

Chapter 5

Historical, Cultural, and Aesthetic Aspects of the Uncanny Valley

Valentin Schwind

5.1 Introduction

The basis of collaborative agency and mutual understanding between all kinds of cooperating systems and entities is communication. Our most common and natural way of communication is communicating with other humans. Artificial systems are often designed according to our expectations and simulate human appearance or human behavior in order to improve communication and cooperation with artificial systems. For example, Alan Turing’s (1950) famous test is only passed by an artificial intelligence that can convince a certain number of people that they are communicating with a human.

This humanization – or anthropomorphization – is described as “the tendency to attribute human characteristics to inanimate objects, animals, and others with a view to helping us rationalize their actions” (Duffy 2003). Artificial entities with an anthropomorphic appearance or behavior produce significantly more positive reactions than a purely functional approach. Thus, it became important or even necessary to enable an unreserved communication with a socially interacting machine (Riek et al. 2009; Breazeal 2004; Scassellati 2001).

Dautenhahn (1999) emphasizes: “Artificial social agents (robotic or software), which are supposed to interact with humans are most successfully designed by imitating life, i.e. making the agents mimic as closely as possible animals, in particular humans.” Meanwhile, many differently motivated disciplines are engaged with the creation of more realistic anthropomorphic agents and figures. Technical enhancements in computer animations, construction of androids, forensics, facial reconstructions, etc. enable human images, movements, and facial expressions that can hardly be distinguished from real human ones.

V. Schwind (✉)

VIS, University of Stuttgart/Stuttgart Media University, Stuttgart, Germany
e-mail: valentin.schwind@vis.uni-stuttgart.de; schwindv@hdm-stuttgart.de

29 One might assume now that a more realistic, human-like image leads to more
30 familiarity and thus to higher acceptance and improved emotional access. But a
31 certain phenomenon ensures that observers of such realistic figures no longer accept
32 an artificial representation. On the contrary, the representation will be rejected and
33 thus a smooth communication or an emotional bonding is made impossible. This
34 seemingly paradoxical phenomenon is known today as the “Uncanny Valley.”

35 In 1970 Masahiro Mori, Professor of Engineering at Tokyo Institute of Technology,
36 presented the hypothesis according to which extremely realistic, human-like robots
37 or prostheses provoke negative emotional sensation (Mori 1970). Mori predicted that
38 the more human-like a robot is, the more accepted it will be. This is true until a
39 certain point of realism is exceeded, and then the acceptance suddenly drops. In
40 Japanese Mori called this phenomenon “bukimi no tani.” Today it is known in its
41 English translation “Uncanny Valley.” The translation goes back to the book *Robots:
42 Facts, Fiction and Prediction* by Jasia Reichardt (1978) where the Japanese word
43 “bukimi” is translated as “uncanny” (Pollick 2010).

44 This term probably refers to two German articles by Ernst Anton Jentsch and
45 Sigmund Freud at the beginning of the twentieth century. In *About the Psychology
46 of the Uncanny* (orig. *Zur Psychologie des Unheimlichen*) Jentsch pointed out that
47 “doubts about the animation or non-animation of things are responsible for an eerie
48 feeling” (Jentsch 1906). In a note he mentioned the ambiguity of automats and their
49 psychological effect in E.T.A. Hoffmann’s pieces. Sigmund Freud took up the arti-
50 cle and criticized Jentsch, on the one hand, for not including among his examples
51 the automat Olimpia from the short story *The Sandman* (Hoffman 2008) and, on the
52 other hand, because of other motifs responsible for the uncanny effect of the narra-
53 tive (including the Sandman himself, who tore out the eyes of children). Freud
54 described the “uncanny” as something once familiar, which is then hidden in the
55 subconscious and later recurs in an alienated shape. For example, he cited the motif
56 of the doppelgänger and “in the highest degree in relation to death and dead bodies,
57 to the return of the dead, and to spirits and ghosts” (Freud 1919). Freud also linked
58 invisible manifestations such as noise or imagination with eerie effects. Thus the
59 uncanny had been associated in compound with artificial figures long before Mori
60 suggested his hypothesis. Jentsch and Freud even explained the uncanny with exam-
61 ples of human-like representations.

62 The “valley” in Mori’s terminology refers to the strong sloping curve at the end
63 of the chart (Fig. 5.1). Mori sets human-similarity (the sum of all human charac-
64 teristics) in relation to the affinity of a figure. Unfortunately at the earlier stage of
65 the uncanny research, the term “affinity” was not used consistently. Other terms
66 like “acceptance,” “familiarity,” “positive emotional response,” or “likeability”
67 were also used. While these terms may have slightly different meanings in other
68 languages, the essential meaning remains the same and describes a feeling that
69 can be either positive or negative.

70 The implications of the phenomenon are not only limited to robots, but circulated
71 to a wide audience through critics of computer animations, movies, and video
72 games. The film critic Kyle Buchanan wrote in the *New York Magazine* about *The
73 Adventures of Tintin* (Spielberg 2011): “The biggest problem with the Tintin movie

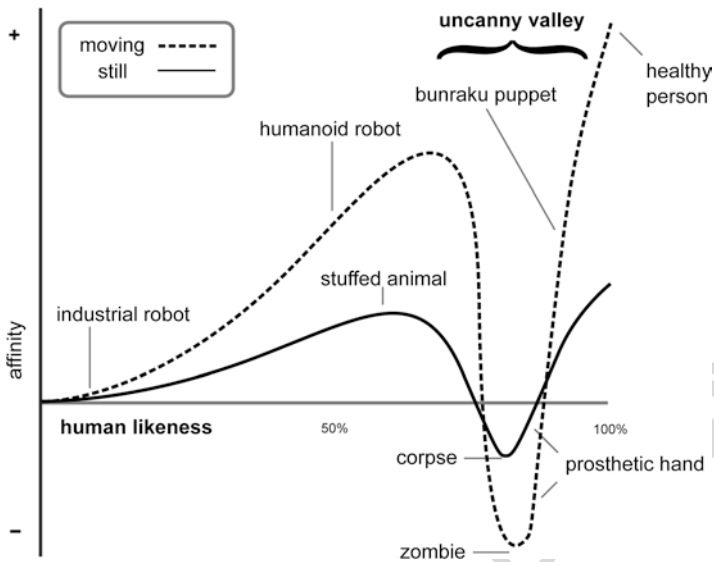


Fig. 5.1 Mori’s illustration of the uncanny valley: This is a simplified diagram (MacDorman 2005b) of Mori’s graph from the original article published in *Energy Magazine* (1970)

might be Tintin himself” (Buchanan 2011). In connection with the creation of Princess Fiona in the computer-animated movie *Shrek* (2001), Lucia Modesto (PDI/Dreamworks) made the following remark: “She was beginning to look too real, and the effect was getting distinctly unpleasant” (Weschler 2006). Andy Jones, Animation Director of the first computer-animated movie with human actors *Final Fantasy* (2001), commented on his work in a similar way: “As you push further and further, it begins to get grotesque. You start to feel like you’re puppeteering a corpse” (Weschler 2006).

Mori’s hypothesis predicts that only a 100 % real and healthy-looking human is fully accepted by an observer. Mori also conjectures possible reasons for this. Visible signs of disease have a negative impact on our feelings. The fear of death and subconscious protection against pathogenic infections are the supposed reasons of this rejection (Greenberg et al. 2000; Cohen et al. 2004; MacDorman 2005a; Shatil 2012). Functional magnetic resonance imaging (fMRI) scans show stronger metabolic responses in areas of brain that are responsible for predictions and are correlated to the negative response. If a figure does not move according to expectations of the observer, contradictions in the categorical perception seem to arise (Saygin and Ishiguro 2009; Cheetham et al. 2011). A study on monkeys shows that this phenomenon also occurs in primates (Steckenfinger and Ghazanfar 2009). This leads us to the conclusion that there is an evolutionary-related cognitive mechanism. Other factors such as attractiveness, familiarity, culture backgrounds, etc. probably also have measurable impact on this effect (Zebrowitz 2001; Hanson et al. 2005; Schneider and Yang 2007; Green et al. 2008).

97 Uncanny Valley research is a highly interdisciplinary field, and yet the subject is
98 still fragmentarily examined. In sum, it is proclaimed with certainty that this phe-
99 nomenon exists. Moreover, due to technical developments in robotics and computer
100 animation sciences, this phenomenon has gained an increasing importance in the
101 last four decades. However, it can be safely assumed that the Uncanny Valley has
102 had an impact on humans long before its discovery.

103 This article explores the hitherto little-discussed historical emergence and con-
104 temporary impact of the Uncanny Valley and shows that it is strongly connected to
105 intentions, aesthetics, and cultural aspects of artificial figures. Examples from the
106 history of art, engineering, and literature demonstrate that the Uncanny Valley is an
107 essential human feature that affects our behavior and our decisions.

108 Here we consider the Uncanny Valley from a new perspective, which turns it
109 from a hypothetical, marginal issue to a relevant aspect of our culture and history
110 with a not negligible impact on the socio-cultural development of mankind. It is
111 herein assumed that Mori's hypothesis relates to human-like representations in
112 general, not only to physical entities in the shape of robots or prosthetics, but also
113 to visual arts and written narratives that have to be envisioned in front of the
114 mind's eye. By incorporating these narratives, we will see and understand why
115 today the image of artificial figures is negatively affected, especially in western
116 parts of the world.

117 The first section will take a look at hints and stories from our past where artificial
118 humans are specially linked to eeriness or attention. This journey begins with one of
119 the earliest extant works of literary poetry: the Epic of Gilgamesh.

120 **5.2 Androids in Ancient Cultures**

121 The Sumerian poem written in the 3rd millennium B.C. about Gilgamesh, the king
122 of Mesopotamia, tells a story of Enkidu, who was made of clay by the goddess
123 Aruru to undermine the strict and extravagant reign of Gilgamesh. Enkidu is a prim-
124 itive form of man who is close to nature and lives together with animals. He is dis-
125 covered by a poacher, and by order of the king who already knows about him,
126 people send Enkidu a woman. He alienates himself from nature and becomes social-
127 ized, undergoing the stages of human development (from nomads, to farmers, and
128 shepherds), and finally meeting the king in the capital Uruk. After a fight they
129 become friends and live through many adventures together. Gilgamesh's mother
130 adopts Enkidu, so that the king and Enkidu become brothers.¹ After killing the Bull
131 of Heaven (a mythical creature in several myths of ancient times), the gods punish
132 Enkidu for his deeds with a deadly disease he later painfully succumbs to. Enkidu
133 disintegrates into dust and Gilgamesh is in deep mourning for a long time. After
134 Enkidu's death Gilgamesh recognizes that he is mortal, too. Thereafter, the search
135 for eternal life becomes the leitmotif of the *Epic of Gilgamesh* (Maul 2012).

