.62 m)
23	16??	Aert van der Neer	Hollandische Kanallandschaft	Wikimedia	man standing on the left side of the fire (1.62 m)
24	1647	Aert van der Neer	Moonlit landscape with a view of the New Amstel river and castle Kostverloren	Wikimedia	man standing on the right side (1.62 m)
25	2017	?	Moon light over green hills	foundmyself.com	height of the left window of the house (0.5 m)
26	1830	Franz Ludwig Catel	View of the Colosseum by night	Wikimedia	woman on the left (1.5 m)
27	18??	Fredericus van Rossum du Chattel	A moonlit windmill	Wikimedia	sail length of the windmill (25 m)
28	1789	Joseph Wright of Derby	View of Vesuvius from Possillipo, Naples	Wikimedia	first man in the middle boat (1.62 m)
29	1662	Egbert van	Seashore by moonlight	Wikimedia	man standing on the

		der Poel			right (1.62 m)
30	1858	John Linnel	Harvest moon	Tate	woman standing on the right (1.5 m)
31	2012	Fernando de Gorocica	Ella y los Pescadores	Wikimedia	freeboard height of the first boat on the left (5 m)
32	1855	Ford Madox Brown	Die Heuernte	Wikimedia	man standing next to the horse in the middle (1.62 m)
33	1821	Caspar David Friedrich	Man and woman contemplating the moon	Wikimedia	man standing in the middle (1.62 m)
34	1907	Granville Redmond	Quiet moonlight (beyond Catalina island)	Wikimedia	height of the middle large wave (0.4 m)
35	1879	John Atkinson Grimshaw	In Peril	Wikimedia	woman standing near on the left (1.5 m)
36	1788	Joseph Wright of Derby	Vesuvius from Posillipo	Wikimedia	left man in the boat (1.62 m)
37	16??	Joos de Momper	Village at full moon	Wikimedia	man standing next to the donkey on the left(1.62 m)
38	?	?	Train wallpaper	wallpapermaiden.com	height of the train (4.5 m)
39	1842	Ivan Aivazovsky	Moonlight in Naples	Wikimedia	man on the right (1.62 m)
40	2014	?	Moon of my delight	ananda.org	man looking at the Moon (1.62 m)
41	1900	Hans am Ende	Mondaufgang	Wikimedia	trees in the background (8 m)
42	1833	Hokusai	Boats and moon	Wikimedia	man standing in the front of the nearest boat (1.62 m)
43	1840	Ivan Aivazovsky	Segelschiff auf hoher See bei Mondschein	Wikimedia	mainmast of the closer ship (34 m)
44	1876	Ivan Aivazovsky	View of Constantinople	Wikimedia	muezzin in the minaret (1.62 m)
45	1816	Jakob Alt	Liebespaar bei Vollmondnacht	Wikimedia	woman in white on the left (1.5 m)
46	19??	Julius Köhnholz	Mondnacht bei Helgoland	Wikimedia	right man standing in the middle (1.62 m)
47	1833	Mihael Stroj	Angelika und Medor	Wikimedia	man lying down (1.62 m)
48	1851	Nannette Bleuler	Der Rheinfall bei Mondschein	Wikimedia	height of the right window of the middle house (0.5 m)
49	1730	Sebastiano Ricci	Gebet Christi am Ölberg	Wikimedia	kneeling Christ (1.12 m)
50	1885	Giovanni Segantini	Frühmesse	Wikimedia	man walking up the stairs (1.62 m)
51	18??	Edward Williams	River by moonlight	Wikimedia	woman on the left (1.5 m)
52	1750	Claude Joseph Vernet	Coastal scene (La Nuit)	Wikimedia	man next to the barrel on the left (1.62 m)
53	1645	Aert van der Neer	River view by moonlight	Wikimedia	man next to the first cart (1.62 m)
54	1777	Philip James de Loutherbourg	Clair de lune (moonlight)	Wikimedia	cow looking out of the painting (1.7 m)
55	1855	Frederik Marinus Kruseman	Meditating monk at night	Wikimedia	sitting male monk (0.9 m)
56	1835	Anthonie Waldorp	View of a bridge over the Seine in Paris by moonlight	Wikimedia	woman next to the river on the right (1.5 m)
57	1534	Battista Dossi	La Notte	Wikimedia	near man lying down (1.62 m)
58	1838	Caspar David Friedrich	Walk at dusk	Wikimedia	standing man (1.62 m)
59	1901	Csontváry Kosztka Tivadar	Full moon over Taormina	Wikimedia	walking man in the middle (1.62 m)
60	1760	Canaletto	La Viglia di	Wikimedia	man standing in the middle

			Santa Marta		with a red hat (1.62 m)
61	201?	Leonid Polotsky	Classical landscape at night	Saatchi Art	length of the right ship (35 m)
62	2014	Rachel Bingman	The night's repose	3.bp.blogspot.com	tree (8 m)
63	1796	Joseph Mallord William Turner	Moonlight, a study at Millbank	Tate	man rowing in the boat (1.62 m)
64	1881	John Atkinson Grimshaw	The trysting tree	Visualelsewhere	man standing on the left (1.62 m)
65	1800	Anton Herzinger	Full moon	Wikimedia	closer carrying man (1.62 m)
66	1870	Ivan Aivazovsky	Ukrainian landscape at night	Wikimedia	man sitting in the middle cart (1.62 m)
67	1869	Knud Baade	Moonlight	Wikimedia	mast height (11 m)
68	1882	John Atkinson Grimshaw	A moonlit walk	Sotheby’s	woman on the right (1.5 m)
69	1824	Johan Christian Dahl	Elbe sett fra Brühlsche terrasse	Wikimedia	man standing between two people (1.62 m)
70	1825	Caspar David Friedrich	Uttewalder grund	Wikimedia	man standing on the right (1.62 m)
71	1872	Claude Monet	Impression, sunrise	Wikimedia	man rowing in the middle (1.62 m)
72	1910	Leo Gestel	Nevelzon	Wikimedia	man hoeing in the middle (1.62 m)
73	1815	Joseph Mallord William Turner	Dido building Carthage	Wikimedia	well-dressed woman next to the river (1.5 m)
74	1648	Claude Lorrain	Seaport with the embarkation of the queen of Sheba	Wikimedia	man on the right dressed in red (1.62 m)
75	18??	Sanford Robinson Gifford	Sunrise, Long Branch, New Jersey	Wikimedia	man standing in the middle (1.62 m)
76	1820	David Cox	Beach scene, sunrise	Wikimedia	man riding in the middle (0.9 m)
77	1870	Albert Bierstadt	Sunrise	Wikiart	large tree on the right (15 m)
78	1855	Frederic Edwin Church	The Andes of Ecuador	Wikiart	travelling man on the left (0.9 m)
79	1828	Richard Parkes Bonington	Sunset in the Pays de Caux	Wikiart	woman talking on the right (1.5 m)
80	1845	Ivan Aivazovsky	The bay Golden Horn	Wikiart	man sitting on the pier on the right (0.9 m)
81	1845	Ivan Aivazovsky	Sea view with chapel	Wikiart	man praying in the middle (1.12 m)
82	1898	Camille Pissarro	Sunset, Rouen	Wikiart	man standing on the right (1.62 m)
83	1883	Jean-Léon Gérome	The two majesties	Wikimedia	shoulder height of the lion (1.2 m)
84	1859	Fritz Hugh Lane	Camden mountains from the south entrance to the harbor	amazon.com	mainmast height of the left ship (11 m)
85	1876	Martin Johnson Heade	Marsh sunset, Newburyport, Massachusetts	Wikimedia	height of the left haystack (5 m)
86	1860	Charles-Francois Daubigny	The orchard at sunset	Wikiart	small wide tree in the middle (3 m)
87	1899	Frithj of Smith-Hald	Sunset over a mountain lake	1st Art Gallery	bodylength of the goose in the middle (0.8 m)
88	1878	Alfred Thompson Bricher	Morning at Grand Manan	Wikimedia	mainmast height of the middle ship (33 m)
89	1880	Claude Monet	Sun setting over the Seine at Lavacourt	petitpalais.paris.fr	large tree on the right (8 m)
90	1871	Jasper Francis Cosprey	Upper Hudson	oceansbridge.com	middle cow in the water (1.7 m)
91	19??	Ferdinand du Puigaudeau	Wheat stack at sunset	Wikimedia	height of the left haystack (5 m)

