The Knowledge Gene

The incredible story of the supergene that gives us human creativity

LYNNE KELLY

Accompanying pdf to the audiobook

FIGURES

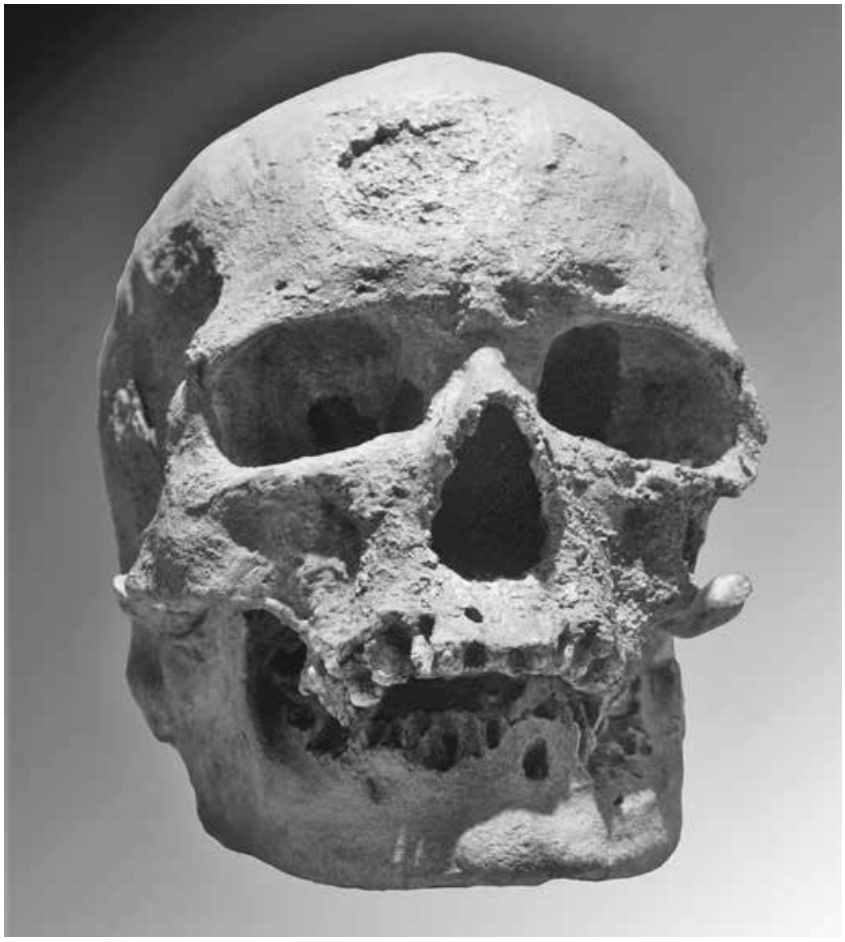

FIGURE 2.1 Cro-Magnon 1 skull, one of the individuals from the Cro-Magnon rock shelter, showcase moulding from the Musée de l'Homme, Paris. PHOTO: 120 (CREATIVE COMMONS LICENCE CC BY-SA 3.0).

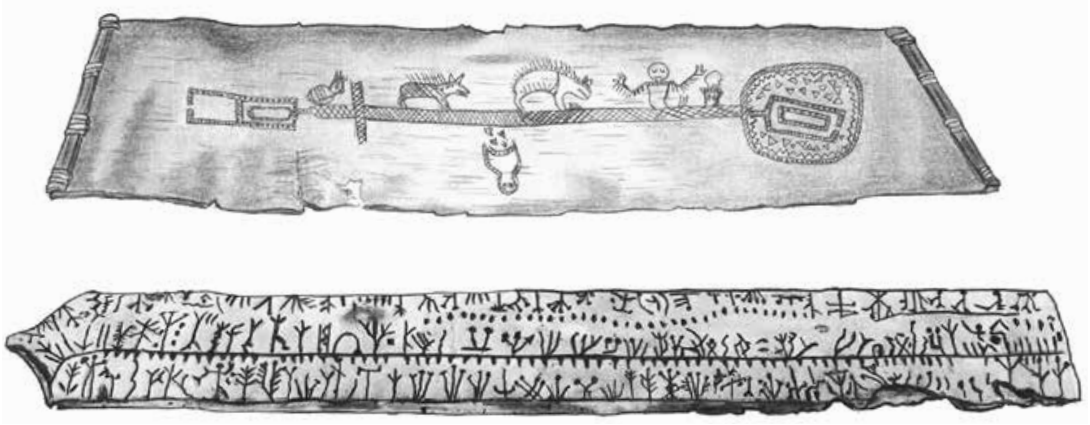

FIGURE 4.1 A birch bark scroll (top) and Ho-Chunk songboard (bottom), drawn from objects examined at the Peabody Museum of Archaeology & Ethnology. IMAGE: LYNNE KELLY.

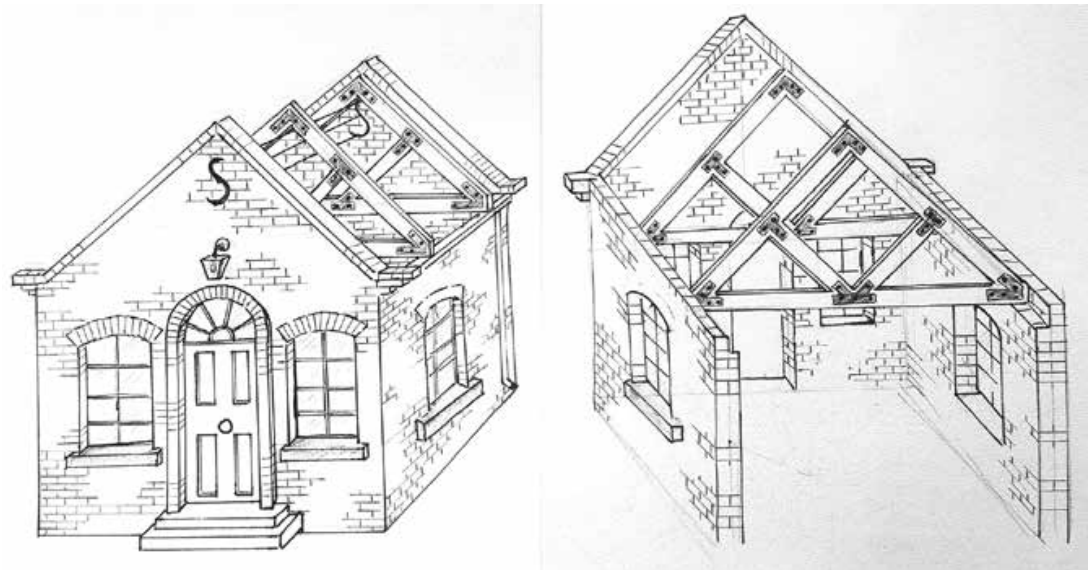

FIGURE 6.1 Marcus Houston's drawings, front and back, of a structure he will build for a client. These images were drawn from imagination of a building that did not yet exist. They took him about fifteen minutes. IMAGES: MARCUS HOUSTON.

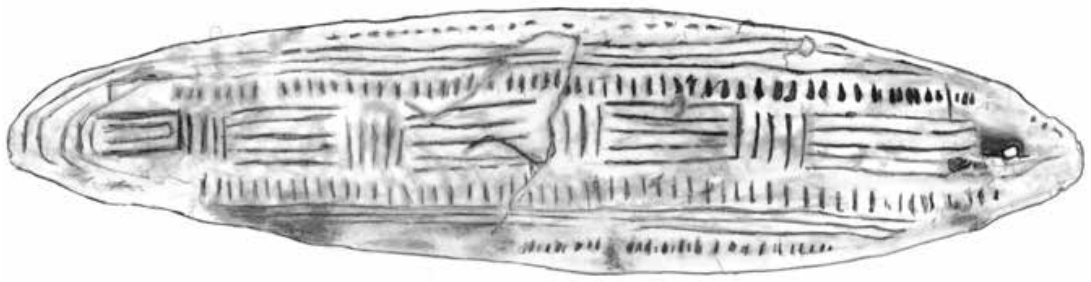

FIGURE 7.1 Markings on the Grotte de la Roche bullroarer. IMAGE: LYNNE KELLY.

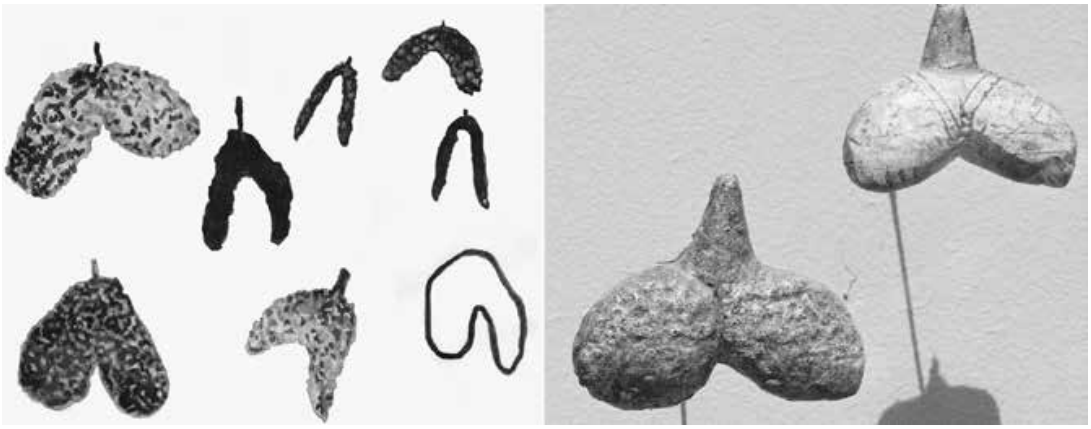

FIGURE 8.1 Left: Symbols from rock art at Burrup Peninsula identified by Traditional Owners as stingray and shark livers and as the tail of dugong or whale. Right: Portion of display labelled as 'Female figurines from Dolní Věstonice'. PHOTO: ZDE (CREATIVE COMMONS LICENCE CC BY-SA 4.0).