¹ In the Sumerian version of the poem, Enkidu remains a slave and servant of Gilgamesh.

Enkidu is created by craftsmanship and divine magic (similar to many other creation myths). Fascinating is the character's helplessness in collision with the environment, which in the end brings him to a tragically fatal end. He becomes an instrument in the hands of gods who want to give Gilgamesh a lesson in humility. In the end, Enkidu pays with his life for the withdrawal from nature and for becoming an unscrupulous hunter. This story has no direct evidence that would speak to a special eerie effect of Enkidu's role. However, this figure causes particular fascination: He is created artificially, is an outsider, and he makes humans aware of their mortality. Later, we will see that these are the characteristics typical for other artificial figures. Another interesting issue about the Gilgamesh story is that Enkidu's death is caused by his creator. For many other artificial figures later – especially those with personality and intelligence – this conflict of existence is automatically preprogrammed. We will see that this is also an important part of the Uncanny Valley phenomenon.

Also in Greek mythology, the creation of artificial life using magic and clay plays an important role. As the Titans Prometheus and his brother Epimetheus take a walk, they see the divine potential of the earth and so they form animals and man from clay. Every animal gets a special talent, and humans get every special quality from all the animals. The goddess Athena, a friend of Prometheus, recognizes the potential of his work and gives people sense and reason as a special gift. Prometheus is so proud of his creation that he becomes a patron and teacher to humankind. But other gods, led by the king of the gods, Zeus, are against an emancipated species and demand sacrifices and worship of the people. Prometheus turns against the gods and brings divine fire to the people. The punishment by Zeus follows immediately: he gives an order to his son Hephaistos, god of craftsmanship, to create an artificial woman: Pandora. She is blessed with all kinds of gifts, she is seductive and beautiful. She possesses a vessel with a disastrous content that shall instigate sorrow and death over mankind. Hermes brings Pandora to Epimetheus who succumbs to her magic and opens the vessel² although his brother had warned him not to accept any presents. Since that day mankind has been struck by illnesses, disasters, and sorrows again and again. Furthermore, Zeus orders Hephaistos to bind Prometheus to a rock in the Caucasus Mountains. An eagle pecks the immortal in the liver day after day. Prometheus is freed several millennia later by Hephaistos. Meanwhile, the cycle of creation and annihilation of mankind repeats several times until the children of Prometheus and Epimetheus, Pyrrha and Themis, create people from stone – “a hard race and able to work” (Schwab 2011, 28).

The ancient Greek poets and philosophers Aischylos, Hesiod, Platon, as well as the Roman Ovid provided different versions of the legend of Prometheus. The myth about the creation of the human species tells about the rebellion against the divine order and about the attempt to develop a self-determined culture. This theme appears most fascinating and encouraging to many artists. Johann Wolfgang von Goethe

²The vessel is usually known as the “Pandora's box”. The term has come about through a translation error. The Greek word *pithos* originally referred to a big amphora used for water, wine, oil, or grain.

177 used this theme in his famous poem *Prometheus* in the time of Storm and Stress
 178 (Goethe 1789; Braemer 1959). “In the Age of Enlightenment, the poem acts as a
 179 firebrand – a well-articulated contempt for all inherited or self-proclaimed authori-
 180 ties” (Gassen and Minol 2012, 70). As we have established earlier the idea that
 181 artificial characters would/can fight for freedom and self-determination appears
 182 uncomfortable to most of us. Perhaps the ancient Greek gods on Mount Olympus
 183 had a similar uncomfortable feeling. The motif of a rebellion of self-determined
 184 artificial species produced in series and also suitable for work was taken up again
 185 only in the twentieth century – when it seemed technically possible to build an
 186 entire class of robots. In earlier times artificial figures were very rare or they were
 187 individual products with a special status. Pandora is a remarkable example for the
 188 first negatively associated artificial figure in history: she embodies our fear of
 189 manipulation and disastrous intention, in this case covered by the seduction abilities
 190 she embodies as a woman. Despite different traditions, we still have an accurate
 191 picture of Pandora: She is seductive and equipped with many gifts such as beauty,
 192 musical talent, curiosity and exuberance. Aphrodite also gives her gracious charm,
 193 Athene adorns her with flowers and Hermes gives her a charming language (Hesiod,
 194 81 ff). Both fascination for her beauty and fear of her gift remain vivid today and
 195 represent probably the first manifestation of the strange effect elicited by an arti-
 196 ficially created figure.

197 Beauty is a quality frequently mentioned in relation to artificial figures. One
 198 example is the fascinating poem by in Ovid’s *Metamorphoses* about *Pygmalion*, a
 199 Cypriot sculptor (Anderson 1972). After having had bad experiences with sexually
 200 licentious women, he withdraws into confinement and carves an ivory statue in
 201 secret. Pygmalion falls in love with the realistic and life-sized statue and treats her
 202 as if she were a real woman. He cares for her: he dresses, adorns and fondles the
 203 figure in a loving way. At a celebration in honor of the goddess Venus (the Greek
 204 Aphrodite) Pygmalion asks in a prayer that gods give him a real wife who looks like
 205 his statue. Venus fulfills his wish: when he comes back home and kisses the statue,
 206 the ivory becomes warm, soft, and alive. The figure awakens to life and becomes a
 207 living female human.

208 The *Pygmalion* story is one of the most popular poems in Ovid’s *Metamorphoses*
 209 (1 B.C.–8 A.D.). Without resorting to any dramatic twists Ovid tells about three
 210 fascinating motifs for the creation of an artificial figure: aesthetics, loneliness, and
 211 love. For the first time, material gets a special meaning: the noble and organic ivory
 212 underlines the natural and aesthetic claim of the figure. Through the centuries, the
 213 Pygmalion motif has been innumerable transferred and reinterpreted by poets,
 214 painters (Fig. 5.2), and musicians. Until 1762, no text mentions the name of the
 215 statue. In a very influential work by Jean-Jacques Rousseau *Pygmalion, scène*
 216 *lyrique* dated in 1762, the sculptor swears eternal fidelity to the statue that was first
 217 named “Galatea” which means “Milk White” (Rousseau et al. 1997). We should
 218 also mention the operetta *The Beautiful Galatea* by Frank Suppé where the statue
 219 transforms from a virgin to a psychotic nymphomaniac until the goddess Venus
 220 transforms Galatea back into a statue (Dinter 1979).



Fig. 5.2 Pygmalion and Galatea (ca. 1890). Oil on canvas by Jean-Léon Gérôme (French, Vésoul 1824–1904 Paris), The Metropolitan Museum of Art, New York

The term Pygmalion effect (or Rosenthal effect) becomes established later in psychology as the outcome of a self-fulfilling prophecy (Rosenthal and Jacobson 221 222 223 224 225 226 227 228 229). For example, anticipated positive assessments by a teacher (“this student is highly gifted”) are subconsciously transmitted and confirmed by increased attention. Furthermore, pygmalionism describes sexual affection towards human representations in the form of statues, paintings, and dolls, which can also serve as a fetish. Life-size human replicas are currently produced commercially as sex dolls (e.g. “Real Dolls” made of silicone). Although these dolls are very realistic, they can be nevertheless disquieting to people without pygmalionism (cf. Valverde

230 2012). The attraction of artificial figures dominates the effect of the Uncanny Valley
 231 (cf. Hanson 2005; Hanson 2006). The intense bond can also be formed by visual
 232 and haptic contact, which is frequently the case of lonely men (Holt 2007). The
 233 habituation also could be an explanation when “[...] the stimuli continue for a long
 234 period without unfavorable results” (Thorpe 1944). The British TV documentary
 235 series *The Secret of the Living Dolls* (Channel4 2014) shows how frightening the
 236 living dolls can be for the viewer. It shows people who live as dolls in whole-body
 237 dresses made of silicone. Critics and the audience describe the documentary as
 238 extremely disturbing, creepy, and scary (Bouc 2014; Michaels 2014; Styles 2014;
 239 Westbrook 2014). Maybe Pygmalion foresaw this effect when he asked Venus
 240 “shyly” for a real wife *like* the ivory virgin, and not for a living statue. Venus trans-
 241 formed the statue into a real human made of flesh and blood – and this was a divine
 242 way out of the Uncanny Valley.

243 5.3 Androids in Non-Western Cultures

244 A series of books³ dated around 350 B.C. are attributed to the Daoist philosopher
 245 Lieh Tzu. In *Book V – The questions of Tang* a story is told about *The Automat* of
 246 the engineer Ning Schi, who is presented with his human-like figure to King Mu of
 247 Chou at his travelling court. First the king does not understand what the inventor
 248 wants to show him because he considers Ning Schi’s construction to be an ordinary
 249 person. The machine can sing, dance and do various tricks. But when the automat
 250 makes advances to the concubines, the king can’t bear it and wants to execute him
 251 immediately. The engineer disassembles the machine to demonstrate that it was
 252 only composed “of leather, wood, glue, paint, from white, black, red and blue parts”
 253 (Lieh-Tzu and Wilhelm 1980). The king orders Ning Schi to reassemble the machine
 254 again, examines the mechanism and recognizes its various functions. “For a sample,
 255 he removed the heart and the mouth could not speak anymore; he removed the liver
 256 and the eyes could not see anymore; he removed the kidneys and the feet could not
 257 walk anymore” (Lieh-Tzu and Wilhelm 1980, 113–114). The king is extremely
 258 impressed and wonders, “how man can reach the works of the creator.” The king
 259 takes the machine into his wagon and drives back to his home. At the end of the
 260 story, two masters of engineering, who thought they had already reached the limits
 261 of the humanly possible, are so impressed by the story about Ning Schi’s machine
 262 that they are afraid to speak ever again about their craft as an “art.”

³There are few English translations. The most well-known summaries of Lieh Tzu’s stories about automats can be found in “Science and Civilisation in China: Volume 2, History of Scientific Thought” (Needham and Wang 1956, 53 ff) and “The Book of Lieh-tzu” (Giles 1925; Graham 1990). A comprehensive translation of Lieh Tzu texts was derived from the German sinologist Richard Wilhelm. This summary refers to his original German translation from “Das wahre Buch vom quellenden Urgrund” (Lieh-Tzu and Wilhelm 1980, 113 ff).