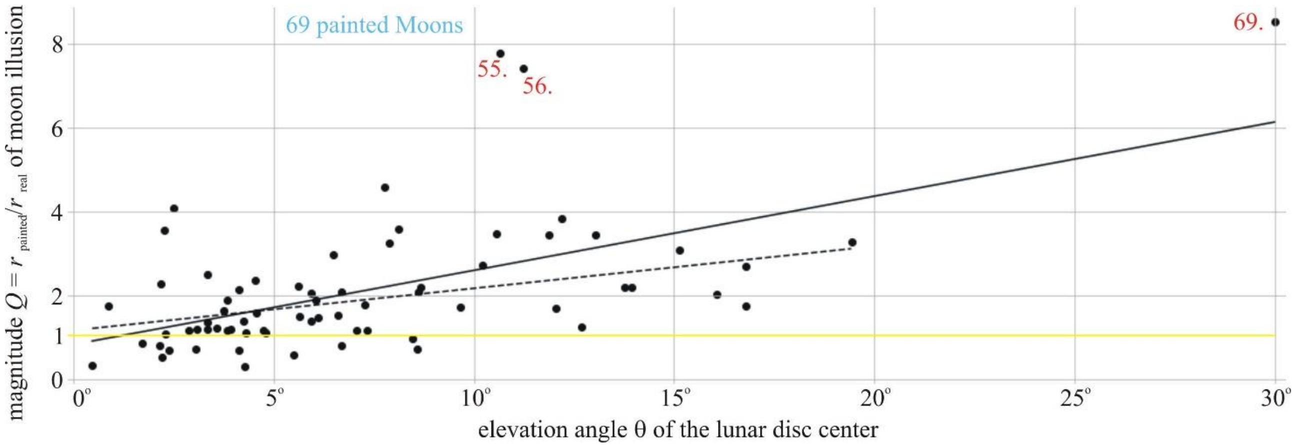
92	18??	Walter Williams	Anglers in a mountainous river landscape at sunset	Wikimedia	man fishing on the left (1.62 m)
93	1884	Vincent van Gogh	Old tower in the fields	Imgur	woman standing in the middle (1.5 m)
94	1918	Felix Edouard Vallotton	Sunset	Cloudfront	tree on the right (5 m)
95	1902	Claude Monet	Houses of parliament sunset	Shopify	Victoria tower of the British parliament (98 m)
96	1862	Frederic Edwin Church	Cotopaxi	Wikimedia	woman on the left leading the llama (1.5 m)
97	1875	Frederic Edwin Church	Autumn	Wikimedia	tree on the left (10 m)
98	18??	Jasper Francis Cosprey	Sunset eagle cliff	Wikimedia	wading bird standing on the left (1 m)
99	1895	Camille Pissarro	The church and farm of Eragny	Wikiart	height of the left cow (1.7 m)
100	1813	Joseph Mallord William Turner	Teignmouth, Devonshire	Wikimedia	man on the left facing backwards (1.62 m)

Supplementary Table S2: Brief characterization of the Hungarian landscape photographs used in experiment 3.

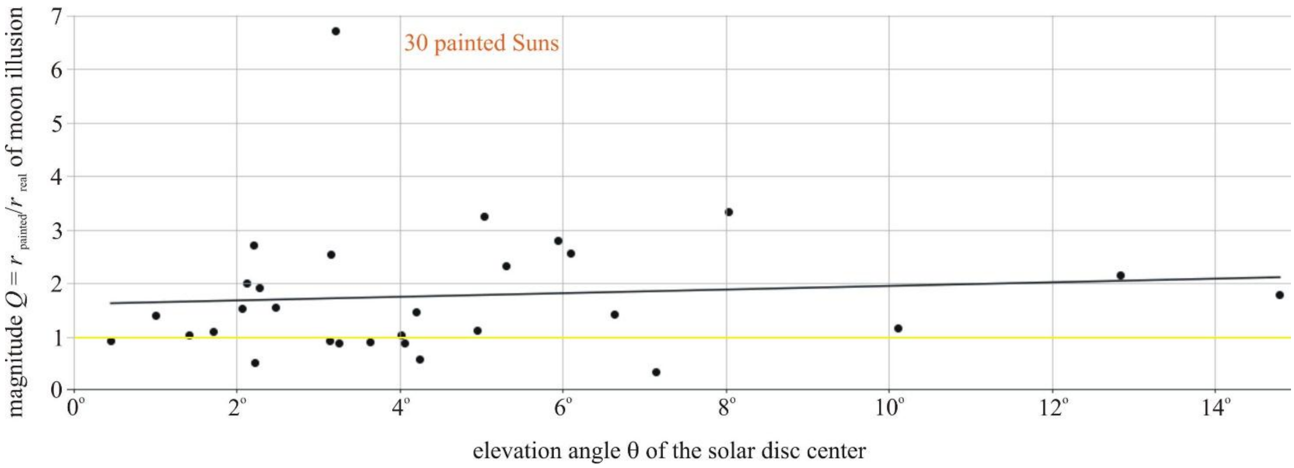
No.	Brief description of the photo
1	Pest side of the river Duna opposite to the Eötvös University (Budapest)
2	Duna Medical Center photographed from the Buda side of the river Duna (Budapest)
3	Duna Bank partially covered with trees (Budapest)
4	field with clouds
5	country road with hills in the background
6	country road with buildings in the background
7	waterfront with trees and benches
8	building wall and lamp post
9	downtown with old buildings
10	shops with trees in the background
11	street with cars and panel houses on the left
12	hillside with bushes
13	Buda side of the river Duna towards the building of the Technical University (Budapest)
14	Petőfi bridge photographed from the Buda side of the river Duna (Budapest)
15	river Duna with boats and the Petőfi bridge in the background (Budapest)
16	Szent Gellért Square (Budapest)
17	gate, wall and bushes
18	building of the Whale photographed from the Buda side of the river Duna (Budapest)
19	field with hills in the background
20	dirt road with village and hills in the background
21	illuminated gateway with trees in the background
22	panel house with cloudy sky
23	light poles with buildings and a water tower in the background
24	railway tracks with cables
25	light pole in the middle of a field with a forest in the background
26	building roof and a tree top in the middle with a hill in the background
27	statue of Liberty on the Gellért Hill (Budapest)
28	entrance photographed from the park side of the Eötvös University (Budapest)
29	building of the Technical University photographed from a park (Budapest)
30	building C of the Eötvös University with the western tip tower (Budapest)
31	staircase of the chemistry building of the Eötvös University (Budapest)
32	tower of building A of the Eötvös University containing the Foucault pendulum (Budapest)
33	entrance of the chemistry building of the Eötvös University (Budapest)
34	gateway on the Lágymányosi Campus (Budapest)
35	circular building with trees in the foreground
36	spike hall of the Eötvös University (Budapest)
37	National Theater photographed from the Buda side of the river Duna (Budapest)
38	panel house with tree branches (Budapest)
39	boat on a river with a hill in the background

40	park side of building A of the Eötvös University (Budapest)
41	lake Balaton with sailboats
42	small shrine on the top of a hill
43	rock walls with vegetation
44	rock wall with trees in the foreground
45	lake with a tower in the background
46	vineyard with fields and trees in the background
47	trees with a castle in the background
48	castle tower with trees
49	waterfront with church towers in the background
50	street with a church tower in the background
51	lake Balaton with sailboats
52	horse and buildings
53	vineyard with a hill in the background
54	riding people in front of a forest
55	lonely tree in a field
56	field with a radio tower and forest
57	field with a small house and trees
58	field with trees and a church tower in the background
59	flowers with a tree and a forest
60	bush with cows grazing in the background
61	highway with a hill in the background
62	fence with a church in the background
63	flowers with houses in the background
64	waterfront with a city and hills in the background
65	trees with a house roof in the background
66	field with a row of trees in the background
67	large Market Hall photographed from the Duna (Budapest)
68	balcony with the lake Balaton in the background
69	church with vegetation in the foreground
70	vegetation with a church in the background
71	castle ruins
72	rooftops with a hill
73	row of houses with trees in the foreground
74	street with a building and trees
75	field with a small house
76	waterfront with boats at sunset
77	sunset with a swan
78	sunset with the Margit Bridge and the Buda Castle (Budapest)
79	sunset with a wall
80	sunset with plants
81	sunset in a field with a forest in the background