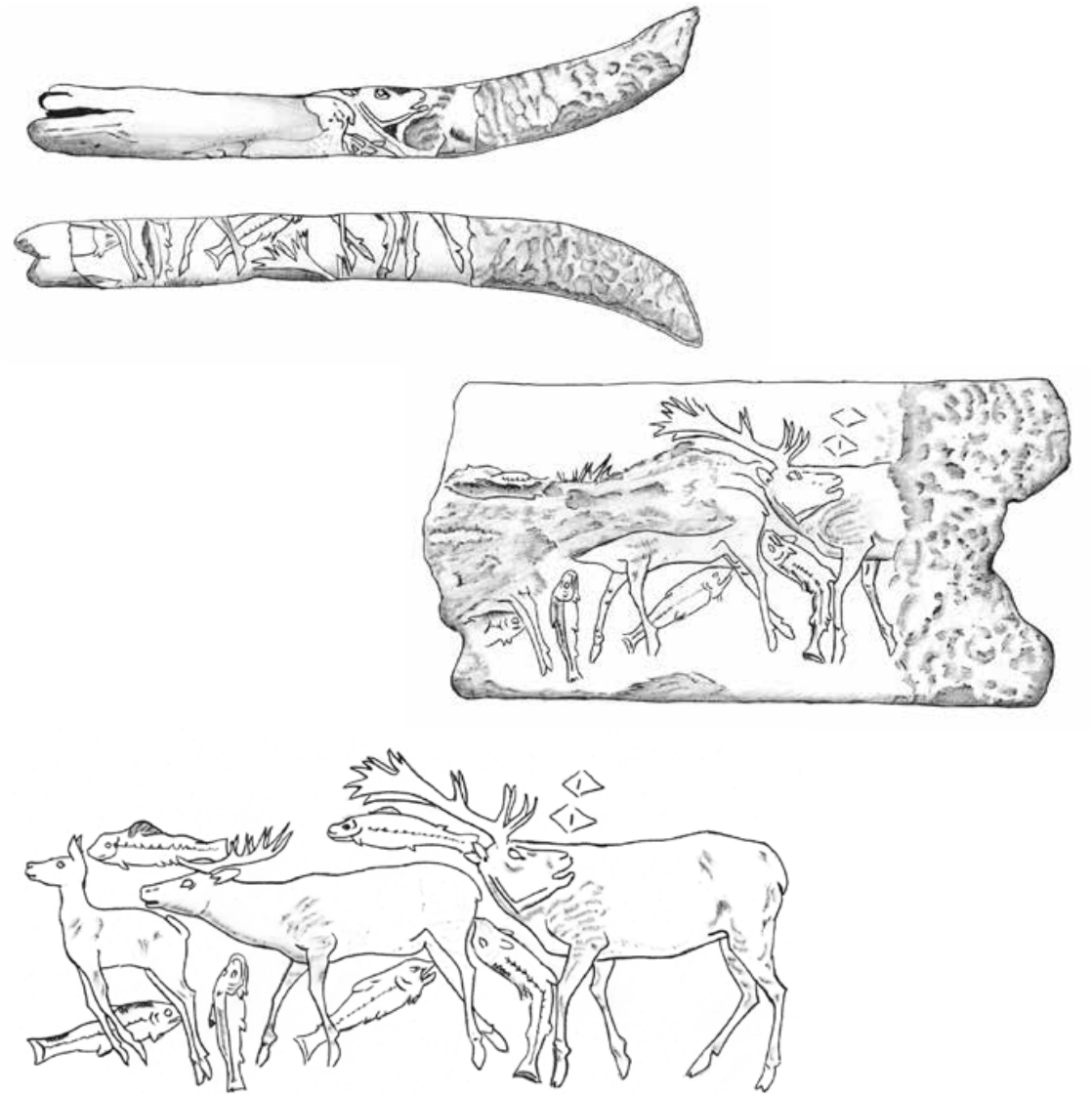

FIGURE 8.2 Drawings of the carving and unrolled versions of the Lortet reindeer horn were published by British zoologist Sir Edwin Ray Lankester in 1920 in *Secrets of Earth and Sea*. IMAGE: LYNNE KELLY.

FIGURE 8.3 Petroglyph of the flute player Kokopelli, in the Mortendad cave, near Los Alamos, New Mexico, USA. PHOTO: LARRY LAMSA (CREATIVE COMMONS LICENCE CC BY-SA 2.0).

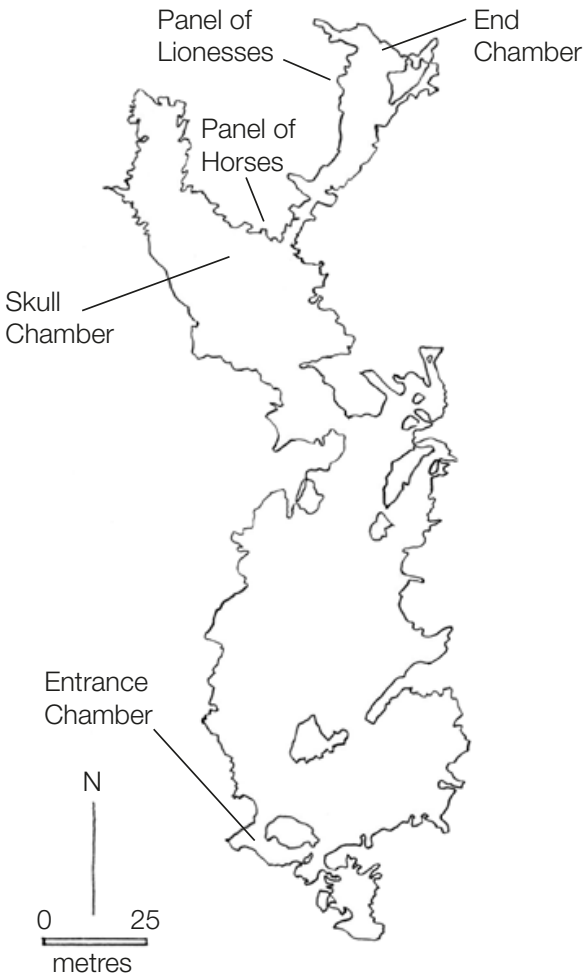

FIGURE 8.4 Map of the Chauvet cave. Adapted from J. Delannoy, B. David, J. Geneste, M. Katherine, B. Barker, R.L. Whear & R.B. Gunn, 'The social construction of caves and rockshelters: Chauvet cave (France) and Nawarla Gabarnmang (Australia)', *Antiquity*, vol. 87, no. 335, 2013, p. 14.

FIGURE 8.5 Survey of the polychrome ceiling of the Altamira cave, published by M. Sanz de Sautuola in 1880 (after Cartailhac, 1902).

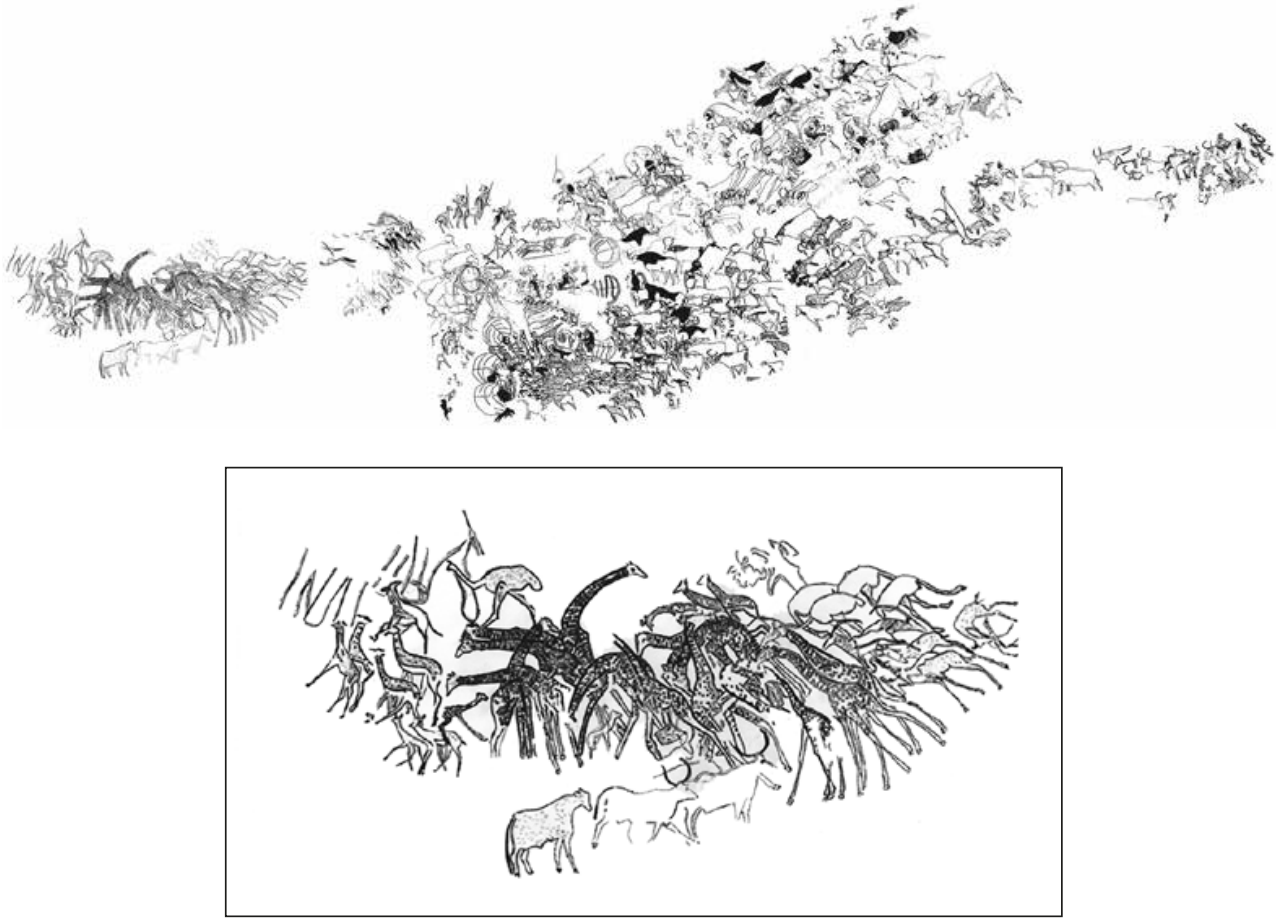

FIGURE 8.6 Part of the massive panel at Tassili-2, and a detail showing the giraffes. IMAGE: LYNNE KELLY.[66]