A second story in the Chinese *Tripitaka* (a collection of educational writings of Buddha) probably has the same origin: the five sons of the king Ta-tch'ouan have different talents. The first son is clever, the second son is inventive, the third one is handsome, the fourth one is vigorous, and the fifth one is always very lucky. The sons decide to travel to various kingdoms to find out which of their "extraordinary virtues is the most outstanding" (Völker 1994, 73). The inventive brother goes to a foreign kingdom and manufactures a mechanical man out of 360 parts (mostly wooden). He gets a lot of respect for his work and is blessed with gifts. The machine sings, dances, and acts. When the king of the land and his wife hear about that craft, they go up to a tower and have a look at the wooden man. They are both very amused but do not see a wooden man until the actor winks upward to the queen. The king orders to cut off the head of the man. But the inventor, who is the "father" of the figure, cries and says how much he loves his "son." He holds himself responsible for his son's poor education, begs for mercy, and finally switches off the machine. The inventor pulls a pin and the mechanical man breaks into its components. The king wonders how he could be fooled by an artificial man. He claims that the inventor has a gift "which is unequaled in the world" and gives him tons of gold. The inventor returns home and distributes the gold among his brothers. In a song he praises his work and boasts: "Who is able to surpass me?"

Both examples show that stories about the creation of artificial figures are not limited to Western culture. Simply the idea that there might have been an artificial mechanical man in China 2,300 years ago is fascinating. The story of Ning Schi's machine and the wooden man of the son King Ta-tch'ouan are inspired by the enthusiasm that such high art of engineering evokes. The creation of an artificial human being is regarded as the greatest gift ever. King Mu was explicitly interested in functionality of the apparatus and kept the machine unceremoniously for himself. Technical scholars also show reverence for the difficulties of the building process of such complex machines and redefined the craft, which they previously regarded as art. Today we cannot know for sure whether such machines truly existed in ancient China and whether these figures were not distinguishable from a real human. But if people really had never seen anything like that before, they had to assume that it was a clad or painted man – and regarded it to be an actor – like it happens in the second story.

Historical reports of amazing apparatuses that have been used for entertainment came not only from China but also from Arabia. The fall of the Roman Empire constitutes at the same time the end of an epoch of many literary and technical achievements. In the beginning of the ninth Century, the Caliph of Baghdad initiated preservation and translation of ancient writings (*Graeco-Arabica*) and thus made an invaluable contribution to the conservation of Greek science and philosophy, which was also characterized by fascination and interest in anthropomorphic machines. In the twelfth century the Arabian engineer and author Al-Jazarī continued antiquity research in his *Book of Knowledge of Ingenious Mechanical Devices* (in particular he uses the knowledge of the pressure and suction of water by Heron of Alexandria) and creates a detailed manual for the construction of such machines (Al-Hassan 1977). Many clocks, fountains, doors, locks, etc. that are preserved until

308 nowadays prove to be functional. Among these machines are barkeeper dolls and a
 309 machine with four mechanical figures sitting in a boat singing and playing musical
 310 instruments. Figures are mostly painted and made of mounted copper, wood and
 311 possibly of papier-mâché (Hill 1996, 208). Some of Al-Jazarī's figures could move
 312 their heads, arms, and legs. There exist different interpretations of the effect these
 313 figures produced: on the one hand, automated mechanisms apparently delayed the
 314 movement of the figures, on the other hand "subtle caprices" of the characters
 315 resulted from these delays may well have been intentional (Nadarajan 2007).
 316 Obviously some of the figures served for amusement and entertainment. The deco-
 317 rations, the intricate design manuals, as well as the high number of contemporary
 318 translations in the Arabian region indicate a high popularity of such machines and
 319 the fascination they evoked. The book by Al-Jazarī represents only one of the high-
 320 lights of the epoch of technical achievements and inventions in the Arabian world.

321 **5.4 Demons and Automata in the Middle Ages** 322 **and Renaissance**

323 Stories of human-like figures in the European Middle Ages are characterized pre-
 324 dominantly by the Christian and Jewish faith. There are traditions of the golem,
 325 legends of mandrake roots with human-like forms, and alchemical instructions for
 326 creating a homunculus. Well-known are several myths about the *Prague Golem*, a
 327 mute Jewish legendary figure who grazed through the cities before the Jewish festi-
 328 val of Passover. A note on Golem's forehead or in his mouth brought him to life and
 329 kept Golem under control. According to a legend, once Rabbi Löw forgot to remove
 330 the note so the Golem was able to walk through the city without any control. In one
 331 legend, it was possible to tear the note so that the golem crumbled into a 1,000
 332 pieces (Völker 1994). The medieval reports have some things in common: artificial
 333 figures are created under mystical or demonic influence. These figures have little to
 334 do with divine creation and have less aesthetic appeal than ancient Greek statues or
 335 the elaborately painted machines of medieval Arabia. They were not used for enter-
 336 tainment or amusement but often had a repulsive effect. In legends the misshapen
 337 Golem does not have the ability to speak or to develop a free will. According to
 338 Hildegard von Bingen (von Bingen and Throop 1998), the devil lives in the man-
 339 drake root, which has to be exorcised by means of spring water. And in most tradi-
 340 tions the homunculus is only about the size of a fetus and could be bred on an
 341 organic substance like blood, flesh, excrement, sperm, or urine (in the epilogue of
 342 Völker 1994).

343 During the European Middle Ages the concept of artificial life is associated with
 344 demonic powers and negative response to the efforts of alchemists (Newman 2005;
 345 cf. LaGrandeur 2010). According to a legend, scholar Albertus Magnus "con-
 346 structed a door guard of metal, wood, wax and leather" (Strandh 1992, 175). The
 347 guard welcomed visitors with the Latin "Salve!" and asked for the reason of their
 348 visit before they were allowed to step in. One day Magnus' pupil, the young

Thomas Aquinas, smashed the door guard angrily into pieces. There are different specifications about the possible reasons: some say he was so scared of the android that he had smashed him with a stick. Others say he did not want to listen any longer to the “chatter” of the guard (Völker 1994, 113). Anyway, Magnus was very upset that Thomas had destroyed the work “of 30 years.” Thomas Aquinas wrote years later that a soul is a prerequisite for any proper motion and demons are responsible when “necromancers make statues speak, move and do other things alike.” (Aquinas 2013, Q. 115).

Both demons and the undead are myths that have existed since before the Middle Ages (e.g. the Lamia from Greek mythology), and these myths are spread beyond Europe (e.g. Asanbosam from West Africa or Jiang Shi from China). However, there is no evidence that all these stories are due to a ubiquitous fear of death or to the Uncanny Valley (cf. MacDorman 2005a). The first extant reports on demons in the shape of living corpses, known as vampires today, come from Southeast European countries (Lecouteux 1999). The peculiarity of vampire stories is how the appearance of the living dead is reported: pale skin, unnatural eyes – these are a few but visible abnormalities which distinguish undead from ordinary people. This allows to establish a link between these stories and the elements that seem responsible for the experiences eeriness of objects that fall in the Uncanny Valley: the reasons why nowadays artificial figures are assigned to the Uncanny Valley resemble those we find in play in stories of vampirism. The combination of visible signs of pathogenic diseases and ambiguity between life and death prompt negative emotions such as the eerie feeling of the Uncanny Valley. It is unlikely that the living dead have harmed someone, but it is quite possible that conscious or subconscious fear of death inspired people to invent stories, myths, or figures. Such fears can function as a warning of potential threats or socially harmful behavior in times when the mortality rate was very high. In times of prosperity and security, these fears may appear superfluous and only fascinate us, especially if we are affected by forbidden stimuli.

Between 1495 and 1497 Leonardo da Vinci presumably built a functional robot which had a complicated mechanism hidden under a knight’s armor. Pulley blocks and cogwheels driven by hydropower put the robot’s arms in motion (Rosheim 1997). Da Vinci’s construction plans have survived until today and display a strong influence from the Arabian entertainment automats (Strandh 1992). Greek and Arabian works on mechanical devices were revised and translated in Europe only at the end of the fifteenth to the beginning of sixteenth century. The extensive and well-known work in Europe of this period is *Les Raisons des forces mouvantes* by the Frenchman Salomon de Caus. De Caus illustrated many constructional ideas; moreover, he took up plans from Greek and Arabic engineers and built elaborate machines himself. Many designs were exhibited with great success in Paris and at the Heidelberg Castle. In the palace of the Duke of Burgundy in Saint-Germain, de Caus built a system with a total of 256 artificial figures or machines driven by the power of water. Particularly popular motifs were wheel-driven animated scenes from Greek mythology (Strandh 1992). Such machines became fashionable at courts and in the big cities of Europe. Caus’ constructions

394 became very popular and were often copied as props for theatre performances.
 395 During the Renaissance, machines were socially acceptable and were popular ele-
 396 ments of garden and park ensembles.

397 In the middle of the sixteenth century an Italian clockmaker and engineer Juanelo
 398 Turriano developed special virtuosity in construction of machines. He became
 399 famous for his water lifting device in Toledo. According to legend, Turriano built an
 400 artificial figure that even went shopping for him (Strandh 1992). This story was very
 401 persistent and gave the street where Turriano lived its present name: *Calle del*
 402 *Hombre del Palo* (the avenue of the wooden man). In his time, he had to defend
 403 himself because of the accusations of an abbot who was convinced that Turriano
 404 was in league with the devil. However, the design of machines developed further
 405 without ceasing till the end of the sixteenth century, and machine builders were
 406 competing in the production of increasingly sophisticated and more and more spec-
 407 tacular and entertaining figures. We have to mention here, of course, the automata
 408 of Vaucanson,⁴ which made their creator very rich, as well as the clockmaker family
 409 Jaquet-Droz, who were the first to develop interchangeable program rollers for their
 410 figures. The *Three Musicians* by the Jaquet-Droz family are in good working condi-
 411 tion and are displayed in the Museum of Neuchatel in Switzerland.