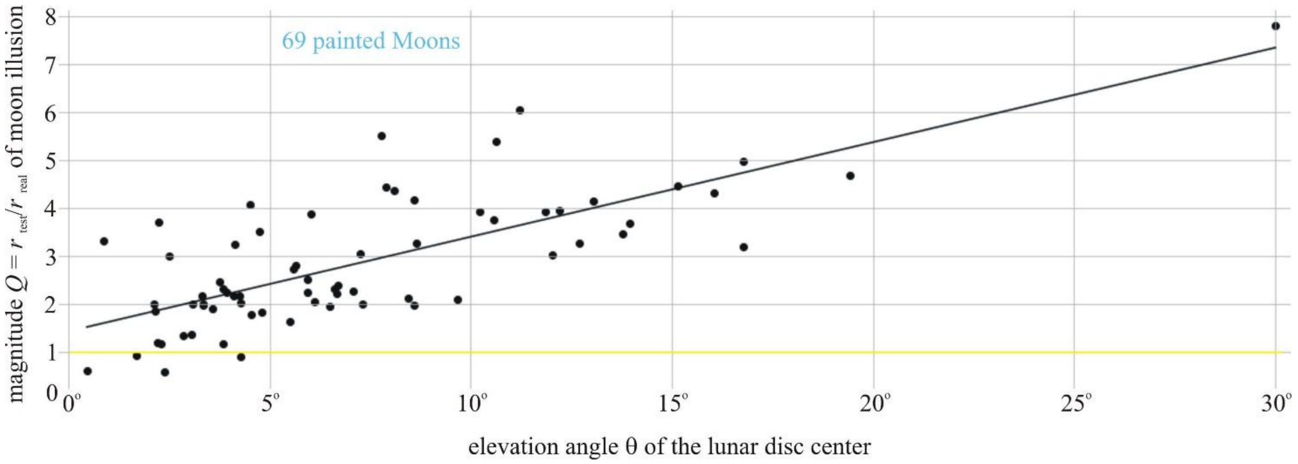
82	sunset in a field with a pole
83	sunset in a field
84	sunset with clouds and trees
85	advertising poles with street lamps
86	sunset with a waterfront
87	sunset with a tree branch
88	road with power lines in the background
89	field with hills in the background
90	sunset with clouds
91	sunset with a hill
92	sunset with a forest in the background
93	mountainside at sunset
94	village with a church in the background
95	road at sunset
96	parking lot at sunset
97	parking car at sunset
98	parking lot
99	street with buildings
100	store with street lamps



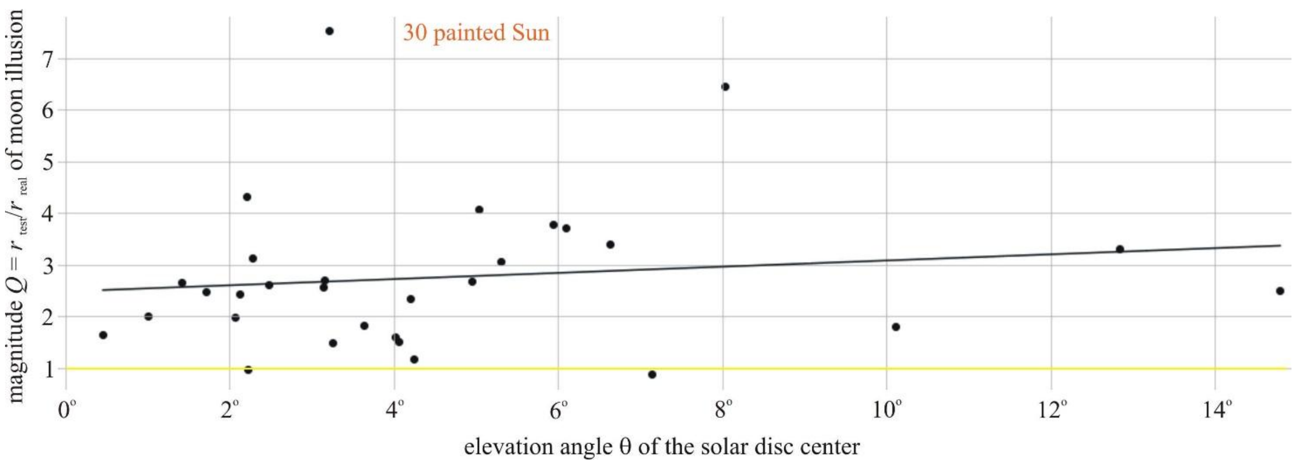
Supplementary Figure S1: Magnitude $Q = r_{painted}/r_{real}$ of moon illusion versus the elevation angle θ of the center of painted lunar discs obtained for 69 paintings with Moon. The solid oblique line is the regression line fitted onto all 69 datapoints, while the dashed line is the regression line fitted to the data points remained after the exclusion of the three paintings with the largest *Q*-values (69.: $Q = 8.5$, $\theta = 30^o$; 55.: $Q = 7.8$, $\theta = 10.6^o$; 56.: $Q = 7.4$, $\theta = 11.2^o$).



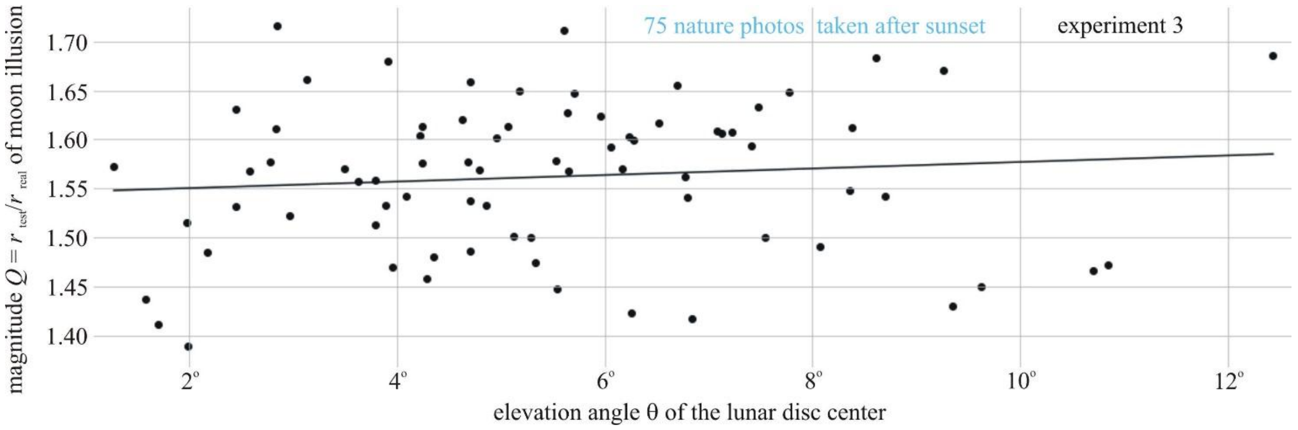
Supplementary Figure S2: Magnitude $Q = r_{painted}/r_{real}$ of moon illusion versus the elevation angle θ of the center of painted solar discs obtained for 30 paintings with Sun. The solid oblique line is the regression line fitted onto the 30 datapoints.



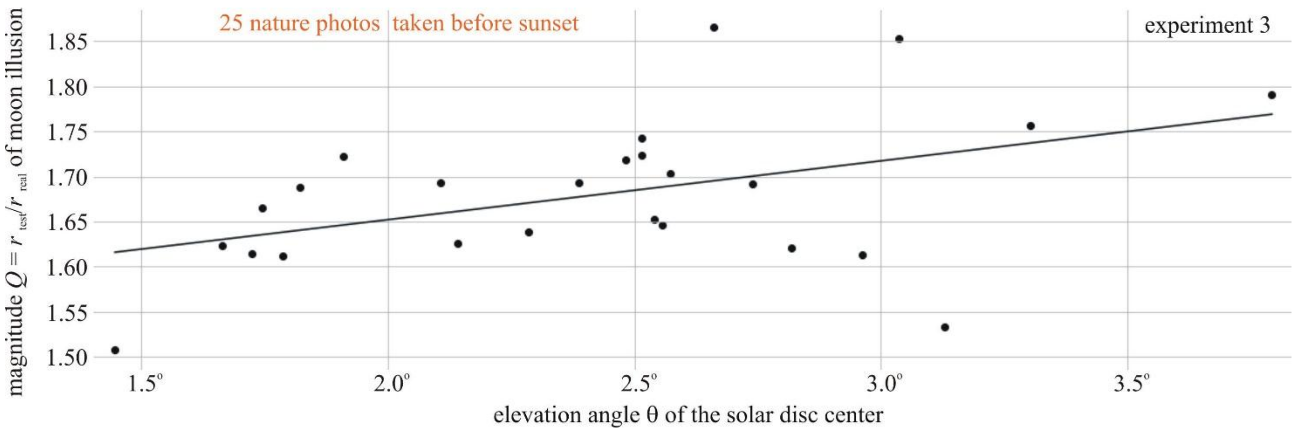
Supplementary Figure S3: Magnitude $Q = r_{test}/r_{real}$ of moon illusion averaged for 10 test persons versus the elevation angle θ of the lunar disc center set by test persons obtained for 69 paintings with Moon. The solid oblique line is the regression line fitted onto the 69 datapoints.



Supplementary Figure S4: Magnitude $Q = r_{test}/r_{real}$ of moon illusion averaged for 10 test persons versus the elevation angle θ of the solar disc center set by test persons obtained for 30 paintings with Sun. The solid oblique line is the regression line fitted onto the 30 datapoints.