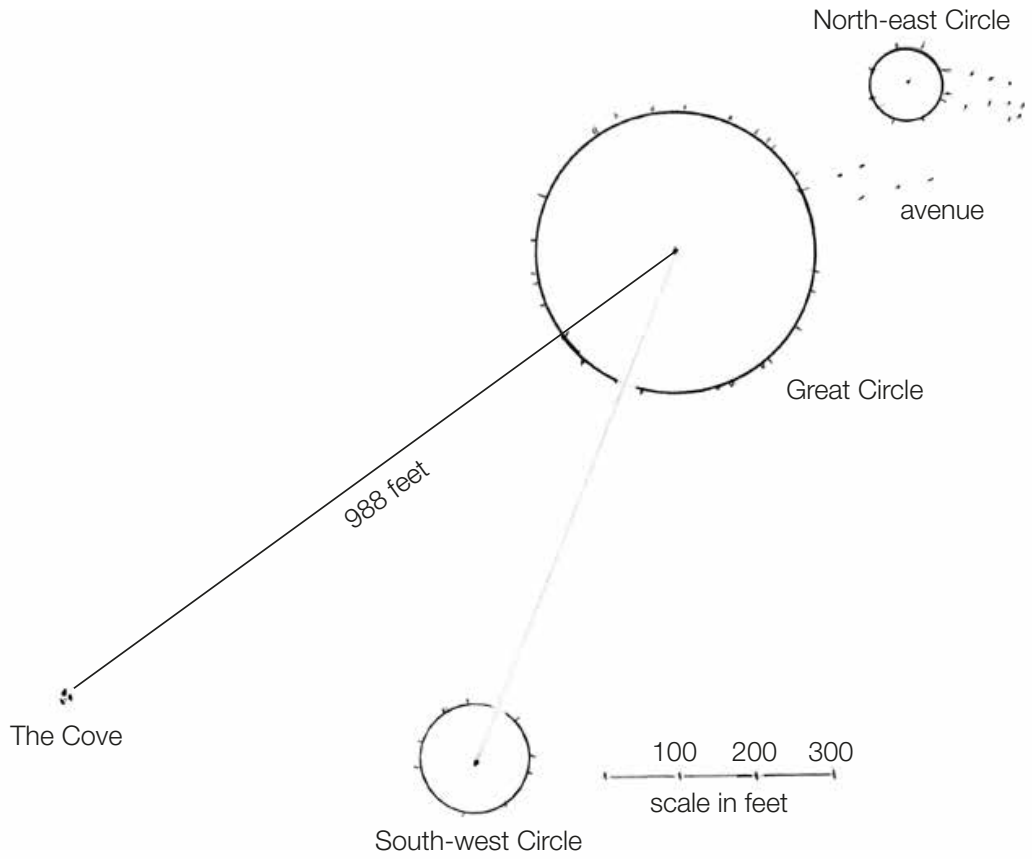

FIGURE 9.1 Plan view of Stanton Drew, redrawn from archaeological surveys. IMAGE: LYNNE KELLY.

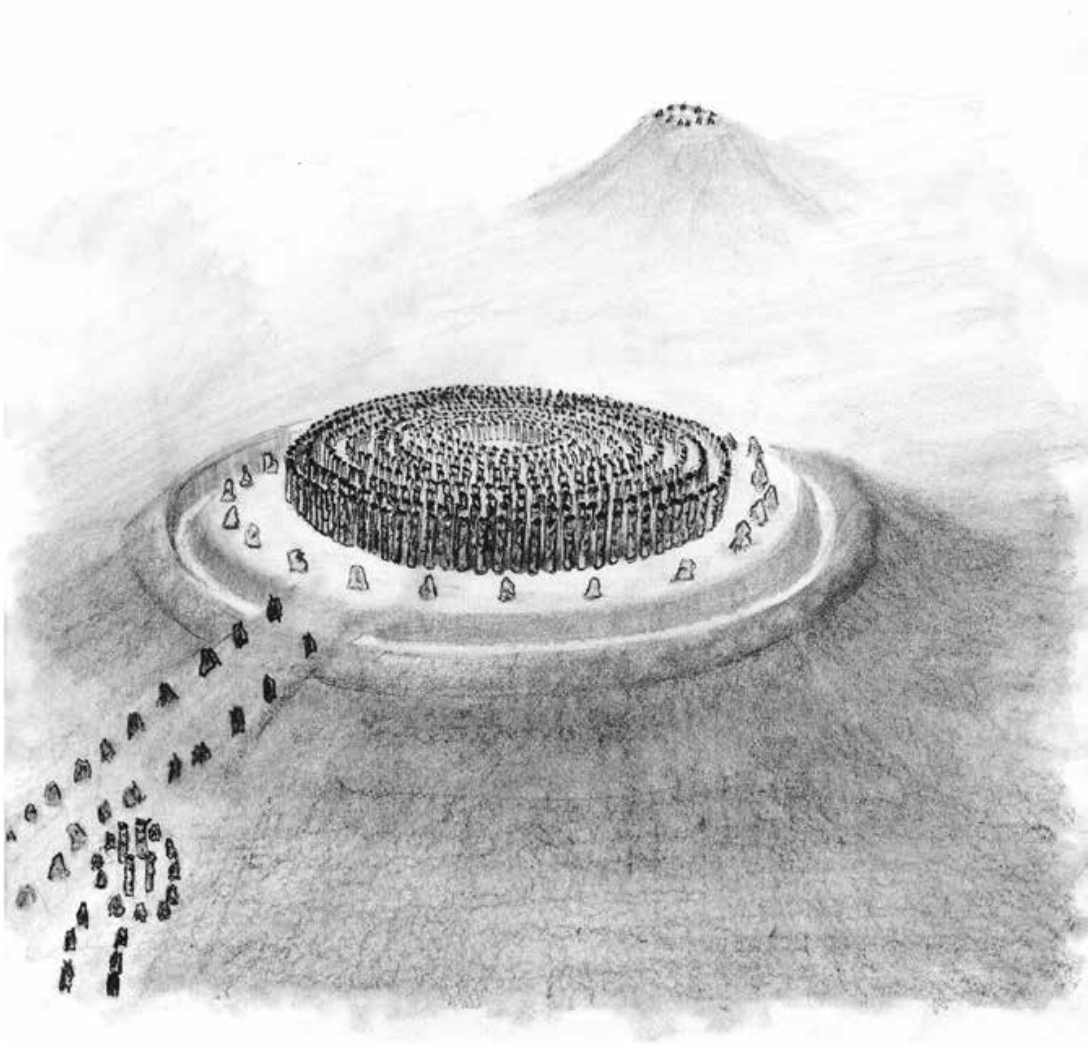

FIGURE 9.2 My interpretation of the archaeological reports of Stanton Drew, adapted from various sources.[9] IMAGE: LYNNE KELLY.

FIGURE 9.3 A six-knobbed carved stone ball, photographed at the Hunterian, Glasgow (left). Photographed at the National Museum of Scotland, Edinburgh, were a many-knobbed stone ball (centre) and the elaborate Towie carved stone ball (right). PHOTOS: DAMIAN KELLY.

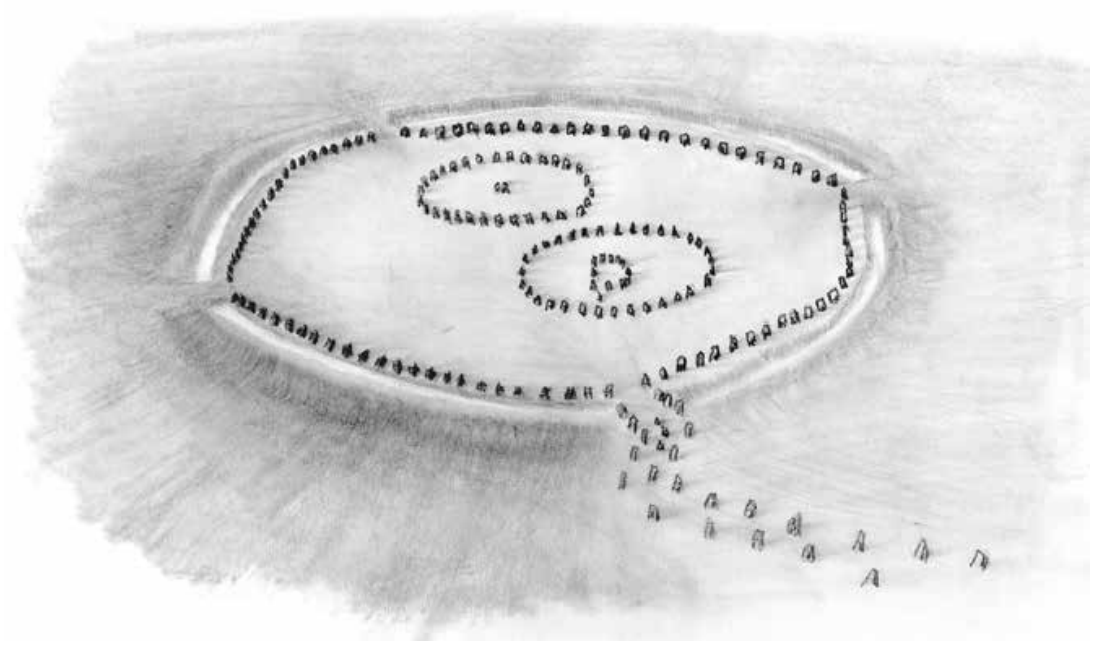

FIGURE 9.4 Avebury henge plan. IMAGE: LYNNE KELLY.