412 At the beginning of the seventeenth century, human-like machines were very
 413 common and were treated like modern day pop stars. Philosophers, doctors, and
 414 anthropologists started to be interested in such constructions. In 1637, French phi-
 415 losopher René Descartes predicted that people would eventually be able to develop
 416 a soulless machine that would look and behave like an animal. He compared a
 417 mechanical pumping process with the blood circulation of animals and also drew
 418 comparisons with humans. A legend tells that Descartes built an eponymous android
 419 child as a replacement for his illegitimate daughter Francine. In 1649 when Descartes
 420 was invited to the court of Christina of Sweden he took Francine with him. On his
 421 journey from Amsterdam to Stockholm, the suitcase with the android drew the
 422 attention of the superstitious sailors. When the ship was caught in a storm in the
 423 North Sea, Descartes was accused of standing in the league with the devil and was
 424 made responsible for the storm. The captain ordered that the android be thrown
 425 overboard (Strandh 1992).

426 Another machine that attracted a lot of attention⁵ a few years later was the
 427 “Chess-playing Turk” dating back to the 1760s. This mechanism, built by Hungarian
 428 Baron Wolfgang von Kempelen, may be considered to be the first machine of
 429 uncanny intelligence. A figure of a male android in a Turkish costume would sit in
 430 front of a box with a chess board mounted on it. The machine was designed so that
 431 when a chess move was made, the android responded with a move of a chess figures
 432 itself. Some claim the construction was able to say the word “Chess!” and “Gardez!”

⁴Vaucanson’s *Canard Digérateur* (Digesting Duck) simulated a metabolism by eating and defecating kernels of grain.

⁵E.T.A. Hoffmann’s story “The Automata” took von Kempelen’s Chess Turks as a model. Contemporary literary critics say that Hoffmann’s fascination with the Turk does not affect the reader (Gendolla 1992).

(Strandh 1992; Völker 1994). Von Kempelen claimed that he succeeded in developing artificial intelligence equal to the chess-playing abilities of humans. From 1783 to 1784 he traveled with his machine through Europe and let the “Chess-playing Turk” compete with well-known chess players (Fig. 5.3).

[AU2] Von Kempelen stopped showing the machine in 1785 after Frederick the Great had offered him a large sum of money for unveiling the secret and had apparently been quite disappointed by the solution of the puzzle. After von Kempelen’s death the Turk fell into oblivion for a few years until the German inventor Johann Mälzel purchased the machine and demonstrated it again in Europe and USA as “The Automaton Chess Player.” The Turk won many games during those demonstrations and defeated some famous statesmen such as Napoleon and Benjamin Franklin. At a presentation in London, the English poet and author Edgar Allen Poe observed the machine closely. In his famous essay *Maelzel’s chess player* he made it clear that the machine must have been a swindle and thus exposed the fraudulent automaton. Apparently both Mälzel and von Kempelen used children or midgets sitting in a small box inside the machine.

Machines in the Renaissance and Enlightenment reached a considerably higher level of acceptance than the machines designed in previous centuries. The machines were built for entertainment and, since they acted autonomously and performed tricks in front of the eyes of spectators, they were a big attraction for the audience.

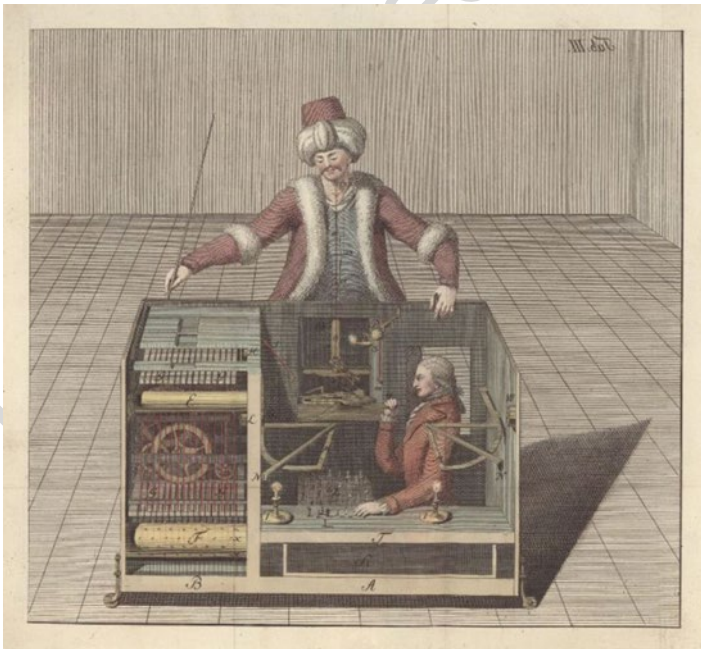


Fig. 5.3 The Chess-playing Turk (1789): From book that tried to explain the illusions behind the Kempelen chess playing automaton (The Turk) after making reconstructions of the device. Author: Joseph Racknitz (Source: University Library, Humboldt University of Berlin, 3639 v.)

453 Presumably, this fascination was particularly triggered by curiosity when the
454 audience – as in the case of the Chess Turk – tried to find out how figures worked.

455 However, society as well as religion did not allow crossing a certain border: an
456 artificial figure could not be designed as one-to-one copy of a human being – and in
457 turn a human was not allowed to be presented as a machine. That became particu-
458 larly evident in the case of French physician and materialist Julien Offray de la
459 Mettrie who was inspired by the theories of Descartes and who described a man as
460 a kind of machine for the first time in 1745 (Mettrie 1990). Mettrie was an atheist
461 and polarized the world with his theories of a demystified human existence, as he
462 not only explained complex bodily functions with mechanical processes but also
463 saw the soul as a result of physical development. He opposed Descartes' dualism of
464 mind and matter. La Mettrie was persecuted by the clergy and his works were heav-
465 ily censored. Enlightenment poets and philosophers such as Friedrich Schiller,
466 Denis Diderot, and Jean-Jacques Rousseau set themselves against La Mettrie instead
467 of giving him their support (Jauch 1998). Frederick the Great took La Mettrie as his
468 “court atheist”, but Voltaire, who also worked at court, ridiculed the physician
469 (Jordan 1910). La Mettrie retired and fell into oblivion until the nineteenth century.
470 The developments in this period show that automation was widespread and
471 accepted – especially in entertainment. The controversy around the construction of
472 artificial figures was more intense the more human-like a machine looked. The idea
473 that a human being can be seen as a machine or can be reproduced as a machine
474 provoked extremely strong rejections, even in times of Enlightenment and in a
475 world with many automats. This era makes it particularly clear that both enormous
476 technical progress and the fear of artificial humans tend to coexist.

477 5.5 Uncanny Creatures in Nineteenth and Early Twentieth 478 Century Literature

479 The uncanny effect produced by artificial characters – particularly the idea that they
480 could look human or threaten humans by their very existence – is often used in sto-
481 ries of the dark romanticism. Seen from the perspective of literary science,
482 E.T.A. Hoffmann's *The Sandman*, published in 1815, is a “special discipline of
483 representatives of all methodological directions” (in the epilogue of Hoffman 2008)
484 of its own – not only in the uncanny research. Jentsch and Freud refer to this
485 Hofmann's piece for their explanations of eerie feelings.

486 Nathanael, a mentally disturbed student from a good home, falls in love with the
487 beautiful “daughter” of the physicist Spalanzani and observes her through the win-
488 dows of the house opposite. To see her more closely, Nathanael uses a spotting scope,
489 which he had gotten from the glass dealer Coppelius. Already in the beginning of
490 the story, Nathanael suspects the glass dealer to be the Sandman – an eye-stealing
491 nightmare figure he knows from his childhood. Although the daughter does not
492 move and sits motionless at the window, through the telescope Nathanael sees the
493 doll as a living being. At a celebration Spalanzani presents Olimpia to the public

and the guests realize that she is a mechanical and therefore artificial wooden doll. Although she is able to play the piano and is part of the entertainment, she looks as a fake with a stiff expression that makes some guests feel uncomfortable. Nathanael does not recognize the fraud because he is so much in love with the android and wants to make her a proposal of marriage. Olimpia's beauty outshines her imperfection in behavior. Spalanzani and Coppelius fight over the doll and its glass eyes fall out and scatter on the floor. The torn-out eyes remind Nathanael of Sandman. Succumbed to madness, he attempts to kill Spalanzani. Nathanael is detained and transferred to an asylum.

As Freud noted, originally Nathanael's fears are not implicitly attributed to the doll but to his terrible fear of the Sandman. The disturbing effect of his behavior is tremendously enhanced by his love for the doll, which he sees as a real woman, especially by viewing her through the enlarging lens. In Hoffmann, the use of such a perspective seems to be a possible way to avoid the Uncanny Valley. The motif of a broken glass eye and the subconscious fear of castration due the loss of the eyesight enhance the eerie effect (Freud 1919). The real horror for Nathanael begins when he realizes that Olimpia is not a real human. Similar to Pygmalion's statue, Olimpia is a product of male fantasy, which was designed according to the wishes of a man and is the object of a man's desire. Passionate love makes both Nathanael and Pygmalion blind for the fact that their figures are not real humans. Hoffmann deliberately uses the uncanny effect produced by an artificial figure to create the atmosphere of horror and fear in his story. This method is taken up again in today's science fiction and horror stories and to the present day it remains a popular method to trigger deep-rooted fears. Particularly interesting in that case is Hoffmann's personal affinity for machines. Machines fascinated him: "once when the time will be, for the benefit of all sensible people I see with me, I will make an automaton" (Heckmann 1982). As Nathanael's character proves, Hoffmann's highly pronounced and contemporary fascination for artificial human-like figures shows the frightening ambiguity when an "idea of an imitation of man by machine turns to a vision of horror" (Müller 1989).

Today's most famous artificial figure in world literature appeared 3 years later in one of the first science-fiction novels ever (Freedman 2000; Murray 2002). Mary Shelley's *Frankenstein, or the Modern Prometheus* written in 1818 tells the story of Victor Frankenstein, who is obsessed by the idea of the creation of an artificial human. Frankenstein works sloppily and compiles his figure out of the body parts of criminals and material from the slaughterhouse. He reanimates the body with electricity and creates a 3-m tall monster that is ugly and scary. Because of shame and fear Frankenstein keeps his creature secret, and this causes numerous serious problems. The beast sees himself as a victim and asks Frankenstein to create him a woman with whom he wants to escape from civilization. But Frankenstein fears that together with his wife the monster could kill even more people and be a danger to future generations. Frankenstein destroys the almost completed figure of the monster's wife. The monster takes revenge by killing Frankenstein's bride Elisabeth and flees. Victor wants to hunt him down and follows the creature up to the Arctic. During his travel, Victor becomes seriously ill and dies. The creature returns to him and commits suicide when it becomes conscious of its poor deeds (Shelley 1818).