Supplementary Figure S5: Magnitude $Q = r_{test}/r_{real}$ of moon illusion averaged for 10 test persons and 10 tests versus the elevation angle $\theta = 0.25^o h/r_{real}$ of the lunar disc center set by test persons in experiment 3 obtained for 75 landscape photos taken after sunset, where r_{test} is the radius (in pixels) of the lunar disc set by test persons, r_{real} is the real radius (in pixels) of the Moon, and h is the height (in pixels) of the lunar disc center above the horizon. The solid oblique line is the regression line fitted onto the 75 datapoints.



Supplementary Figure S6: Magnitude $Q = r_{test}/r_{real}$ of moon illusion averaged for 10 test persons and 10 tests versus the elevation angle $\theta = 0.25^o h/r_{real}$ of the solar disc center set by test persons in experiment 3 obtained for 25 landscape photos taken before sunset, where r_{test} is the radius (in pixels) of the solar disc set by test persons, r_{real} is the real radius (in pixels) of the Sun, and h is the height (in pixels) of the solar disc center above the horizon. The solid oblique line is the regression line fitted onto the 25 datapoints.

Appendix A: 100 retouched paintings without lunar/solar discs used in experiment 1

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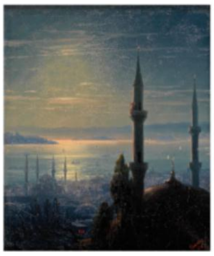
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Appendix B: 100 paintings used for distance estimation in experiment 2

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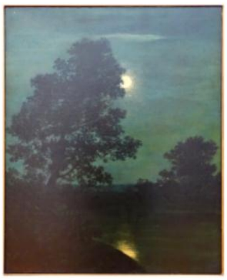

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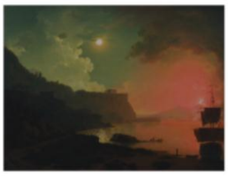

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Appendix C: 100 landscape photos used in experiment 3

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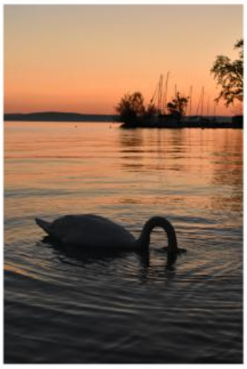

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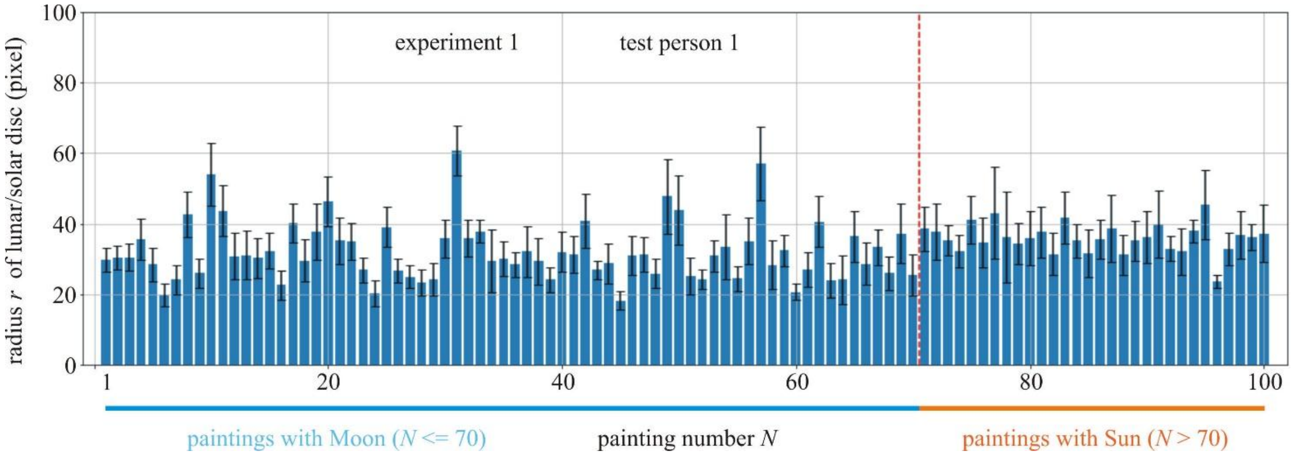
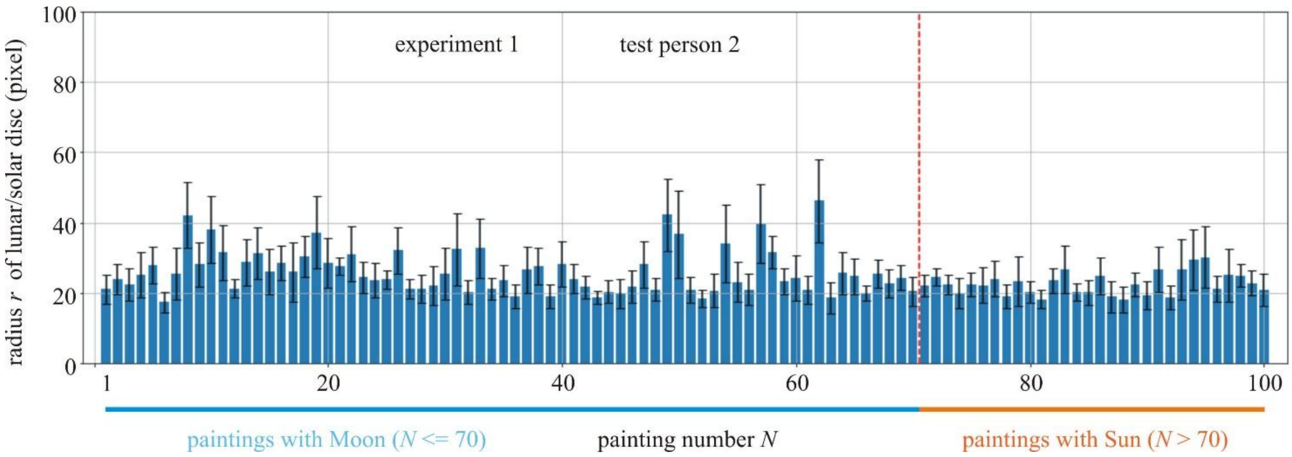
Appendix D

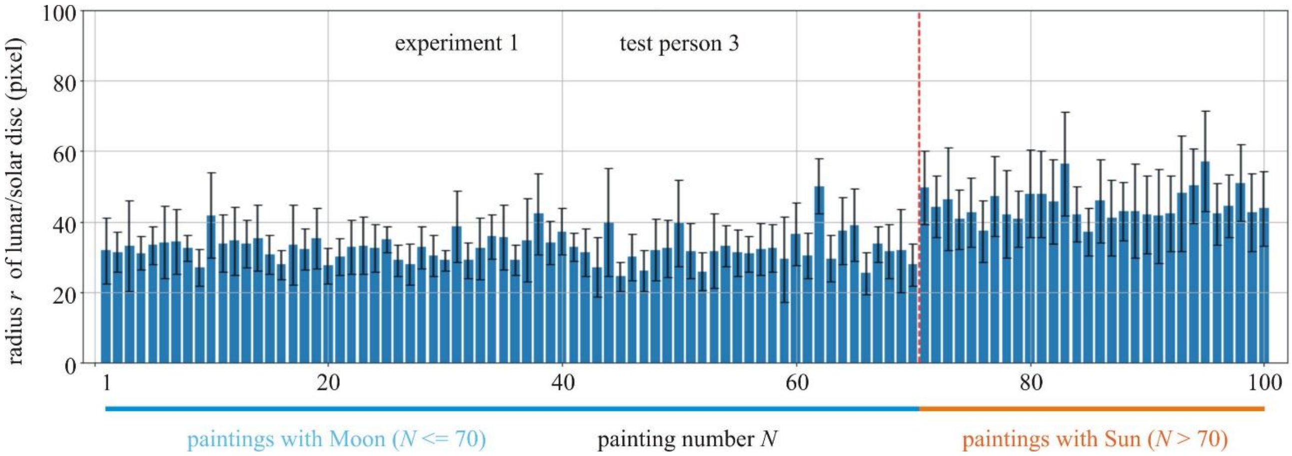
Radii of the lunar/solar discs estimated by the test persons on paintings in experiment 1