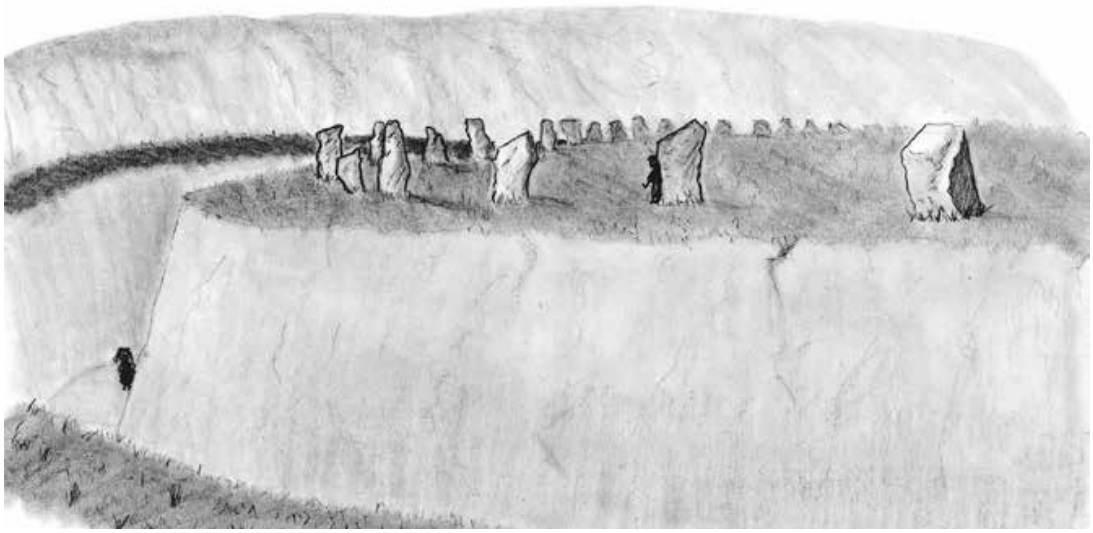

FIGURE 9.5 Illustration showing the scale of the Avebury ditch against the stones. IMAGE: LYNNE KELLY.

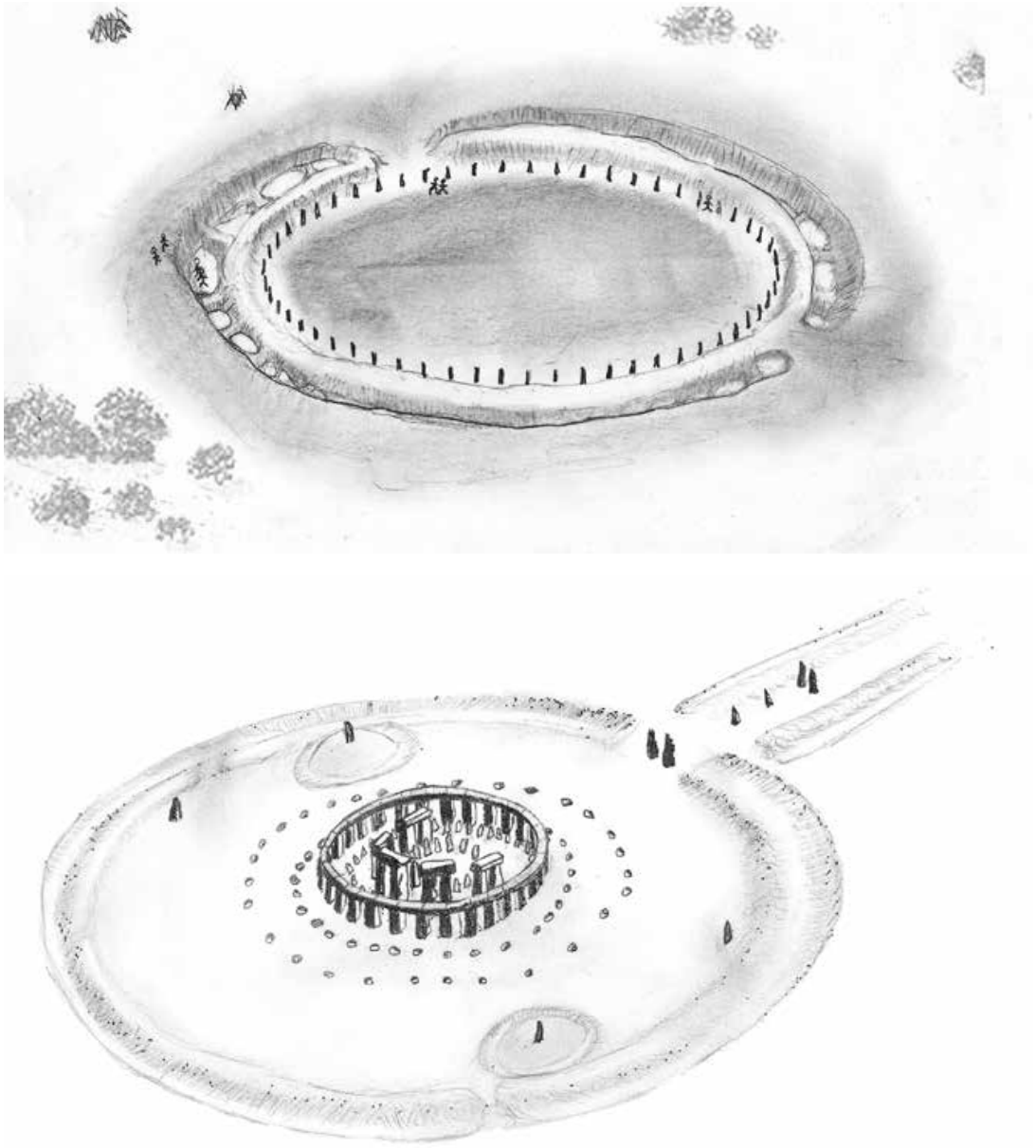

FIGURE 9.6 The initial stage of Stonehenge dates to about 5000 years ago. The sarsens were erected at Stonehenge about 4500 years ago.
IMAGE: LYNNE KELLY.

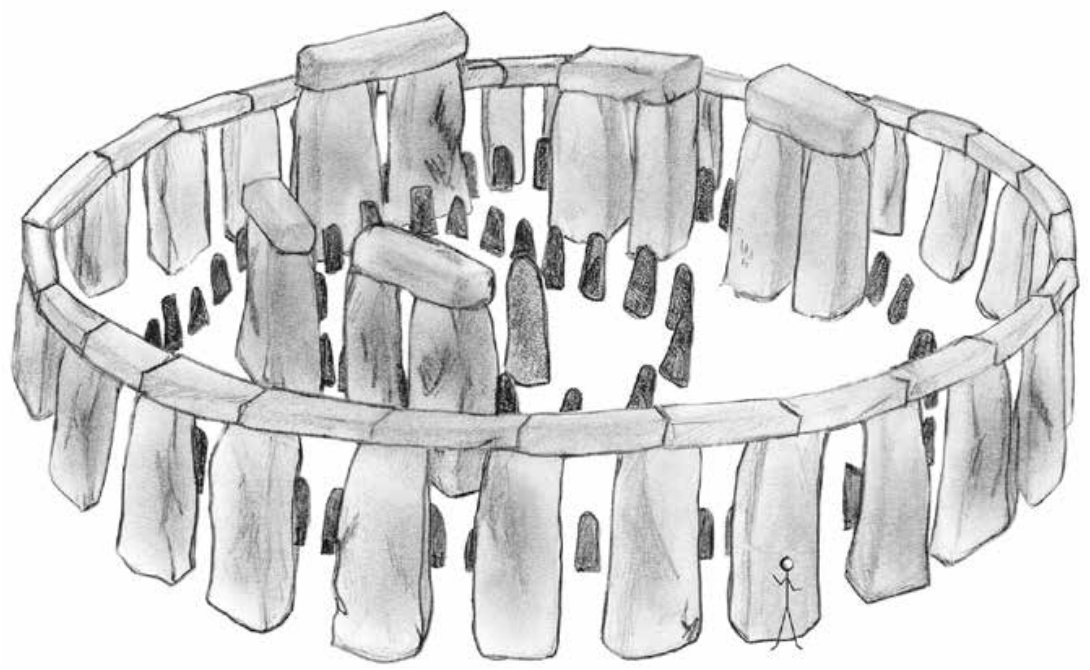

FIGURE 9.7 The sarsens and bluestones in the centre of the Stonehenge monument as it appeared in the final stage of use about 4500 years ago.
IMAGE: LYNNE KELLY.