539 Warning against too much enthusiasm and the irresponsible use of modern
540 technology is a feature that characterizes the period of gothic novels at the begin-
541 ning of the nineteenth century, when the topic of artificial figures was particularly
542 important. The general eerie effect produced by the gruesome story is reinforced
543 because the nameless monster is composed of corpses. The image of a monster is
544 being deliberately exploited in Frankenstein not only to initiate suspense and horror
545 but also to highlight the dangers of a human trying to take over the role of God. Such
546 eerie stories grew popular in that period along with the widespread machine manu-
547 facturing. We can assume that highly realistic copies of human-like figures or
548 reports about them not only triggered an eerie and disturbing effect, but also served
549 as an indication of the potential dangers and as advice to deal carefully with the
550 technical heritage of the antiquity. A novel aspect about Frankenstein's monster is
551 its autonomous, uncontrolled behavior, which illustrates the powerlessness of cre-
552 ator towards his creation (Kormann 2006). The image of Shelley's monster had a
553 strong influence not only on the literature of dark romanticism, but also on many
554 generations thereafter. Until the twenty-first century it remains a highly controver-
555 sial topic. Shelley's and Hoffmann's figures were templates and role models for
556 numerous theatre adaptations, plays, and films and were deliberately used to express
557 our deep-rooted fear of human-like artificial figures and to issue warnings against
558 excessive technological advances and irresponsible actions of science.

559 Between the nineteenth century and the early twentieth century, there was a fur-
560 ther intermezzo of particularly complex human-like machines produced by known
561 magicians. The machines could demonstrate various magic tricks. Famous design-
562 ers of that period were the founder of modern magic Jean Eugène Robert-Houdin,
563 French magician Stèvenard, Jacques-Henri Rodolphe, Jean David, and brothers
564 Maillardet. The figures of this period had a strong appeal not only on stage. During
565 the period of industrialization, especially in Paris, a small industry of automatic
566 machines emerged, so enthusiasts and collectors could purchase artificial figures.
567 With the outbreak of World War I the industry came to an abrupt end and the era of
568 artistically designed, complex, and human-like amusement machines was over.

569 After the First World War, the role and effect of artificial figures particularly
570 depended on whether the country was a winner or a loser in the war. Victory led to
571 euphoria and an optimistic approach to technological progress, whereas the defeated
572 countries were generally very skeptical about it. The Czech author Karel Čapek
573 connected this fear with the vision of a collective of artificial entities. Influenced by
574 the subject of the *Prague Golem* from Jewish mysticism, he addressed the use and
575 danger of artificial figures to warn of a further World War in his play *Rossumovi*
576 *Univerzální Roboti (R.U.R.)*, whose premiere was in 1921. The play centers on a
577 company that manufactures robots to be used as a cheap workforce. The influential
578 utopian drama describes social and global economic consequences of the wide-
579 spread usage of robots. The robots finally rebel against oppression and extinguish
580 mankind in a terrible war. The play was a major success worldwide and was trans-
581 lated into almost thirty languages (Koreis 2008).

582 The remarkable aspect about Čapek's play is that artificial, human-like figures
583 are used not for amusement but for hard work, which people are not willing to do

any longer. On the other hand, machines are not artistically-crafted, individual productions anymore, but uniform entities of serial mass production. The use of robots has an enormous social and economic impact on the world, and the rebellion of the machines even leads to the end of mankind. In his play Čapek warns against the power of political concerns and dictatorships and against the power of artificial intelligence. Karel's brother Josef, painter and also a writer, coined the title of the play. The Czech word "robota" stands for forced labor and at the same time is a synonym for a human-like artificial apparatus, which should ease the people's cumbersome work. The fate of the two politically engaged brothers is tragic: Karel died as a result of a hunger strike, as he demonstrated against the Munich Agreement in which the Allies decided to surrender the Czech Republic to Germany. His brother Josef kept on demonstrating against the seizure of power by the Nazis through numerous performances with the play *R.U.R.* (Thiele 1988). He was murdered in the concentration camp Bergen-Belsen in 1939.

5.6 Androids in Animated Movies and Films

In 1927 Fritz Lang made the ambiguity of artificially created robots the topic of his expressionist silent movie *Metropolis*. In the eponymous city there are two societies: the upper class living in luxury and the working underclass in the lower parts of the city. The city is administrated by the sole ruler Joh Fredersen, whose son Freder falls in love with Maria, a worker woman and preacher who lives in the lower part of the city. Frederson wants to suppress the rebellion at the early stage by replacing Maria with a machine-man that the scientist Rotwang has constructed. Fredersen compels Rotwang to make the robot look like Maria. But Rotwang, who is driven by revenge, reprograms the machine so that it incites the workers to rebel against the authorities. The rebellion succeeds, and the crowd rushes in a nerve-wracking chase through the city, running into the real Maria, who tries to appease the mob. The workers accuse her of being a "witch" and drag Maria through the streets. Meanwhile, the machine-man is thrown on the pyre and the human-like shell of the machine burns. As the metal is exposed, workers recognize the fraud and that Rotwang misused them, pursuing his own purposes. They chase Rotwang and Fredersen to the roof of a cathedral, where they start fighting each other. After Rotwang falls down, Maria mediates between the workers and Frederson and restores peace (Fig. 5.4).

Brigitte Helm played the part and embodied both figures in an eerie double role: helpful and benign Maria and the sexually unbridled machine-man that is the personification of Rotwang's sinful plans to manipulate the frustrated workers. It was the first time that a robot embodied the uncanny doppelganger motif in a film, which was described by Freud as fear-inducing in "the highest degree" (Freud 1919). However, in America the reviews of *Metropolis* were devastating. H. G. Wells wrote in the *New York Times* on April 17, 1927: "I have recently seen the silliest film. (...) It gives in one eddying concentration almost every possible foolishness, cliché,

Fig. 5.4 Brigitte Helm in *Metropolis* (Lang 1927), Remastered, Creative Commons license: CC0 1.0 Universal, Public Domain Dedication, online available at: archive.org



625 platitude, and muddlement about mechanical progress and progress in general
 626 served up with a sauce of sentimentality that is all its own” (Wells 1927). The review
 627 was written and printed at a time when the newspapers were full of reports about the
 628 tragedy of Titanic; the passenger liner had sunk exactly 1 week before and is seen
 629 today as emblematic of the hubris of people delighted with the possibilities of tech-
 630 nology. However, both *Metropolis* and *R.U.R.* made clear for the first time that
 631 machines may replace humans one day due to superiority in intelligence, strength or
 632 in mere number.

633 After World War II, computers and their intelligence had a strong influence on
 634 our view of artificial characters. It had been already been established that androids
 635 would need an extremely high intelligence and a huge amount of computing power
 636 in order to interact with their environment. For emotions, however, it was com-
 637 pletely unclear whether could be calculated by machinery. One of the first figures
 638 focusing on this distinction is the Tin Man from Lyman Frank Baum’s fairy tale *The*
 639 *Wonderful Wizard of Oz* (Baum 2008). The Tin Man, part of fellowship in the story
 640 about Dorothy Gale, wants a heart to be able to feel emotions. Since then, science
 641 fiction writers and film directors have been making use of the emotionlessness of
 642 artificial characters or intelligences to produce drama or weirdness. For example, in
 643 *Do Androids Dream of Electric Sheep?* by Philip K. Dick (1968) a group of androids
 644 which can hardly be distinguished from humans go out of control (Dick 2010).
 645 These androids are unable to simulate emotional reactions what can only be deter-
 646 mined with a complex detector – the “Voigt-Kampff machine.” The science fiction
 647 thriller *Blade Runner* directed by Ridley Scott (1982) is based on Philip K. Dick’s
 648 short story and is a paragon of how to deal with sinister figures. Here, the androids
 649 are called replicants.

650 Whereas the android/replicant Rachael is unaware of its artificiality and appears
 651 helpless and pitying, other androids are well aware of their superior skills and use
 652 them, thus posing a threat to humans. They are chased by the Blade Runner – a
 653 bounty hunter. In test screening the audience was unsatisfied with the end of the
 654 film, and producers insisted on changing it to a “happy ending.” The director’s cut
 655 (Scott 1992), however, indicates that the Blade Runner himself is a replicant and has
 656 to flee together with Rachael. The attitude toward artificial protagonists changed
 657 quite similarly in the science fiction series *Star Trek: The Original Series* (1966–
 658 1969) and *Star Trek: The Next Generation* (1987–1994) by Gene Roddenberry.

Whereas in the original series, artificial intelligences or figures were mostly just eerie, highly intelligent series antagonists, in the following series the emotionless android Data is a full member of the crew. The search for humanity and emotions of Data has become a leitmotif of the series and the subsequent movies.

Horror films have also made use of the terrifying effect of human-like figures. Film critic Steve Rose writes: “(...) but film-makers have known about it long before it had a name. It’s what makes many horror movies tick. Zombies are archetypal monsters from the bottom of the uncanny valley, with their dead eyes and expressionless faces. Likewise the glazed-over doppelgangers in *Invasion of The Bodysnatchers* or the robotic *Stepford Wives*, not to mention the legions of dolls, dummies, puppets, waxwork figures and clowns that have struck terror in the hearts of horror fans, from the ventriloquist’s dummy in *Dead of Night* to *Chucky* in *Child’s Play*” (Rose 2011).

The Scandinavian series *Real Humans* (Baron et al. 2012) shows that only a subtle adjustment is needed to make real actors look like eerie robots. The author of the series Lars Lundström explains in an interview how the special gesture play of the “Hubots” (human household robots) developed: “For this we actually needed a long time. (...) Finally we consult a mime actor to learn how to decompose movements and recompose them liquidly again. Then we thought how we could avoid all the small human gestures: no blinks of the eyes, no scratching or touching of the own face, an upright posture. Basically, the actor had to act normal, but in an abnormal way. The Hubots act like humans, but you can see that there are no real people. They are somewhat like bad actors: you can exactly see what they are trying to do” (Hurard 2013).