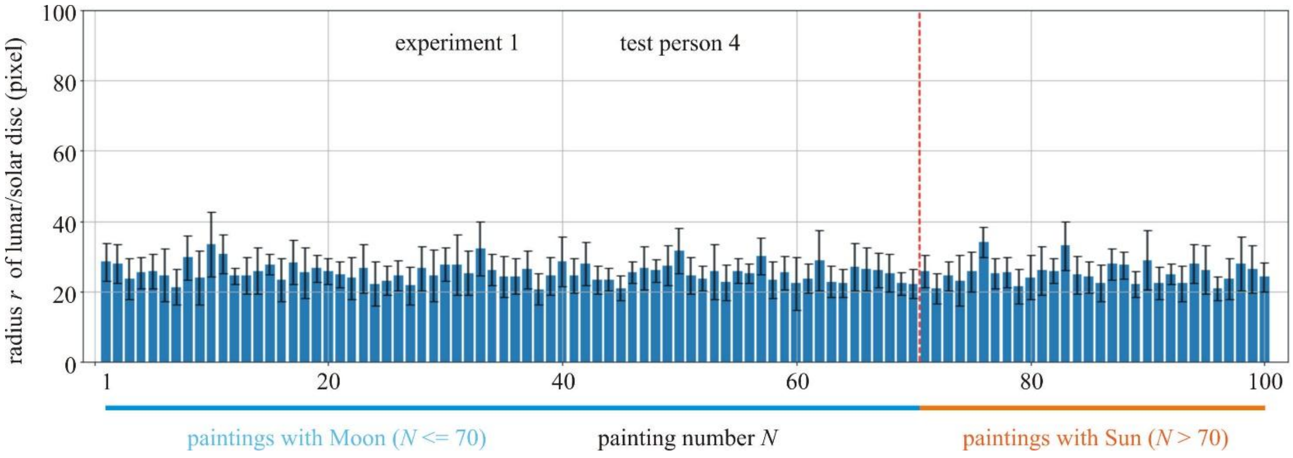
Supplementary Figure D1: Average ± standard deviation of radius r (in pixels) of the lunar/solar dics averaged for 10 tests versus the painting number N ($1 \leq N \leq 70$: paintings with Moon, $71 \leq N \leq 100$: paintings with Sun) set by test person 1 in the 100 paintings used in experiment 1.



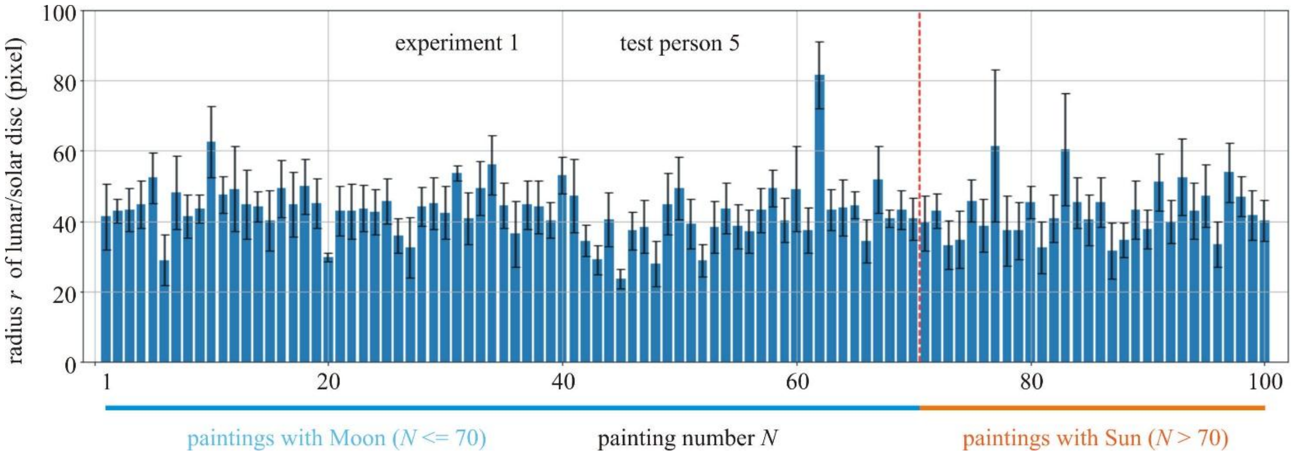
Supplementary Figure D2: Same as Supplementary Fig. D1 for test person 2.



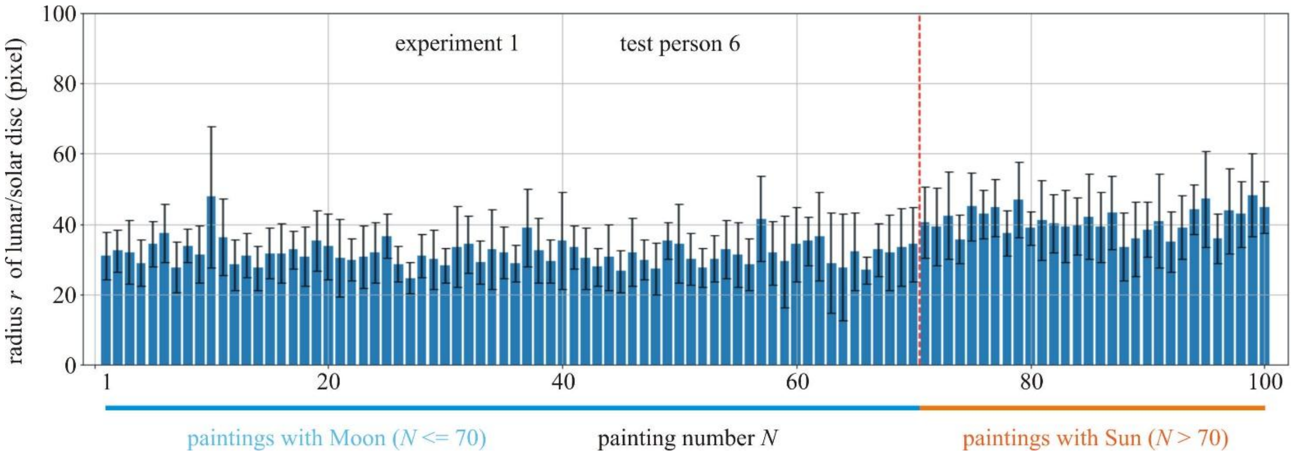
Supplementary Figure D3: Same as Supplementary Fig. D1 for test person 3.



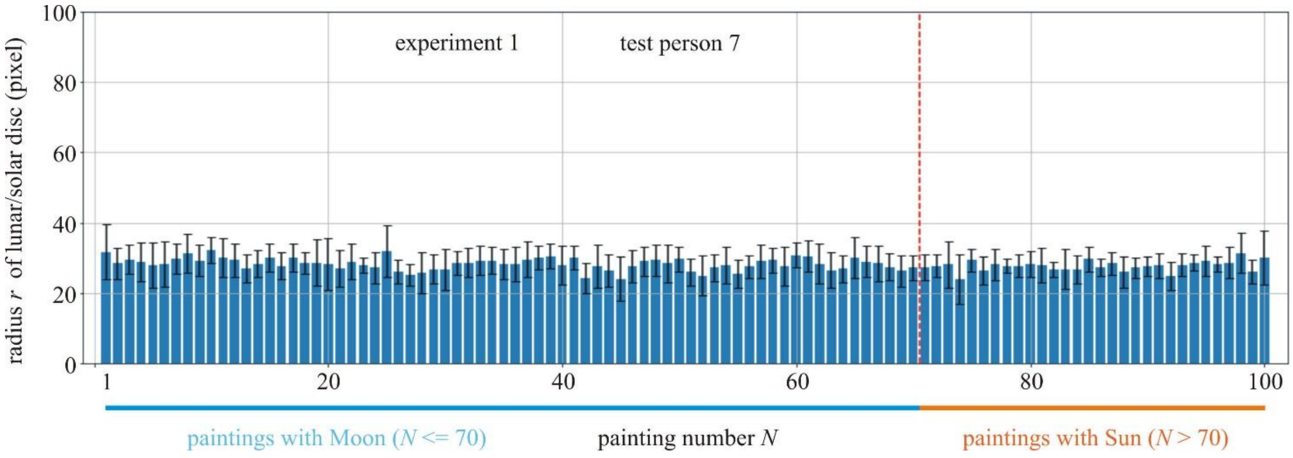
Supplementary Figure D4: Same as Supplementary Fig. D1 for test person 4.