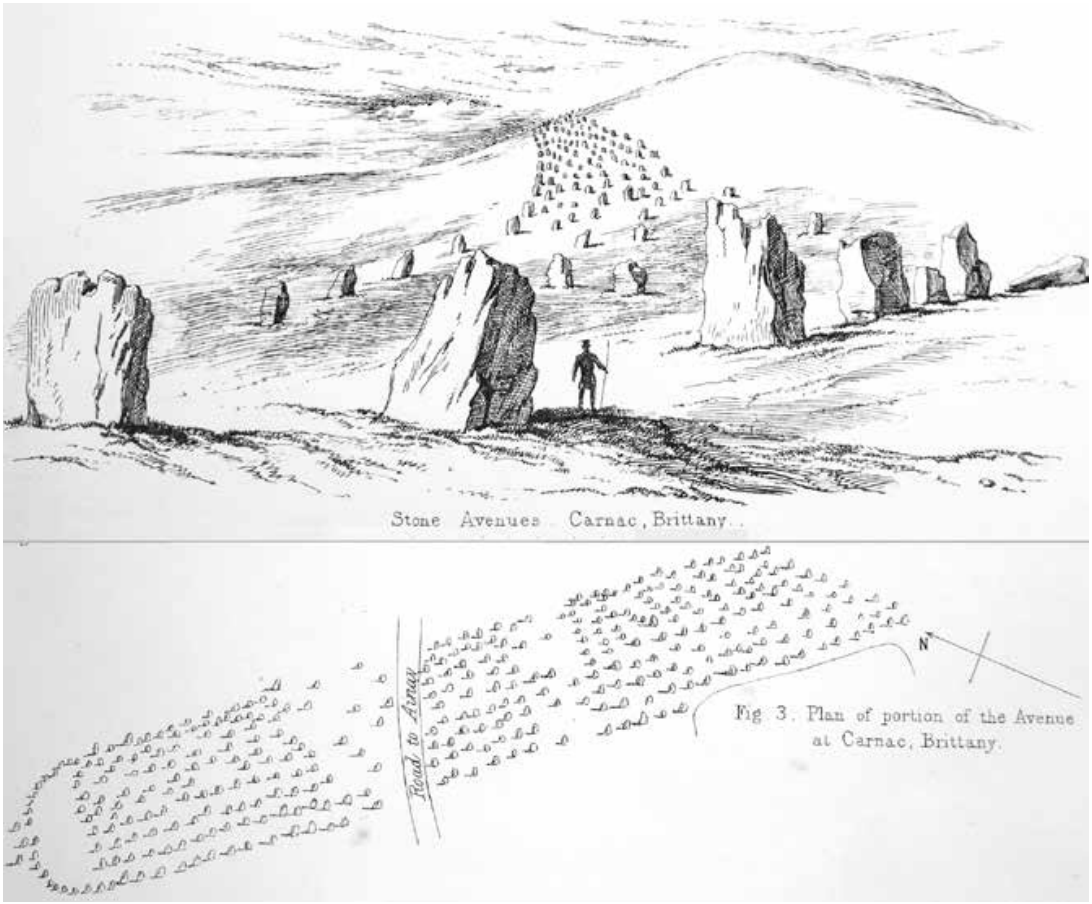

FIGURE 9.8 The rows of standing stones at Carnac, France, in 1870. From J.B. Waring, *Stone Monuments, Tumuli and Ornament of Remote Ages*, John B. Day, London, 1870, p. 43.

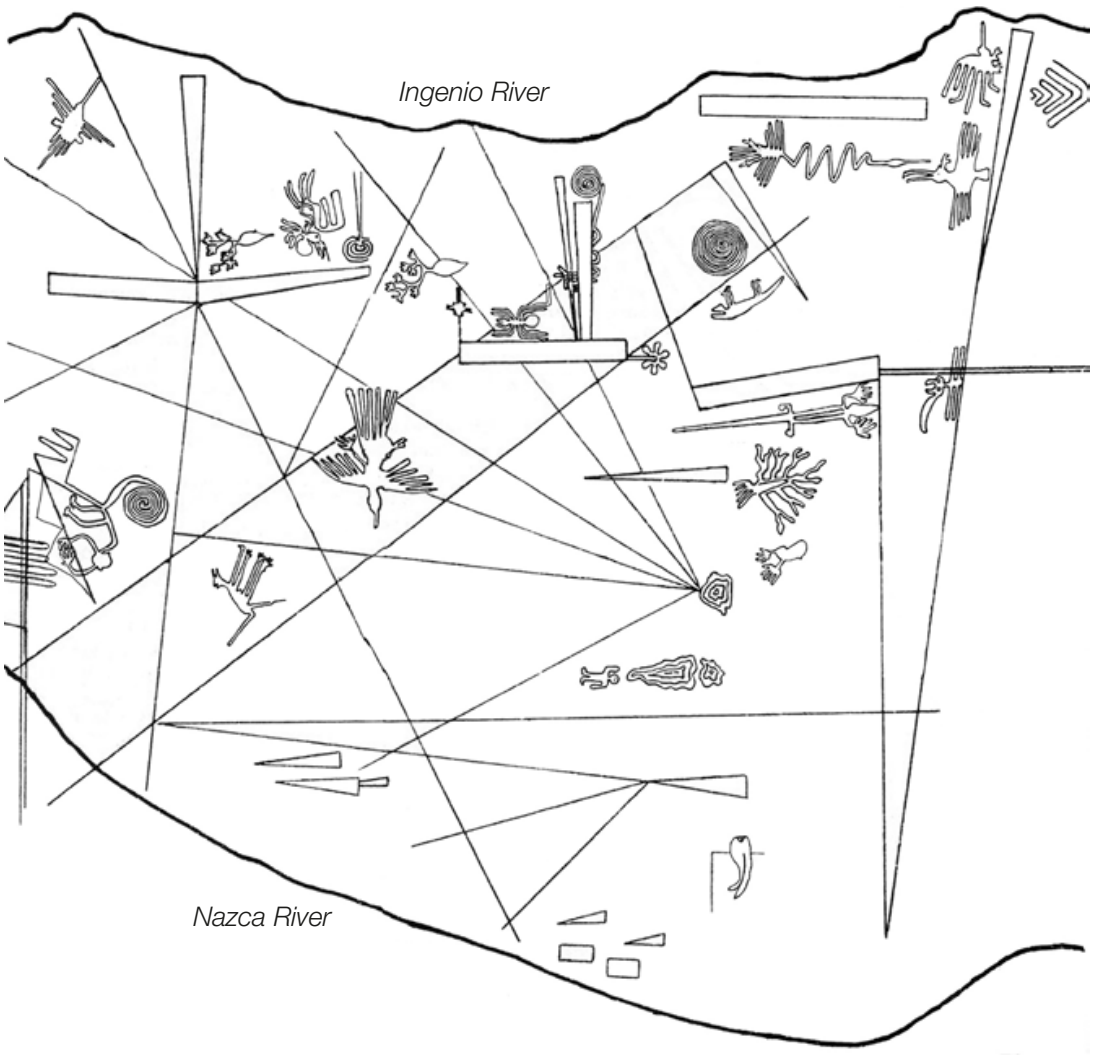

FIGURE 9.9 Part of the Nazca Lines, including the animal glyphs, lines and trapezoids. The monkey is on the left. IMAGE: LYNNE KELLY.

FIGURE 9.10 Verso of *rongorongo* Tablet B, or Aruku-Kurenga; dating from before 1860, it is 43 centimetres long and 16 centimetres wide, with ten lines on the front and twelve on the back—a total of 1135 signs. PHOTO: STÉPHEN-CHARLES CHAUVET (CREATIVE COMMONS LICENCE CC BY-SA 3.0).

FIGURE 10.1 Warring States Period bronze vessel, redrawn from Melinda Pap, 'Rituális étkezés az ókori Kínában', *Convivium*, Faculty of Humanities of Eötvös Loránd University, Budapest, 2012, p. 184. IMAGE: LYNNE KELLY.

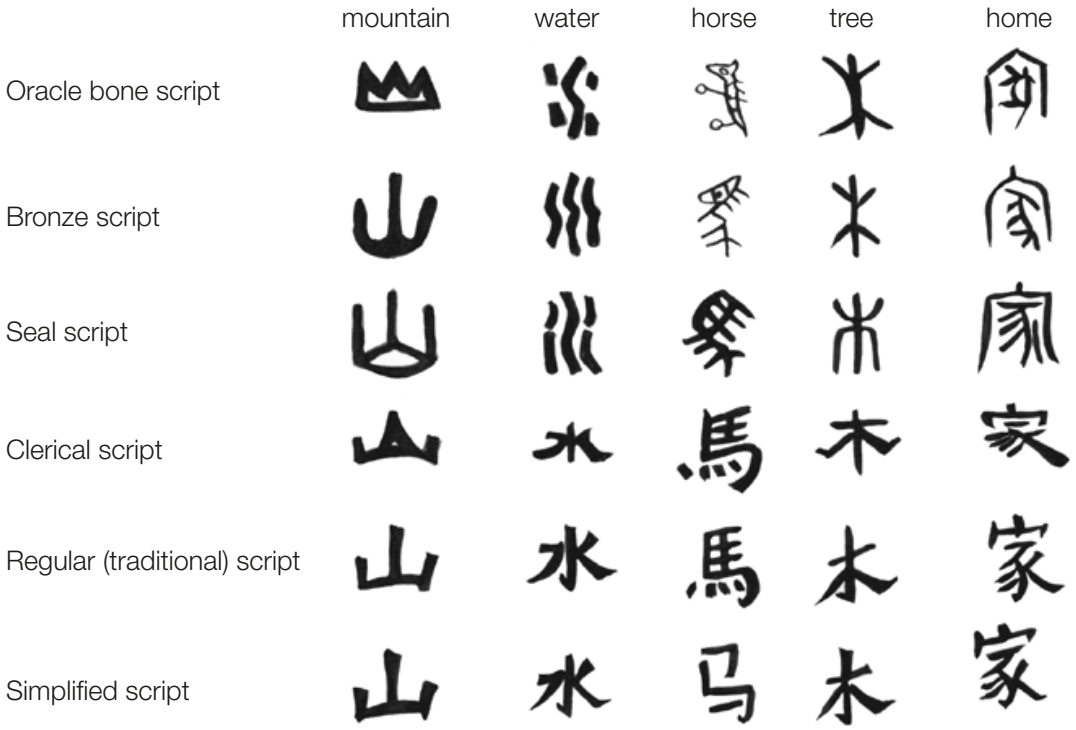

FIGURE 10.2 A comparison of the Shang oracle bone, bronze great seal, small seal, clerical (scribal), regular (traditional) and simplified scripts.
IMAGE: LYNNE KELLY.