The uncanny effect of artificial figures can be specifically transmitted through the actors’ craft, but also occurs unintentionally. This happens with obviously artificial protagonists with whom an emotional connection to the audience should be made. In this case the Uncanny Valley phenomenon can be held responsible if there is no emotional bond of the target audience with artificial actors. According to Misselhorn (2009) this is due to the fact that movies require a kind of “imaginative perception”, i.e., the spectator only imagines perceiving something, but does not really perceive it. In animated characters that fall into the uncanny valley and cause a feeling of eeriness, imaginative perception gets in conflict with real perception. The Uncanny Valley is often mentioned as a reason why films like *Final Fantasy* (Sakaguchi and Sakakibara 2001), *The Polar Express* (Zemeckis 2004), or *The Adventures of Tintin* (Spielberg 2011) are criticized and have not achieved box office success. The Disney production *Mars Needs Moms* (S. Wells 2011) even counts to as one of the biggest flops in film history (Barnes 2011). Studies on uncanny research also use computer-generated images to investigate the eerie effect (Karl F. MacDorman et al. 2009; Steckenfinger and Ghazanfar 2009; Cheetham et al. 2011; Tinwell et al. 2011; Cheetham et al. 2013).

A particular feature of artificial figures in the twentieth century is that their intelligence works without figurative representations or representative bodies. Only the voice and indirect actions of HAL9000 in *2001 – A Space Odyssey*, both in the book (Clarke 1968), as well as in the eponymous film version (Kubrick 1968), are suffi-

704 cient to create an oppressive atmosphere. Man can hardly prevail against the
 705 uncanny intelligence in the background. Other examples of undefinable forces in
 706 the background sending deadly humanoid machines to fight mankind: Skynet from
 707 *Terminator* (1984) sends a cyborg from the future into the present to wipe out the
 708 human race; similarly, the Wachowski Brothers let the last survivors of humanity
 709 fight against the *Matrix* (1999) and their virtual agents. However, machines and
 710 their artificial intelligence are mostly man-made and display significant weaknesses.
 711 Many of these figures or intelligences have become an integral part of pop culture
 712 and major trademarks.

713 Whereas artificial figures and intelligences are seen rather negatively in the West,
 714 in Asia especially in Japan “where cultural perspectives on robots have developed
 715 rather differently from perspectives in the West” (Karl F. MacDorman et al. 2008)
 716 exists a more positive attitude toward robots. This is possibly due to the rapid tech-
 717 nological development of Japan, which has relied on robots since the industrializa-
 718 tion of the country and robots do not constitute a threat to jobs there. In Japan,
 719 advanced household robots are considered as health care and are being increasingly
 720 used to care for the elderly, which allows for the peaceful application of robots.
 721 Nevertheless, the Japanese affinity for robots has its limitations: 11 years after the
 722 discovery of his Uncanny Valley Masahiro Mori wrote: “(...) when the negative
 723 qualities of human beings are multiplied by the negative qualities of a machine, the
 724 results can be catastrophic” (Mori 1989, 51).

725 5.7 Discussion

726 The historical review reveals that communication and cooperation between humans
 727 and anthropomorphic figures or machines did not always run smoothly. I will
 728 address the positive examples later, but in total, negative or skeptical experiences
 729 influence our view of the encounter between real and artificial humans. Artificial
 730 figures are often exemplarily used to warn of the consequences of rapid advance-
 731 ments in technology. Running into danger to be vanquished by an uncontrollable
 732 species often triggers an existential fear.⁶ But the question is how our imagination of
 733 artificial figures has been influenced by the Uncanny Valley. Are artificial figures
 734 only eerie because of their negative image in history or because of their negative
 735 impact due to the Uncanny Valley?

736 With hindsight, we look back at a divergent picture of the Uncanny Valley in his-
 737 tory, because relying on handed down reports can hardly provide us with an accu-
 738 rate idea of how artificial characters from the past really looked like and what people
 739 really felt when they saw them. But in the moment of a sensory impression as well
 740 as in stories, we always try to get a concept of a figure or person in our minds. Only

⁶The science fiction author Isaac Asimov directly addresses this fear of mechanical man in some of his robot novels. His term “Frankenstein complex” also predicts a strong phobia against all resembled human beings – similar to the Uncanny Valley.

a few have ever seen an android, but many will have formed a negative, neutral, or even positive view on androids. But both the direct perception, as well as the indirect notion of an ambiguous shape or form, can arouse uncomfortable feelings.

Conceptual as well as imaginative perception (cf. Reid et al. 2014) of artificial figures are influenced by hitherto neglected factors: intention, aesthetics, and the cultural context of a figure.

Intention As mentioned in the beginning, artificial figures are often designed according to our expectations and simulate human appearance or human behavior. This mental model (Lee et al. 2005) also includes a kind of awareness and intention (Zlatev 2001; Fong et al. 2003). Amusement machines made by the Chinese, the Arabs, and during the Renaissance in Europe were primarily described as entertaining devices or just as tools. The lack of awareness leads to no rejection, because there is no active threat against humanity. So, these stories tell of no further conflict between man and machine, however, stories like from the men of Prometheus, Capek’s robots in *R.U.R.*, the androids from *Blade Runner*, etc. show that self-determination of an autonomous and emancipated species is not accepted by the predominant type and treated as a serious threat that often results in a devastating conflict. Mary Shelley’s *Frankenstein* deals with a figure’s self-determination and obviously describes the artificial figure as a monster with apparent cruel intentions and moral errors. This not only decreases the emotional bonding of the reader with the tragic role of the figure, but also increases the reader’s doubts and fears. Artificial figures like Pandora, Olympia, or the Machine from “Metropolis” also produce an eerie image when distracting (often with their appearance) from an evil purpose or leaving the reader or protagonist in the dark about their true intention. This might, in principle, also apply to von Kempelen’s/Mälzel’s “intelligent” Chess-playing Turk, because of its ambitious intention to win the game against humans. In contrast, neutral, or philanthropic intentions in combination with tragic fates like the death of Gilgamesh’s companion Enkidu, the end of Magnus’ doorman, Descartes’ daughter, or Rachael’s role in *Blade Runner* may appear less eerie and even pitiful for human beings.

Aesthetics Because people are accustomed to associating their counterparts to a specific gender, androgynous artificial figures are nearly always portrayed as male or female. In addition to gender, the visual aesthetics of artificial figures are especially emphasized – as beautiful (like Pygmalion’s sculpture, Pandora, Olympia, etc.), repulsive (Frankenstein’s monster), or just unobtrusively human-like (Ning Shi’s wooden man). These stories precisely described the figures’ intricately formed, lifelike details, and later we will see that this issue is very important. Generally speaking, we can say that responsive aesthetics lead to more initial acceptance by the viewer (cf. Hanson 2005) and seem to successfully obscure the artificial being. Because of their human shape, attractive, human-like figures can also be considered as a potential partner and sometimes produce sexual longing (as in the case of Pygmalion, Pandora, and Olympia). Combined with knowledge about a baleful motivation or a figure’s unknown intentions, the eerie idea of the figure increases.

784 **Cultural Context** Almost all historical reports tell of the high level of craftsmanship
785 and technical know-how necessary to create artificial humans. It is fascinating
786 when the underlying technical processes cannot be completely understood right
787 away, or when we wish we could be like these characters or when we expect from
788 characters things we wish we could achieve ourselves. In addition to the figure itself
789 as well as the creator, reason, materials, or the method of development are high-
790 lighted and depend on epoch, religion, as well as culture. In antiquity and the
791 European Middle Ages, especially mystical or divine factors were accountable for
792 the creation of artificial life. In Asia, in Arabia, and during the Renaissance in
793 Europe, especially the art of engineering was highlighted. And as we have seen,
794 today there is another image of robots in Asia (especially in Japan) than in the West.
795 Thus, it is clearly significant in which culture an artificial figure exists.

796 The presented aspects are relevant in forming both short and long term mostly
797 negative judgments influenced by the Uncanny Valley. There are some few positive
798 examples, like Pygmalion's sculpture, the android Data from *Star Trek*, or the Tin
799 Man from *Alice in Wonderland* that demonstrate a peaceful coexistence between
800 natural and artificial beings. They also show that only equality, good intentions,
801 and mutual respect can lead to higher emotional levels and relationships like
802 friendship or love. A true example of this emotional bond shows the case of the
803 bomb defusing PackBot "Scooby Doo," which was mourned by US soldiers in Iraq
804 after he was destroyed by a mine explosion and could not be repaired (Singer
805 2009). Scooby Doo's case indicates that not only the appearance, but also the
806 alleged common intention as well as its role in a group of humans may be critical
807 for human acceptance.

808 The historical references often described artificial figures' lifelike details. Why
809 were these details as well as their skills and abilities so important, and why were
810 they so precisely described? Artificial characters also need to look attractive and
811 have enormous aesthetic qualities. Did the narrators hope that their description
812 would seem more interesting by mentioning these details? Assuming that these fig-
813 ures had really possessed all these abilities and properties, why, excluding the previ-
814 ously mentioned positive examples, were such figures unable to integrate
815 permanently into human society? Or: why did Olimpia attract adverse attention at
816 the party? Consciously or subconsciously, the authors could create a sinister con-
817 cept with their accurate description of artificial characters. These figures attracted
818 attention due to their "lifelike" details, but despite high visual aesthetics, artificial
819 figures are unable to get the long term acceptance of men. They just bring evil upon
820 the people, disappear, or get destroyed. A permanent and stable relationship between
821 human and human-like figures is rarely mentioned.

822 The most plausible answer for that reason is that these figures were consciously
823 or subconsciously exploited by their creators due to their uncanny effect and thus
824 increased the tension of stories. Intention, aesthetics, as well as the cultural context
825 are combined by the mind to a certain role model of a human entity. The historical
826 review shows that not only observing a real figure but also the idea of an artificial
827 human is sufficient to trigger eerie responses – not only towards human protagonists
828 within the stories but also to the readers. This idea of an ambiguous creature can

also be declared as uncanny like its real embodiment. Only a few people may have truly seen an artificial human in the past, but the conflict between man and machine seem comprehensible and plausible if the Uncanny Valley within our imagination is already taken into account.

As previously mentioned, human standards according to which a human-like artificial figure are evaluated are the same criteria by which we evaluate humans. As this is the precondition for social interaction with anthropomorphic figures, we cannot ignore missing human attributes – e.g. imperfections in facial expressions or errors in speech, etc. This is also evident, either in the short term by processing a negative perceived sensory impression, or in the long term by imaginations and the resulting kinds of prejudices.