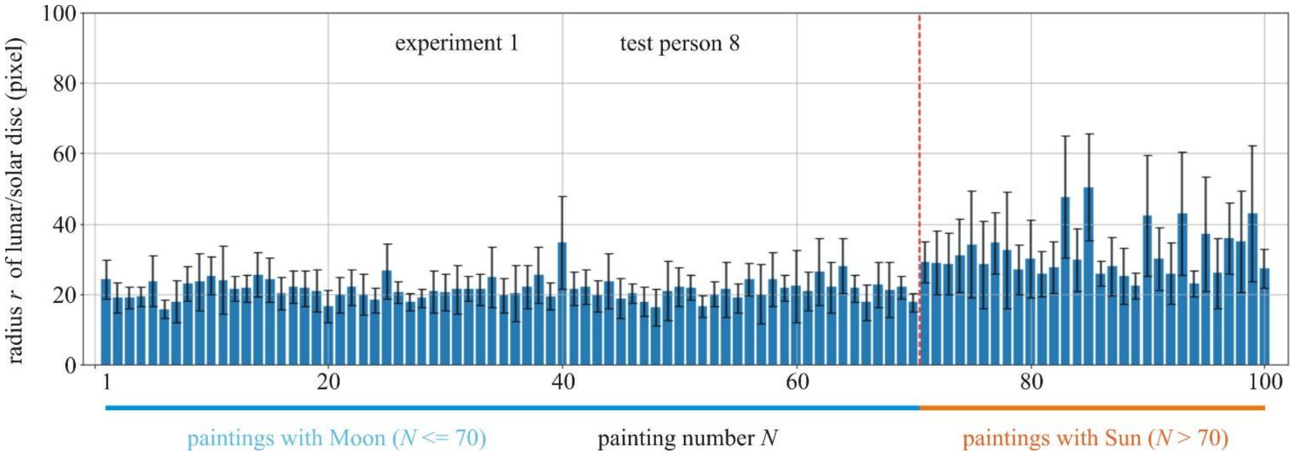
Supplementary Figure D5: Same as Supplementary Fig. D1 for test person 5.



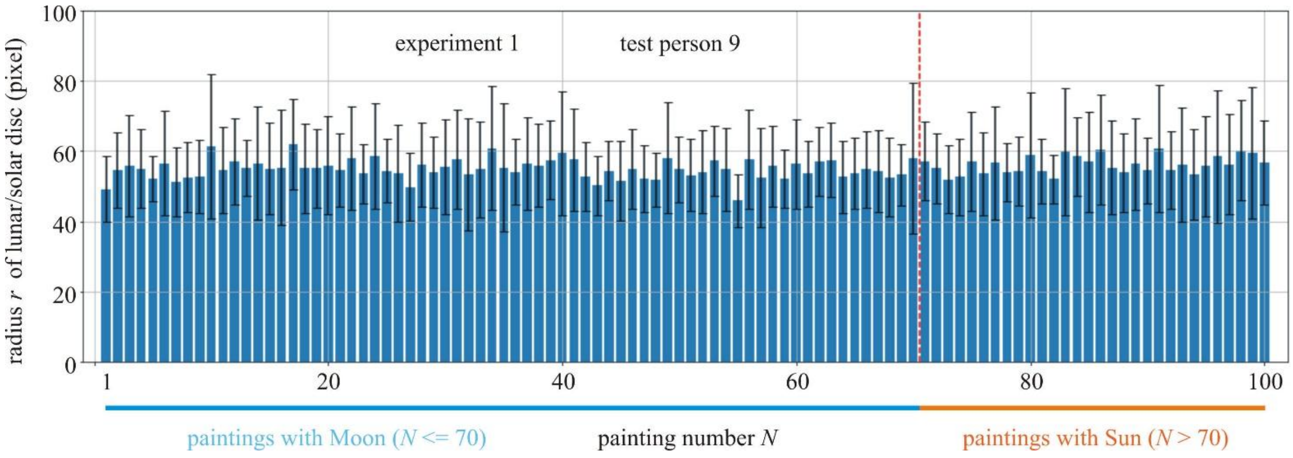
Supplementary Figure D6: Same as Supplementary Fig. D1 for test person 6.



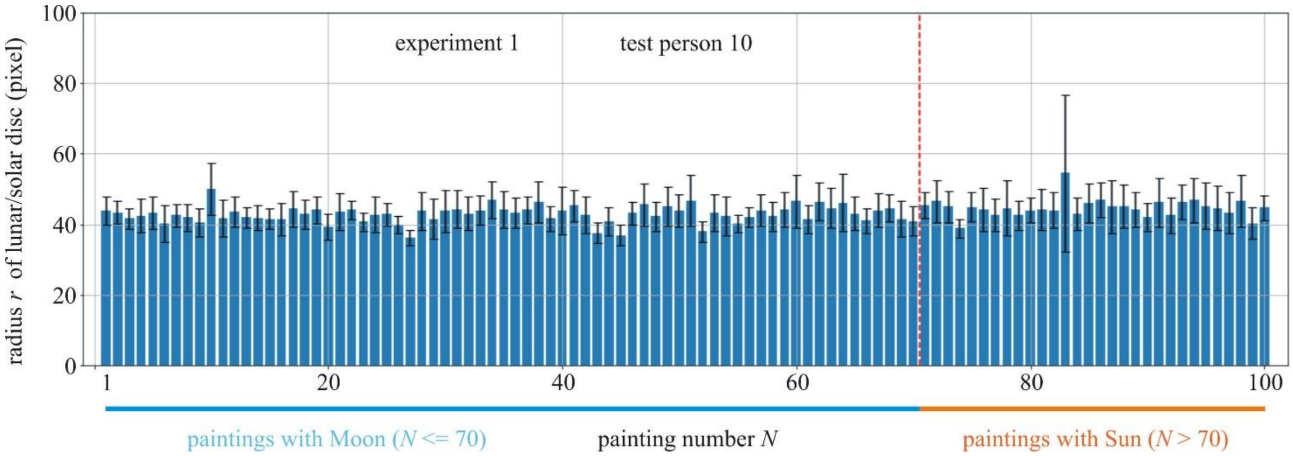
Supplementary Figure D7: Same as Supplementary Fig. D1 for test person 7.



Supplementary Figure D8: Same as Supplementary Fig. D1 for test person 8.



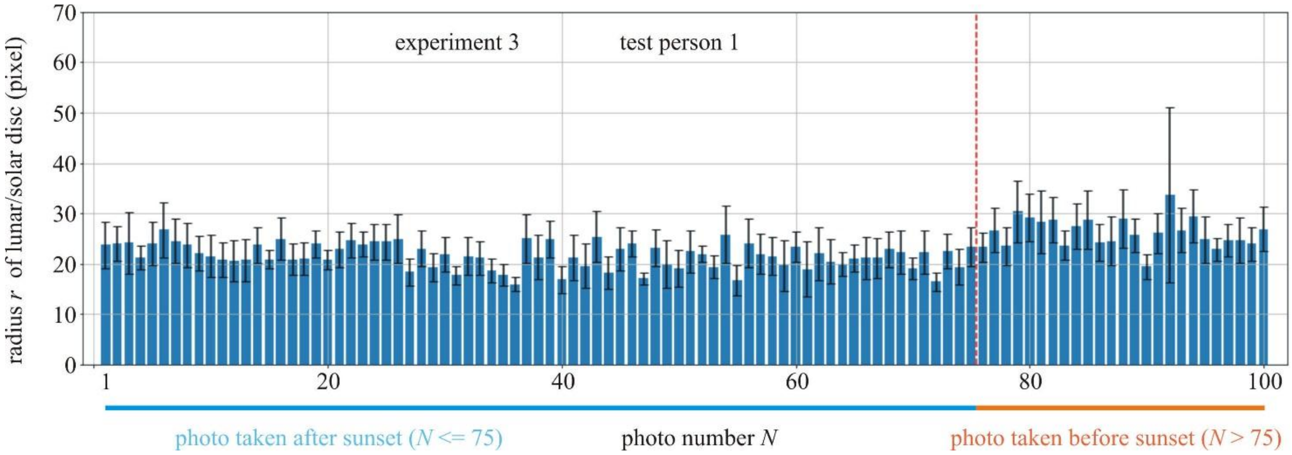
Supplementary Figure D9: Same as Supplementary Fig. D1 for test person 9.



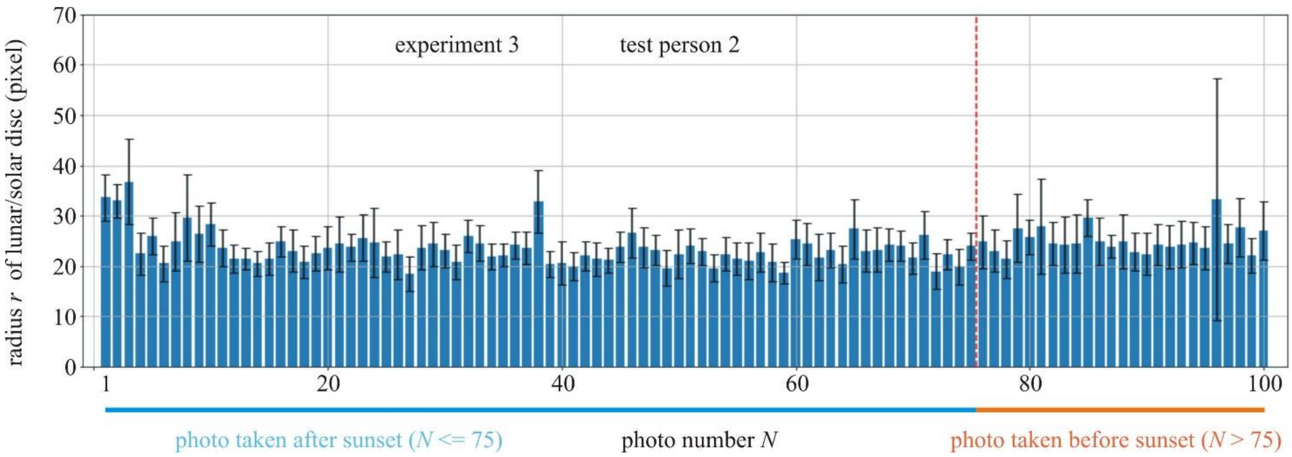
Supplementary Figure D10: Same as Supplementary Fig. D1 for test person 10.