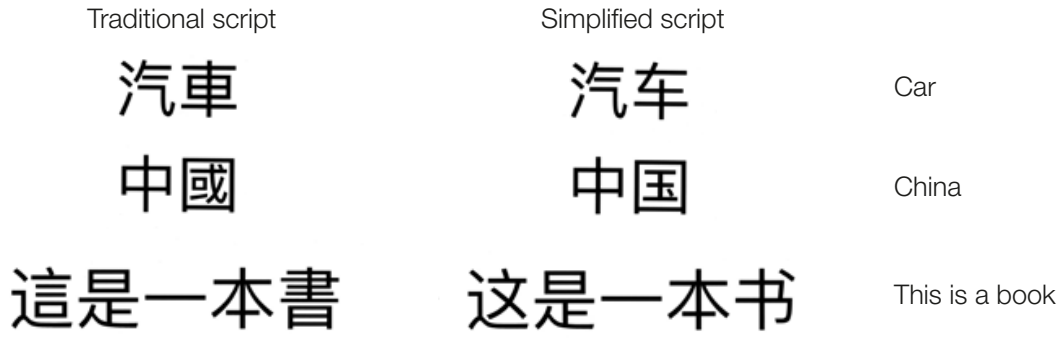

FIGURE 10.3 Examples of characters in traditional and simplified Chinese scripts. IMAGE: LYNNE KELLY.

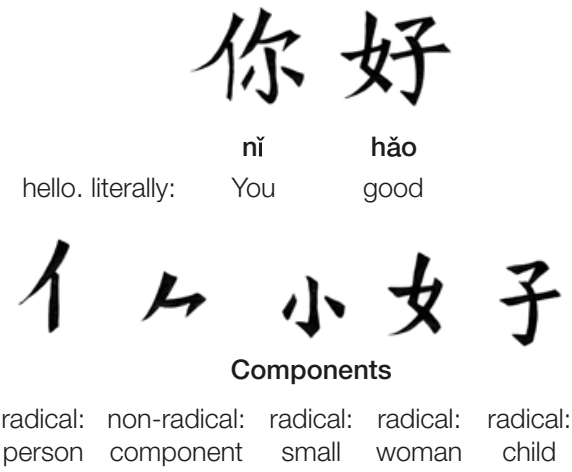

FIGURE 10.4 A word consisting of compound Chinese characters, *Ni hao*, broken down. IMAGE: LYNNE KELLY.

FIGURE 10.5 A sample of Hokusai's 'manga' from a woodblock-printed book dated 1834. IMAGE: THE METROPOLITAN MUSEUM, NEW YORK.

PLATES

PLATE 1.1 A screenshot from the Horizon documentary *My Amazing Twin* depicting Neil Pearson (left) and Adam Pearson (right). The identical twins have neurofibromatosis type 1 but they have vastly different physical and mental symptoms. SOURCE: JAMES NEWTON FILMS (CREATIVE COMMONS LICENCE CC BY-SA 3.0).

PLATE 1.2 The hand of a person with multiple neurofibromas.
PHOTO: JFVELASQUEZ FLORO (CREATIVE COMMONS LICENCE CC0 1.0).

PLATE 4.1 Anna's home as a memory location, as I imagined it before and after I had met her. The difference as a memory location is immense.
IMAGE: LYNNE KELLY, WITH PERMISSION FROM ANNA.

PLATE 4.2 The Sealaska Cultural Values Totem Pole represents the shared core values of all three tribes of south-eastern Alaska: Tlingit, Haida and Tsimshian. PHOTO COURTESY OF SHI.

PLATE 4.3 The Tsimshian clan house front was commissioned by the Sealaska Heritage Institute and represents the region's three tribes—Tlingit, Haida and Tsimshian. PHOTO COURTESY OF SHI.

PLATE 4.4 Tlingit group Sitka Kaagwaantaan Dancers performs at the Sealaska Heritage Celebration 2018. David Kanosh tells the origin story of the Kaagwaantaan, with guidance from clan leader Nels Lawson. PHOTO COURTESY OF SHI.

Plates 4.2–4.5 include copyright-protected clan property in the form of crests and regalia. These cannot be replicated without clan permission.

PLATE 4.5 Dancers of the Shangukeidí (Thunderbird) clan, also known as Chilkat. The Lukaax.ádi (Sockeye Salmon) clan, also known as Chilkoot, were invited to join the dance, along with the clan children. This photo contains sacred clan crests that are owned by the Shangukeidí and the Lukaax.ádi and cannot be replicated by those who are not members of these clans. PHOTO COURTESY OF SHI.

PLATE 4.6 A *lukasa* memory board from the late 19th or early 20th century and made from wood, metal and beads. PHOTO COURTESY OF BROOKLYN MUSEUM.

PLATE 6.1 Jane Rusden's nature journalling exercise, painted in a fern gully. IMAGE: JANE RUSDEN.

PLATE 7.1 The Divje Babe flute, measuring 11.4 cm long, alleged to be Neanderthal. National Museum of Slovenia. PHOTO: PETAR MILOŠEVIĆ (CREATIVE COMMONS LICENCE CC BY-SA 4.0).

PLATE 7.2 Various instruments from Grotte de la Roche, France, including a flute and decorated bullroarer. IMAGE: BASTIENM (CREATIVE COMMONS LICENCE CC BY-SA 3.0).

PLATE 8.1 Hand axe knapped around a fossil shell, West Tofts, Norfolk, England, *c.* 500,000–300,000 years ago. PHOTO: MUSEUM OF ARCHAEOLOGY AND ANTHROPOLOGY, UNIVERSITY OF CAMBRIDGE (CREATIVE COMMONS LICENCE CC BY-NC-ND 4.0).

PLATE 8.2 The Neanderthal engraving of a deer toe bone at Einhornhöhle. PHOTO: AXEL HINDEMITH (CREATIVE COMMONS CC BY-SA-3.0 DE).

PLATE 8.3 The Neanderthal structure dating back *c.* 175,000 years, deep in Bruniquel Cave, France. PHOTO: LUC-HENRI FAGE/SSAC (CREATIVE COMMONS LICENCE CC BY-SA 4.0).

PLATE 8.4 Lake Mungo, in south-western New South Wales, is no longer a lake.
PHOTO: DAMIAN KELLY.

PLATE 8.5 Nawarla Gabarnmang art site, Jawoyn Country, Australia.
PHOTO: JEAN-JACQUES DELANNOY (CREATIVE COMMONS LICENCE CC BY-SA 4.0).

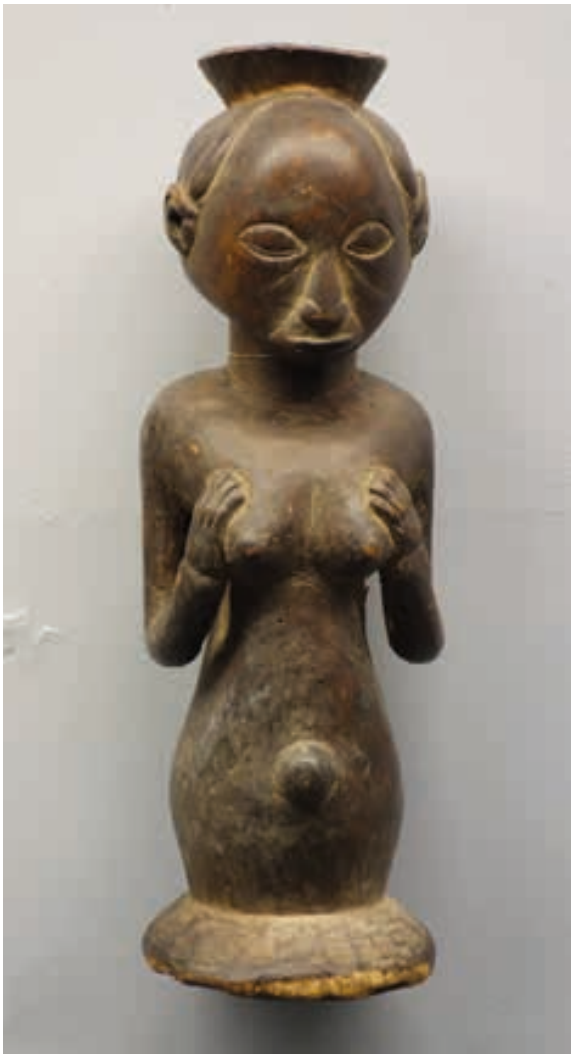

PLATE 8.6 Female figurine from the Luba culture, West Africa, in the Royal Museum for Central Africa, Tervuren, Belgium. PHOTO: DADEROT (CREATIVE COMMONS LICENCE CC BY-SA 1.0).

PLATE 8.8 The oldest known figurine, *Löwenmensch*, from the German cave of Hohlenstein-Stadel (dated to 40,000–35,000 years ago). PHOTO: DAGMAR HOLLMANN (CREATIVE COMMONS LICENCE CC BY-SA 4.0).

PLATE 8.7 Venus figures. Left: four sides of the Venus of Willendorf (dated to 25,000–30,000 years ago). Right: Venus of Laussel (dated to 20,000–18,000 years ago). PHOTOS: BJØRN CHRISTIAN TØRRISSEN (CREATIVE COMMONS LICENCE CC BY-SA 4.0) AND 120 (CREATIVE COMMONS LICENCE CC BY-SA 3.0).