Finally, the historical review shows that sensations as well as thoughts result in the same stereotypical image of artificial figures – imperfect and therefore negatively associated. To enable smooth social interactions with machines we must ensure that artificial figures are strongly designed according to human expectations and attitudes. And we need to rethink our understanding and image about artificial figures and about ourselves. An entity’s intention has to be clear, the appearance has to be appropriate, and we generally have to reject unjustified prejudices towards artificial figures caused by our historical or cultural backgrounds.

Nevertheless, it remains very difficult to finally improve the impact and acceptance that figures are always accepted by people. In the end, there are still our personal preferences, prejudices, and subjective attitudes that will decide whether we accept a figure or not. Finding the best commonalities and the most reasonable route around obstacles like the Uncanny Valley will present the most difficult challenges to improving social interaction and communication between human-like artificial figures and real humans.

Acknowledgments This work is supported by the graduate program Digital Media of the Universities of Stuttgart and Tübingen, and the Stuttgart Media University (HdM) as well as by the German Research Foundation (DFG) for support of the *SimTech Cluster of Excellence* (EXC 310/1).

[AU3] **References** 859

Adamson, Andrew, and Vicky Jenson. 2001. *Shrek*. United States: DreamWorks, Pacific Data Images DreamWorks Animation. 860
 Al-Hassan, Ahmad Yussuf. 1977. The Arabic text of Al-Jazari’s “A compendium on the theory and practice of the mechanical arts”. *Journal for the History of Arabic Science* 1: 47–64. 862
 [AU4] Anderson, William S. 1972. *Ovid’s metamorphoses*, American Philological Association series, vol. 2. Norman: University of Oklahoma Press. 864
 Aquinas, S.T. 2013. *Summa theologica*. Vol. 1. COSIMO CLASSICS. 866
 Barnes, Brooks. 2011. Many culprits in fall of a family film. *New York Times*. 867
 Baron, Stefan, Henrik Widman, and Lars Lundström. 2012. *Real humans (Äkta människor)*. Matador Film AB, SVT, DR, YLE. 868
 Baum, L. Frank. 2008. *The wonderful wizard of Oz*. Oxford: Oxford University Press. 870

- 871 Bouc, Angelina. 2014. *Men who dress up as rubber dolls star on secrets of the living dolls*. guardi-
872 antv.com.
- 873 Braemer, E.A. 1959. *Goethes Prometheus und die Grundpositionen des Sturm und Drang*, Beiträge
874 Zur Deutschen Klassik. Weimar: Arion Verlag.
- 875 Buchanan, Kyle. 2011. The biggest problem with the Tintin movie might be Tintin himself. *New*
876 *York Magazine*.
- 877 Cameron, James. 1984. *The Terminator*. United States: Orion Pictures, Hemdale Film Corporation,
878 Pacific Western Productions.
- 879 Channel4, 4OD. 2014. *The secret of the living dolls*. U.K.: 4OD – Channel 4.
- 880 Cheetham, Marcus, Pascal Suter, and Lutz Jäncke. 2011. The human likeness dimension of the
881 “uncanny valley hypothesis”: Behavioral and functional MRI findings. *Frontiers in Human*
882 *Neuroscience* 5: 126. doi:10.3389/fnhum.2011.00126.
- 883 Cheetham, Marcus, Ivana Pavlovic, Nicola Jordan, Pascal Suter, and Lutz Jancke. 2013. Category
884 processing and the human likeness dimension of the uncanny valley hypothesis: Eye-tracking
885 data. *Frontiers in Psychology* 4: 108. doi:10.3389/fpsyg.2013.00108.
- 886 Cohen, Florette, Sheldon Solomon, Molly Maxfield, Tom Pyszczynski, and Jeff Greenberg. 2004.
887 Fatal attraction: The effects of mortality salience on evaluations of charismatic, task-oriented,
888 and relationship-oriented leaders. *Psychological Science* 15: 846–851.
889 doi:10.1111/j.0956-7976.2004.00765.x.
- 890 Dick, Philip K. 2010. *Do androids dream of electric sheep?* Orion.
- 891 Dinter, Annegret. 1979. *Der Pygmalion-Stoff in der europäischen Literatur*, Studien Zum
892 Fortwirken Der Antike. Heidelberg: Winter Verlag.
- 893 Fong, Terrence, Iilah Nourbakhsh, and Kerstin Dautenhahn. 2003. A survey of socially interactive
894 robots. *Robotics and Autonomous Systems* 42: 143–166. doi:10.1016/
895 S0921-8890(02)00372-X.
- 896 Freedman, C. 2000. *Critical theory and science fiction*, Literary studies: Science fiction. Hanover:
897 Wesleyan University Press.
- 898 Freud, Sigmund. 1919. Das Unheimliche. *Imago. Zeitschrift für Anwendung der Psychoanalyse*
899 *auf die Geisteswissenschaften*.
- 900 Gassen, Hans-Günther, and Sabine Minol. 2012. *Die Menschen Macher: Sehnsucht nach*
901 *Unsterblichkeit*, Erlebnis Wissenschaft. Hoboken: Wiley.
- 902 Gendolla, Peter. 1992. *Anatomien der Puppe: zur Geschichte des Maschinen – Menschen bei Jean*
903 *Paul, ETA Hoffmann, Villiers de l’Isle-Adam und Hans Bellmer*. Vol. 113. Universitätsverlag
904 Winter.
- 905 Giles, Lionel. 1925. *Taoist teachings from the book of Lieh Tzū*, Wisdom of the East series. London:
906 J. Murray.
- 907 Goethe, Johann Wolfgang von. 1789. *Prometheus: Dramatisches Fragment*. Library of Alexandria.
- [A066] 908 Graham, angus Charles. 1990. *The book of Lieh-Tzu: A classic of the Tao*. UNESCO collection of
909 representative works. Chinese series. J. Murray.
- 910 Green, Robert D., Karl F. MacDorman, Chin-Chang Ho, and Sandosh Vasudevan. 2008. Sensitivity
911 to the proportions of faces that vary in human likeness. *Computers in Human Behavior* 24:
912 2456–2474. doi:10.1016/j.chb.2008.02.019.
- 913 Greenberg, J., J. Arndt, L. Simon, T. Pyszczynski, and S. Solomon. 2000. Proximal and distal
914 defenses in response to reminders of one’s mortality: Evidence of a temporal sequence.
915 *Personality and Social Psychology Bulletin* 26: 91–99. doi:10.1177/0146167200261009.
- [A066] 916 Hanson, David. 2005. Expanding the aesthetic possibilities for humanoid robots. *IEEE-RAS inter-*
917 *national conference on humanoid robots*.
- 918 Hanson, David. 2006. Exploring the aesthetic range for humanoid robots. *Proceedings of the*
919 *ICCS/CogSci-2006*.
- 920 Hanson, David, Andrew Olney, and S. Prilliman. 2005. Upending the uncanny valley. *Proceedings*
921 *of the National Conference on Artificial Intelligence* 20: 24/1728.
- 922 Heckmann, Herbert. 1982. *Die andere Schöpfung: Geschichte der frühen Automaten in Wirklichkeit*
923 *und Dichtung*. Frankfurt am Main: Umschau.

- [AU7] Hesiod. *Works and Days*. *Online Medieval and Classical Library Release #8*. 924
 Hill, Donald R. 1996. *A history of engineering in classical and medieval times*. London: Routledge. 925
 Hoffman, E.T.A. 2008. *Der Sandmann*. Reclam. 926
 Holt, Nick. 2007. *Guys and dolls*. UK: BBC. 927
 Hurard, Oriane. 2013. Lars Lundström, Autor der Serie “Real Humans”: “Ein Spiegel unserer eigenen Existenz”. *arte.tv*. 928
 Jauch, Ursula Pia. 1998. *Jenseits der Maschine: Philosophie, Ironie und Ästhetik bei Julien Offray de La Mettrie (1709–1751)*. München: C. Hanser Verlag. 930
 Jentsch, Ernst. 1906. Psychiatrisch-Neurologische Wochenschrift. *The Journal of Nervous and Mental Disease*: 33: 50. 931
 Jordan, Leo. 1910. Pars Secunda Philosophiae, seu Metaphisica. *Archiv für Geschichte der Philosophie*. 23: 338–373. 932
 Koreis, Voyen. 2008. Čapek’s R.U.R. 2014. 936
 Kormann, Eva. 2006. Künstliche Menschen oder der moderne Prometheus. Der Schrecken der Autonomie. *Amsterdamer Beiträge zur neueren Germanistik* 59: 73. 937
 LaGrandeur, Kevin. 2010. Do medieval and renaissance androids presage the posthuman? *CLCWeb: Comparative Literature and Culture* 12. doi: [10.7771/1481-4374.1553](https://doi.org/10.7771/1481-4374.1553). 938
 Lang, Fritz. 1927. *Metropolis*. Germany: UFA Film. 939
 Lecouteux, Claude. 1999. *Histoire des Vampires, Autopsie d’un mythe*. Paris: Editions Imago. 940
 Lee, Sau-lai, Kiesler, S., Ivy Yee-man Lau, and Chi-Yue Chiu. 2005. Human mental models of humanoid robots. In *Proceedings of the 2005 IEEE international conference on robotics and automation*, 2767–2772. Washington, DC: IEEE Computer Science Press. doi: [10.1109/ROBOT.2005.1570532](https://doi.org/10.1109/ROBOT.2005.1570532). 941
 Lieh-Tzu, and Richard Wilhelm. 1980. *Das Wahre Buch Vom Quellenden Urgrund*. Stuttgart: Zenodot Verlagsgesellscha. 942
 MacDorman, K.F. 2005a. Mortality salience and the uncanny valley. In *5th IEEE-RAS international conference on humanoid robots, 2005.*, 3:399–405. IEEE Publication Database. doi: [10.1109/ICHR.2005.1573600](https://doi.org/10.1109/ICHR.2005.1573600). 943
 [AU10] MacDorman, Karl F. 2005b. Androids as an experimental apparatus: Why is there an uncanny valley and can we exploit it? *Android Science* 3. 944
 MacDorman, Karl F., Sandosh K. Vasudevan, and Chin-Chang Ho. 2008. Does Japan really have robot mania? Comparing attitudes by implicit and explicit measures. *AI and Society* 23: 485–510. doi:[10.1007/s00146-008-0181-2](https://doi.org/10.1007/s00146-008-0181-2). 945
 MacDorman, Karl F., Robert D. Green, Chin-Chang Ho, and Clinton T. Koch. 2009. Too real for comfort? Uncanny responses to computer generated faces. *Computers in Human Behavior* 25: 695–710. doi:[10.1016/j.chb.2008.12.026](https://doi.org/10.1016/j.chb.2008.12.026). 946
 Maul, Stefan M. 2012. *Das Gilgamesch-Epos*. 5th ed. C.H.Beck. 947
 Mettrie, Julien Offray de La. 1990. *L’homme machine*. 948
 Michaels, Adrian. 2014. Secrets of the living dolls, Channel 4, Review. *The Telegraph*. 949
 Misselhorn, Catrin. 2009. Empathy with inanimate objects and the uncanny valley. *Minds and Machines* 19: 345–359. doi:[10.1007/s11023-009-9158-2](https://doi.org/10.1007/s11023-009-9158-2). 950
 Mori, Masahiro. 1970. The uncanny valley. *Energy* 7: 33–35. 951
 Mori, Masahiro, Charles Terry, and Ralph Friedrich. 1989. *The Buddha in the robot*. Tokyo: Kosei Publishing Company. 952
 Müller, Götz. 1989. *Gegenwelten: Die Utopie in der deutschen Literatur*. Stuttgart: J.B. Metzlersche Verlagsbuchhandlung. 953
 Murray, Charles Shaar. 2002. Horror as Dr X builds his creator. *The Telegraph*, February. 954
 [AU11] Nadarajan, Gunalan. 2007. Islamic automation: A reading of Al-Jazari’s the book of knowledge of ingenious mechanical devices (1206). *Foundation for Science Technology and Civilisation*: 1–16. 955
 Needham, J., and L. Wang. 1956. *Science and civilisation in China: Volume 2. History of scientific thought*. Cambridge: Cambridge University Press. 956