Appendix E

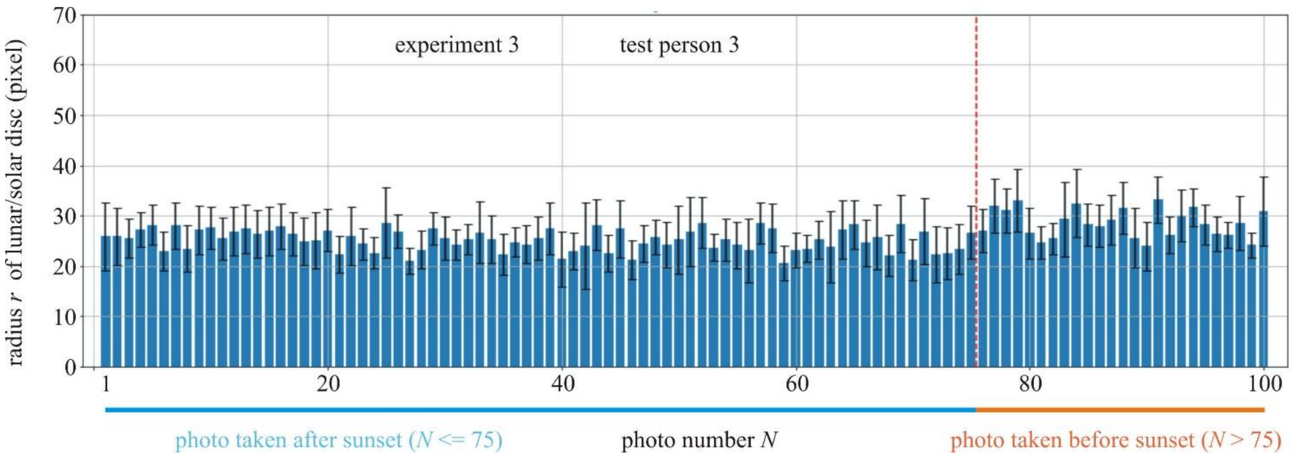
Radii of the lunar/solar discs estimated by the test persons on landscape photos in experiment 3



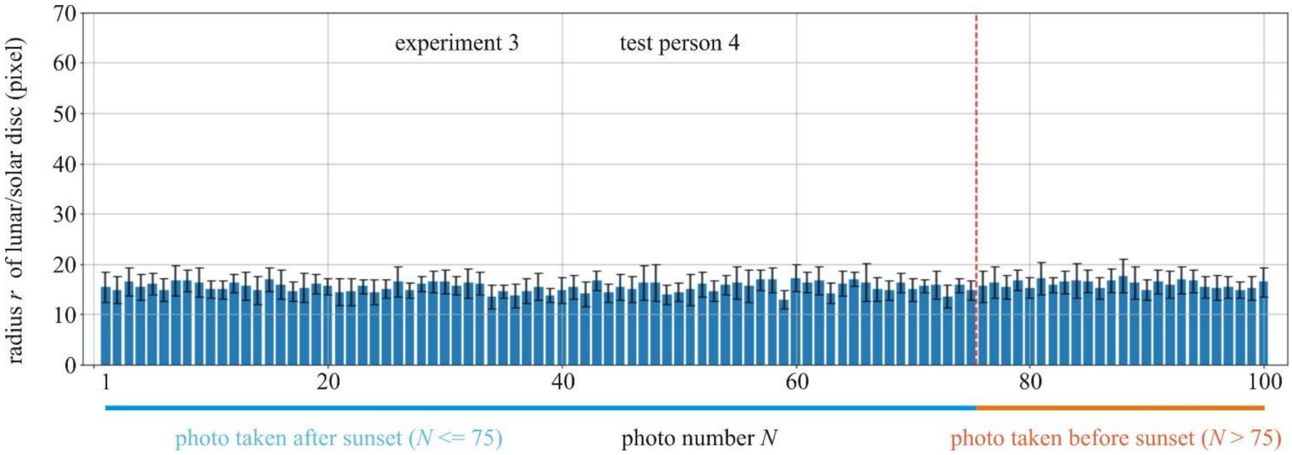
Supplementary Figure E1: Average ± standard deviation of radius r (in pixels) of the lunar/solar dics averaged for 10 tests versus the photo number N ($1 \leq N \leq 75$: photo taken after sunset, $76 \leq N \leq 100$: photo taken before sunset) set by test person 1 in the 100 landscape photos used in experiment 3.



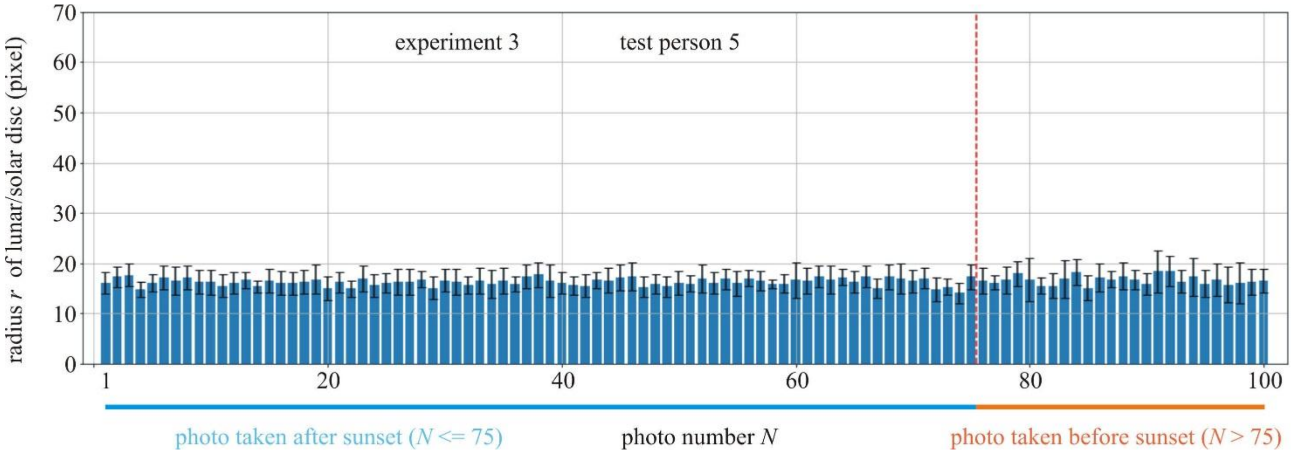
Supplementary Figure E2: Same as Supplementary Fig. E1 for test person 2.



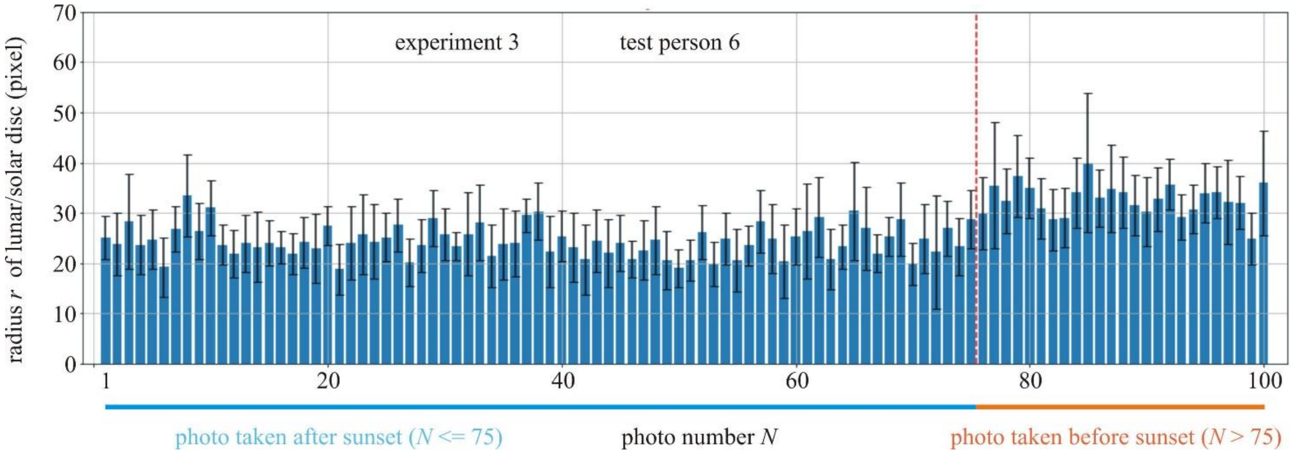
Supplementary Figure E3: Same as Supplementary Fig. E1 for test person 3.