PLATE 8.9 The Panel of the Horses from Pont d'Arc cave, an accurate copy of the Chauvet Cave. PHOTO: CLAUDE VALETTE (CREATIVE COMMONS LICENCE CC BY-SA 4.0).

PLATE 8.10 The polychrome ceiling at Altamira, Spain. PHOTO: MUSEO DE ALTAMIRA Y D. RODRÍGUEZ (CREATIVE COMMONS LICENCE CC BY-SA 3.0).

PLATE 8.11 A small section of the thirteen kilometres of the Serranía de La Lindosa rock art panel in Colombia. The arrow points to a proposed extinct giant ground sloth. PHOTO: JOSÉ IRIARTE ET AL. (CREATIVE COMMONS LICENCE CC BY-SA 4.0).

PLATE 8.12 The Sandhill Crane Site at the mouth of Currant Canyon, part of Nine Mile Canyon in Utah, United States. PHOTO: COURTESY COLORADO PLATEAU ARCHAEOLOGICAL ALLIANCE.

PLATE 8.13 The petroglyphs at Winnemucca Lake subbasin, Nevada, are North America's oldest. PHOTO: UNITED STATES GEOLOGICAL SURVEY.

PLATE 8.14 Petroglyph of a sleeping antelope, located at Tin Taghirt on the Tassili n'Ajjer, in southern Algeria. PHOTO: LINUS WOLF (CREATIVE COMMONS LICENCE CC BY-SA 3.0).

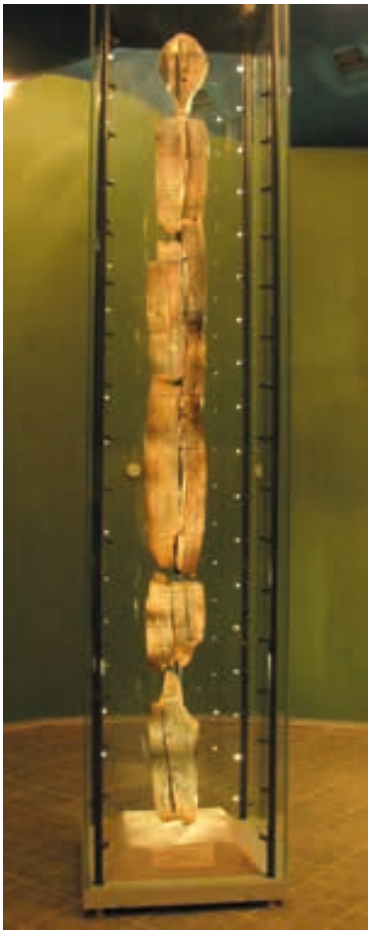

PLATE 9.1 The Shigir Idol, the oldest known wooden sculpture in the world, carved about 11,600 years ago. Sverdlovsk Regional Museum of Local Lore, Yekaterinburg, Russia. PHOTO: ВЛАДИСЛАВ ФАЛЬШИВОМОНЕТЧИК (CREATIVE COMMONS LICENCE CC BY-SA 3.0).

PLATE 9.2 Göbekli Tepe from a distance, and detail of a single pillar (above right). PHOTOS: VOLKER HÖHFELD AND KLAUS-PETER SIMON (CREATIVE COMMONS LICENCE CC BY-SA 4.0).

PLATE 9.3 The Ring of Brodgar, with the Loch of Stenness in the background and the remains of the ditch in the foreground. PHOTO: STEVEKEIRETSU (CREATIVE COMMONS LICENCE CC BY-SA 3.0).

PLATE 9.4 The chamber in the Dwarfie Stane, on the Orkney island of Hoy, was carved out using only stone tools. PHOTO: DAMIAN KELLY.

PLATE 9.5 One of the 97 kerbstones at Newgrange, Ireland. The triskelion, the symbol used on the cover of this book, can be seen on the left of the stone. PHOTO: DAMIAN KELLY.

PLATE 9.6 Rujm el-Hiri, the 'Stonehenge of the Levant', Golan Heights, dating from the Early Bronze Age. PHOTO: SHII (CREATIVE COMMONS LICENCE CC BY-SA 3.0).

PLATE 9.7 Nazca jar (325–440 CE) with monkey. Held by the Brooklyn Museum, New York. PHOTO: LYNNE KELLY.

PLATE 9.8 The Paracas Textile, created by Nazca people *c.* 100–300 CE. Ninety figures decorate the intricate border. PHOTO: BROOKLYN MUSEUM, NEW YORK.

PLATE 9.9 Ahu Tongariki *moai*, platform and performance space, Rapa Nui.
PHOTO: PIOTR BIERNACKI (CREATIVE COMMONS LICENCE CC BY-SA 4.0).

PLATE 9.10 An artist's impression of Cahokia, 1100–1200 CE, with Woodhenge in the foreground. ILLUSTRATION: CAHOKIA MOUNDS STATE HISTORIC SITE, PAINTING BY LLOYD K. TOWNSEND.

PLATE 9.11 Pueblo Bonito: a digital reconstruction of the Great House in Chaco Canyon just before abandonment. ILLUSTRATION: COURTESY OF NASA.

PLATE 10.1 A section of a mural from the Tepantitla compound in the Mesoamerican ruins of Teotihuacan, Mexico. There are at least twenty speech scrolls in this detail. PHOTO: TESEUM (CREATIVE COMMONS LICENCE CC BY-SA 2.0).

PLATE 10.2 Four sheets of the Maya Dresden Codex (pp. 55–58), depicting eclipses, multiplication tables and the flood (*c.* 1200 CE).

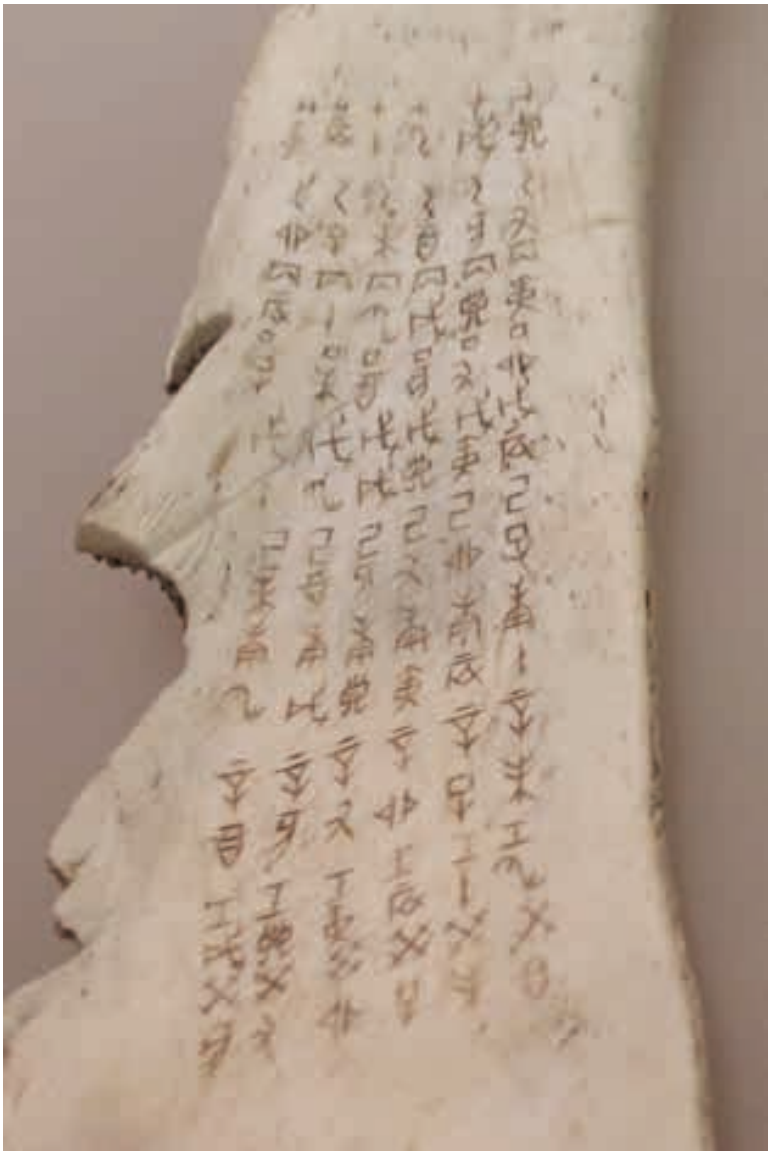

PLATE 10.3 Table of the Chinese sexagenary cycle, an ancient counting system, inscribed on an ox scapula, corresponding to the reigns of the last two kings of the Shang Dynasty. PHOTO: GARY LEE TODD (CREATIVE COMMONS LICENCE CC BY-SA 1.0).

PLATE 10.4 A portion of the main rock painting on Huashan Mountain. The paintings are located on a cliff face along the west bank of the Mingjiang River in Yaoda Town, Ningming County, Guangxi, China. PHOTO: ROLFMUELLER (CREATIVE COMMONS LICENCE CC BY-SA 3.0).

PLATE 10.5 A small segment of the handscroll *Along the River During the Qingming Festival* created by artist Zhang Zeduan (1085–1145), Northern Song Dynasty, and housed in the Palace Museum, Forbidden City, Beijing.

PLATE 10.6 Chinese artwork *Walking on a Mountain Path in Spring*, by Ma Yuan (1160–1225), in which calligraphy is an intrinsic component.

PLATE 10.7 A manuscript from the *Mewar Ramayaṇa*, depicting Rāma slaying Rāvaṇa. It was created by scribes and painters employed by the Kingdom of Mewar and dates to the 17th century. Held by the British Library.

PLATE 10.8 A contemporary painting titled *Kecak (Monkey) Dance*. IMAGE: COURTESY OF REBECCA AND RUDI HEITBAUM.