- 976 Newman, W.R. 2005. *Promethean ambitions: Alchemy and the quest to perfect nature*, American
977 politics and political economy series. Chicago: University of Chicago Press.
- 978 Pollick, Frank E. 2010. In search of the uncanny valley. In *User centric media*, eds. Petros Daras,
979 Oscar Mayora Ibarra, Ozgur Akan, Paolo Bellavista, Jiannong Cao, Falko Dressler, Domenico
980 Ferrari, et al., 40, 69–78. Berlin Heidelberg: Springer. Lecture notes of the institute for com-
981 puter sciences, social informatics and telecommunications engineering. doi:
982 [10.1007/978-3-642-12630-7](https://doi.org/10.1007/978-3-642-12630-7).
- 983 Reichardt, Jasia. 1978. *Robots: Fact, fiction, and prediction*. New York: Viking Penguin.
- 984 Reid, Thomas, Gideon Yaffe, and Ryan Nichols. 2014. Thomas reid. In *The Stanford encyclopedia*
985 *of philosophy*, ed. Edward N. Zalta. Stanford: Stanford University.
- 986 Rose, Steve. 2011. Tintin and the uncanny valley: When CGI gets too real. *The Guardian*.
- 987 Rosenthal, Robert, and Lenore Jacobson. 1968. Pygmalion in the classroom. *The Urban Review* 3:
988 16–20. doi:[10.1007/BF02322211](https://doi.org/10.1007/BF02322211). Weinheim/Basel: Beltz.
- 989 Rosheim, Mark E. 1997. In the footsteps of Leonardo (articulated anthropomorphic robot). *IEEE*
990 *Robotics and Automation Magazine* 4: 12–14. doi:[10.1109/100.591641](https://doi.org/10.1109/100.591641).
- 991 Rousseau, Jean-Jacques, Horace Coignet, and Jacqueline Waeber. 1997. *Pygmalion: Scène lyrique*.
992 Paris: Université-Conservatoire de musique.
- 993 Sakaguchi, Hironobu, and Motonori Sakakibara. 2001. *Final Fantasy – The Spirits Within*.
994 Columbia Pictures.
- 995 Saygin, Ayse Pinar, and Hiroshi Ishiguro. 2009. The perception of humans and robots : Uncanny
996 hills in parietal cortex. In *Proceedings of the 32nd annual conference of the cognitive science*
997 *society*, ed. R. Catrambone. Cognitive Science Society: 2004–2008.
- 998 Schneider, Edward, and Shanshan Yang. 2007. Exploring the uncanny valley with Japanese video
999 game characters. In *Intelligence*, ed. Baba Akira, 546–549. Tokyo: The University of Tokyo.
- 1000 Schwab, Gustav. 2011. *Sagen des klassischen Altertums*. Leipzig: Anaconda Verlag.
- 1001 Scott, Ridley. 1982. *Blade Runner*. Warner Bros.
- 1002 Shatil, Sharon R. 2012. Terror management theory: Interplay between mortality salience, death-
1003 thoughts, and overall worldview defense.
- 1004 Shelley, Mary. 1818. *Frankenstein or the modern prometheus*. London: Lackington, Hughes,
1005 Harding, Mavor, & Jones.
- 1006 Singer, P.W. 2009. *Wired for war: The robotics revolution and conflict in the twenty-first century*,
1007 A Penguin book. Technology/military science. New York: Penguin Press.
- 1008 Spielberg, Steven. 2011. *The Adventures of Tintin*. Paramount Pictures (North America), Columbia
1009 Pictures (International).
- 1010 Steckenfinger, S.A., and A.A. Ghazanfar. 2009. Monkey visual behavior falls into the uncanny
1011 valley. *Proceedings of the National Academy of Sciences of the United States of America* 106:
1012 18362–18366. doi:[10.1073/pnas.0910063106](https://doi.org/10.1073/pnas.0910063106).
- 1013 Strandh, Sigvard. 1992. *Die Maschine: Geschichte, Elemente*. Weltbild-Verlag: Funktion Ein
1014 enzyklopädisches Sachbuch.
- 1015 Styles, Ruth. 2014. Secrets of men who dress up as rubber dolls revealed in new documentary.
1016 dailymail.co.uk.
- 1017 Thiele, Eckhard. 1988. *Karel Čapek*. Vol. 1257. P. Reclam.
- 1018 Thorpe, William H. 1944. Some problems of animal learning. *Proceedings of the Linnean Society*
1019 *of London* 156: 70–83. doi:[10.1111/j.1095-8312.1944.tb00374.x](https://doi.org/10.1111/j.1095-8312.1944.tb00374.x).
- 1020 Tinwell, Angela, Mark Grimshaw, Debbie Abdel Nabi, Andrew Williams, Debbie Abdel Nabi,
1021 Tinwell Angela, and Grimshaw Mark. 2011. Uncanny valley in virtual characters 1 facial
1022 expression of emotion and perception of the uncanny valley in virtual characters Angela
1023 Tinwell. *Computers in Human Behavior* 44: 1–34. doi:[10.1016/j.chb.2010.10.018](https://doi.org/10.1016/j.chb.2010.10.018). Elsevier
1024 Ltd.
- 1025 Valverde, Sarah Hatheway. 2012. *The modern sex doll-owner: A descriptive analysis*. San Luis
1026 Obispo: California Polytechnic State University.
- 1027 Völker, Klaus. 1994. *Künstliche Menschen: Dichtungen und Dokumente über Golems, Homunculi,*
1028 *lebende Statuen und Androiden*. Suhrkamp Verlag KG: Phantastische Bibliothek.

[AU12] Von Bingen, Hildegard, and Priscilla Throop. 1998. *Hildegard von Bingen's Physica: The complete English translation of her classic work on health and healing*. Inner Traditions/Bear. 1029
1030
Wachowski, Andy, and Larry Wachowski. 1999. *The matrix*. United States, Australia: Warner Bros. 1031
Pictures, Roadshow Entertainment. 1032
Wells, Herbert G. 1927. Mr. Wells reviews a current Film: He takes issue with this German conception of what the city of one hundred years hence will be like. *The New York Times Company*, 17 1033
Apr. 1035
Wells, Simon. 2011. *Mars needs Moms*. Walt Disney Animation Studios. 1036
Weschler, Lawrence. 2006. Wired 10. 06: Why is this man smiling ? *Wired*: 1–6. 1037
Westbrook, Caroline. 2014. C4's secrets of the living dolls pulls in and freaks out viewers in equal 1038
measure. *metro.co.uk*. 1039
Zebrowitz, Leslie. 2001. *Facial attractiveness: Evolutionary, cognitive, and social perspectives: Evolutionary, cognitive, cultural and motivational perspectives*. Ablex Pub Corp. 1040
1041
Zemeckis, Robert. 2004. *The polar express*. United States: Warner Bros. Pictures, Castle Rock 1042
Entertainment, Shangri-La Entertainment, ImageMovers, Playtone, Golden Mean. 1043
Zlatev, Jordan. 2001. The epigenesis of meaning in human beings, and possibly in robots. *Minds and Machines* 11: 155–195. doi:[10.1023/A:1011218919464](https://doi.org/10.1023/A:1011218919464). 1044
1045

Author Queries

Chapter No.: 5 0002506195

Queries	Details Required	Author's Response
AU1	Please include Duffy (2003), Riek et al. (2009), Breazeal (2004), Scassellati (2001), Dautenhahn (1999), Dick (1968), Scott (1992), Clarke (1968), Kubrick (1968) in the reference list.	
AU2	Please check if inserted citation for Figures 5.3 and 5.4 is okay.	
AU3	Please cite MacDorman (2005) in the text.	
AU4	Please check if updated publisher location for Anderson (1972), Baum (2008), Braemer (1959), Dinter (1979), Freedman (2000), Gassen and Minol (2012), Giles (1925), Heckmann (1982), Hill (1996), Lecouteux (1999), Mori (1989), Müller (1989), Needham and Wang (1956), Newman (2005), Reichardt (1978), Rousseau et al. (1997), Singer (2009), Valverde (2012) is okay.	
AU5	Please update publisher name and publisher location for Graham (1990).	
AU6	Please update volume number and page range for Hanson (2005, 2006).	
AU7	Please updated "Hesiod", Shatil (2012).	
AU8	Please check if updated publisher name and publisher location for Jauch (1998), Reid et al. (2014), Shelley (1818) is okay.	
AU9	Please check if updated volume number and page range for Jentsch (1906), Jordan (1910), Mori (1970) is okay.	
AU10	Please update page range for MacDorman (2005).	
AU11	Please update volume number for Nadarajan (2007) and Weschler (2006).	
AU12	Please update publisher location for Von Bingen and Throop (1998), Dick (2010), Gendolla (1992), Goethe (1789), Hoffman (2008), and Zebrowitz (2001).	