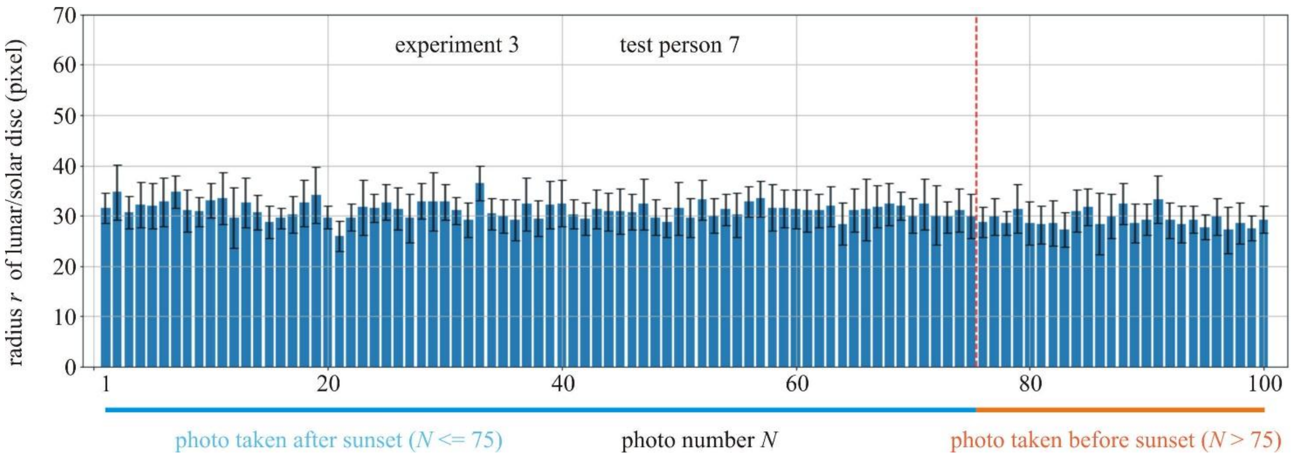
Supplementary Figure E4: Same as Supplementary Fig. E1 for test person 4.



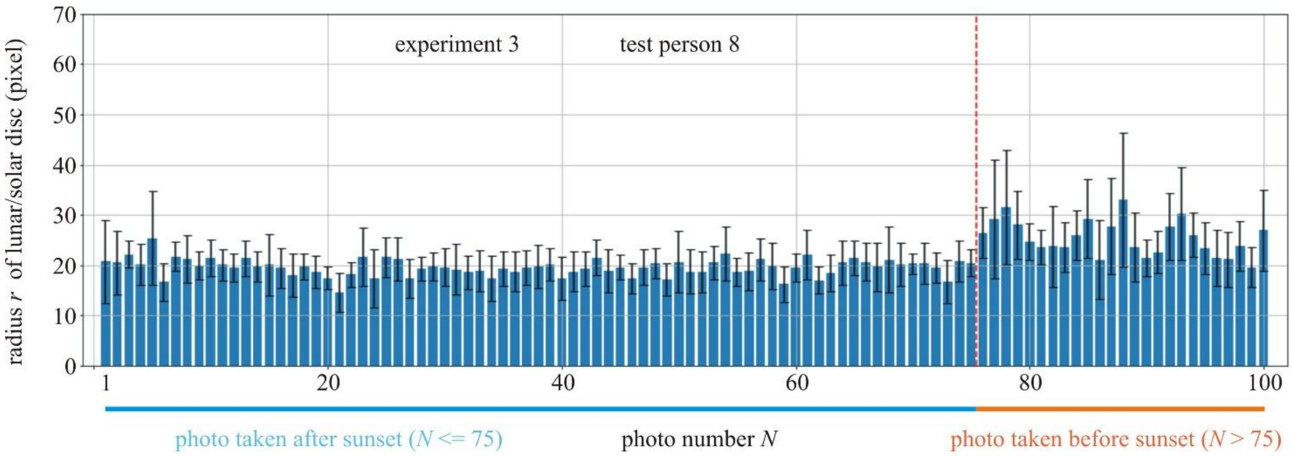
Supplementary Figure E5: Same as Supplementary Fig. E1 for test person 5.



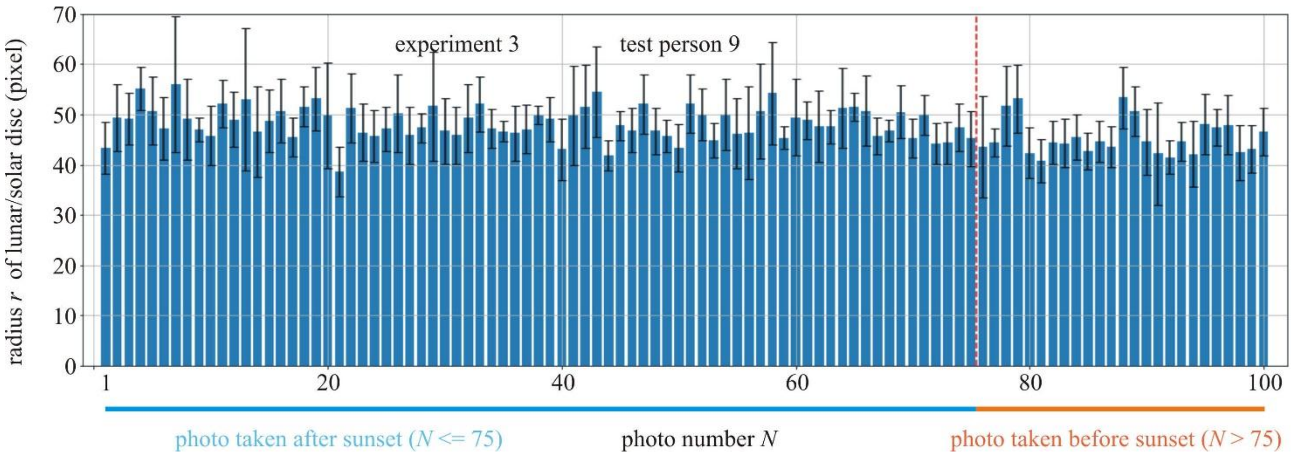
Supplementary Figure E6: Same as Supplementary Fig. E1 for test person 6.



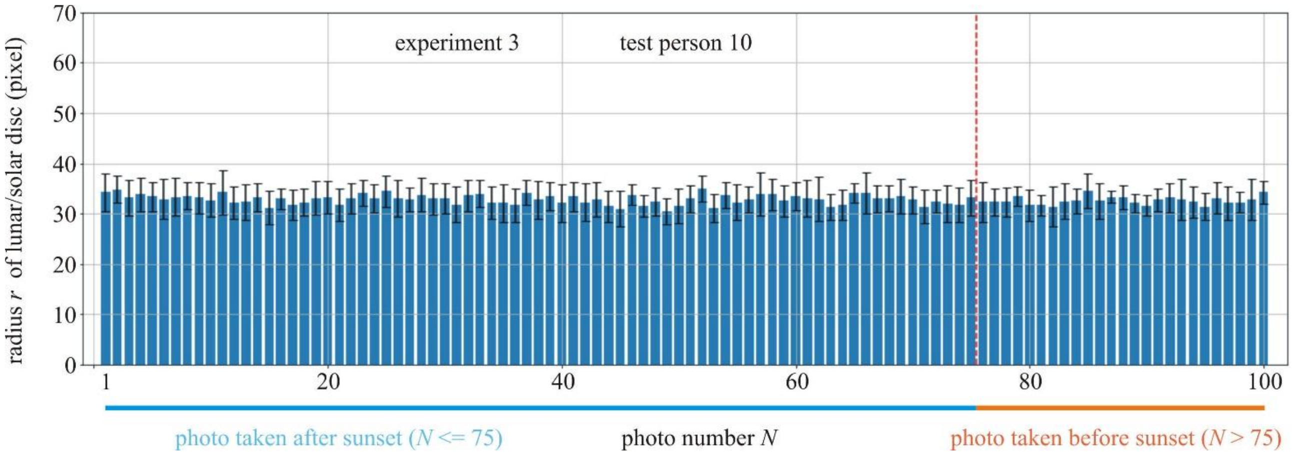
Supplementary Figure E7: Same as Supplementary Fig. E1 for test person 7.



Supplementary Figure E8: Same as Supplementary Fig. E1 for test person 8.



Supplementary Figure E9: Same as Supplementary Fig. E1 for test person 9.



Supplementary Figure E10: Same as Supplementary Fig. E1 for test person 10.