PLATE 10.9 Cuneiform tablet: hymn to Marduk, possibly Babylonian, 1st millennium BCE. IMAGE: COURTESY OF THE METROPOLITAN MUSEUM OF ART.

PLATE 10.10 Part of the decoration of an Attic red-figure vase, depicting Greek mythological characters: Eurynome, Pothos, Hippodamia, Eros, Iaso and Asteria; *c.* 400 BCE.

PLATE 10.11 A leaf from a manuscript of Valerius Maximus from the workshop of Pierre Remiet, *c.* 1380–90. IMAGE: COURTESY OF THE METROPOLITAN MUSEUM OF ART.

PLATE 11.1 A small portion of the handscroll *Spring Morning in the Han Palace*, by Qiu Ying (*c.* 1494–1552), which measures 30.6 x 574.1 cm. Held in the National Palace Museum, Taipei.

PLATE 11.2. Part of a Japanese narrative scroll, *The Illustrated Sutra of Past and Present Karma* (*Kako genzai inga kyō emaki*), by an unidentified artist, late 13th century. IMAGE: COURTESY OF THE METROPOLITAN MUSEUM OF ART.

PLATE 11.3 An illustration (left) of a spotted pardalote to show accurate colours and habitat, and ‘art for art’s sake’ (right)—a drawing of the superb fairywren that captures personality. IMAGES: BRIDGET FARMER.

PLATE 11.4 Jane Rusden’s painting of a brown falcon conveys the power and presence of a bird that dominates the food chain. IMAGE: JANE RUSDEN.

APPENDIX

The knowledge gene skill set

The following 89 skills were identified in the knowledge systems of oral cultures, divided into seven categories: Music, Performance, Spatial, Art, Language, Cognitive and Social. Those that were selected are highlighted in grey.

Key:

†	challenges for the NF1 cohort
⋆	skills observed in chimpanzees
NSD	no significant difference
PS	possible strength
UN	unknown/no relevant testing

Music skills

1. Perform music in songs or chants to store knowledge†
2. Use rhythm as a memory aid (mnemonic)†
3. Add complexity to music†
4. Create embodied musical forms†
5. Encode knowledge in dance†
6. Use music to generate emotional response[UN]
7. Compose music†
8. Create musical instruments[UN]

None of these skills have been seen in chimpanzees. Skills 1, 2, 3, 4, 5 and 7 were assessed as being a challenge for those with the NF1 disorder, especially given the high rate of amusia. Embodied musical forms include all forms of rhythmic movement to music, which includes the critical role of dance. Skills 6 and 8 could not be rated as there has been no relevant testing done.

Performance skills

9. Enact knowledge in performance[UN]
10. Take on different persona in performance[NSD]
11. Mimic animals in performance[NSD]
12. Represent plants in performance[NSD]
13. Predict and enact possible future events[NSD]
14. Maintain core pedagogy accurately, embellish for entertainment†
15. Sequence a performance of multiple elements†

Some semblance of skill 15 has been observed in chimpanzees, as male displays can incorporate performances involving

a sequence of elements. But they have never been observed creating the complex performances with multiple participants that are so common in human ceremonies, so this skill has been retained.

There is no research to indicate whether or not skill 9 would pose a challenge for those with the NF1 disorder, so it was eliminated. No significant difference has been observed for skills 10, 11, 12 and 13. However, skills 14 and 15 were considered to be a challenge for the NF1 cohort due to issues with executive function.

Spatial skills

16. Conceptualise vast areas of land†
17. Use structured knowledge of land as mnemonic[NSD]
18. Visualise distant spaces†
19. Navigate from information in songs†
20. Conceptualise a constantly moving skyscape[UN]
21. Link the skyscape to the landscape[UN]
22. Use cardinal directions rather than right and left†

Chimpanzees display some spatial awareness in knowing the location of resources within their territory, as required for skill 16. But there is nothing that would indicate that chimpanzees encode those vast spaces with stories, conceptualising them as knowledge spaces. They do not mark specific sites or in any other way indicate the significance of their landscape. Hence skill 16 was retained. None of the other spatial skills have been recorded for chimpanzees.

For those with the NF1 disorder, skill 17 was assessed as showing no significant difference. There is no research relating

to skills 20 and 21, although it can be predicted that these would provide challenges due to visuospatial problems.

It is the difficulties those with the NF1 disorder are likely to experience with skills 16, 18, 19 and 22 that are highly significant for this research.

Art skills

23. Create art primarily as mnemonic, not aesthetic[NSD]
24. Visualise objects in 3D†
25. Use art as representation of place[NSD]
26. Create abstract art as mnemonic†
27. Use abstract elements to enable adaptability†
28. Use ephemeral art as learning process[NSD]
29. Produce standardised designs†
30. Adhere to standardised designs[PS]
31. Create representational art†
32. Organise art in ceremony†
33. Participate with art in ceremony[PS]
34. Create art communally[PS]
35. Create pictographic art[NSD]
36. Adapt established artwork for new knowledge†
37. Utilise manual dexterity†
38. Create memory devices on wood, stone, cords or fabric[NSD]
39. Create art on utilitarian objects[NSD]
40. Use art as a passport, a message to other tribes[NSD]
41. Use poles, posts and tree trunks for mnemonic art[NSD]
42. Combine art with performance[UN]
43. Use natural colour sources[NSD]
44. Visualise a new form from common materials★[NSD]
45. Create tattoos to standardised forms[NSD]

Chimpanzees have not been observed demonstrating any of the art skills other than skills 37 and 44. In grooming, nut-cracking and fishing, they demonstrate fine motor skills, but none of the manual dexterity required to create and manipulate complex tools and artworks. Although chimpanzees do modify objects to use as tools, they do not create objects that require carving wood, chipping stone or moulding clay as humans do. The complex manual dexterity of humans justifies the retention of skill 37, while the three-dimensional visualisation is already accounted for in the retained skill list because of skill 24.

Those with the NF1 disorder find challenges with mastering tasks requiring visuospatial abilities or fine motor skills. Skills 24, 26, 27, 29, 31, 32, 36 and 37 were therefore assessed as providing challenges for this cohort. Skills 23, 25, 28, 35, 38, 39, 40, 41, 43, 44 and 45 were assessed as indicating no difference from those with two fully functioning NF1 genes. Skills 30, 33 and 34 were assessed as possible strengths for those with the NF1 disorder.

Skill 42 couldn't be assessed as there is no relevant research to draw on.

Language skills

46. Prosody*
47. Work with language in complex forms†

Chimpanzees demonstrate prosody in their different vocalisations. Due to speech challenges for those with the NF1 disorder, skill 47 was considered a challenge.

Cognitive skills

48. General comprehension★NSD
49. Repeat information extensively and systematicallyPS
50. Retain an integrated knowledge system†
51. Use narrative and mythology as mnemonic†
52. Use metaphor to reduce mnemonic effort†
53. Optimise focus, concentration and perseverance★†
54. Layer knowledge in levels of complexity†
55. Maintain classification of aspects of the environmentPS
56. Optimise memory skills†
57. Act upon new observations encoded as rulesPS
58. Integrate environmental knowledge†
59. Distinguish between reality and fantasy†
60. Conceive inanimate objects as livingNSD
61. Curate and utilise apparently non-utilitarian objectsNSD
62. Conceptualise time and maintain a calendarPS
63. Gain knowledge from experimentation★NSD
64. Use imagination to create characters and scenarios†
65. Exploit anthropomorphic thinkingNSD
66. Make patterns with common objects for memory aids†
67. Add new classifications of environmental aspects to existing system†
68. Encode knowledge efficiently†
69. Decode knowledge from encoded formats†
70. Maintain complex genealogies†
71. Value knowledge for knowledge's sakeNSD
72. Think scientifically★NSD
73. Record observations and act upon them†
74. Exploit magical thinkingNSD
75. Create structured, coherent knowledge formats†

It is important to note that those with the NF1 disorder were assessed as having no significant difference from those with two fully functioning NF1 genes in general comprehension (skill 48). The challenges they experience are not related to intelligence.

Chimpanzees show some degree of general comprehension. They also demonstrate skill 53 in their focus, concentration and perseverance in tool use. They gain knowledge from experimentation (skill 63) when devising tools and demonstrate some ability to think scientifically (skill 72).

There is no significant difference in skills 48, 60, 61, 63, 65, 71, 72, and 74 between those with the NF1 disorder and those without. Skills 50, 51, 52, 53, 54, 56, 58, 59, 64, 66, 67, 68, 69, 70, 73 and 75 were all assessed as presenting challenges for those with the NF1 disorder. Skills 49, 55, 57 and 62 were assessed as possible strengths due to a preference for rules, schedules and repetition.

Social skills

76. Ensure adherence to formal teaching processes[PS]
77. Ensure public/restricted knowledge dichotomy maintained[PS]
78. Ensure adherence to public and restricted ceremonial places[PS]
79. Maintain structured knowledge formats[PS]
80. Adapt to community needs★†
81. Enhance cooperative skills★†
82. Organise ceremonies and cycles†
83. Participate in ceremonies and cycles[PS]
84. Record and ensure maintenance of processes[PS]

85. Use charisma and physical presence to maintain audience interest★†
86. Maintain law through socially accepted punishment★†
87. Maintain a cohesive social structure with material egalitarianism★PS
88. Use emotional intelligence†
89. Maintain relationships with humans and with others★†

Chimpanzees are social animals. Although not to a human level, they were assessed as demonstrating skills 80, 81, 85, 86, 87 and 89.

Those with the NF1 disorder were considered to find skills 80, 81, 82, 85, 86, 88 and 89 as possible challenges. They were also assessed as demonstrating possible strengths in skills 76, 77, 78, 79, 83, 84 and 87.

The social skills could not be considered indicative of the impact of the NF1 disorder on the human NF1 allele and the category was not included in assessing NF1 as our knowledge gene.