Exploring the Uncanny Valley to Find the Edge of Play

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Play often rewards us with a thrill or a sense of wonder. But, just over the edge of play, uncanny objects like dolls, automata, robots, and realistic animations may become monstrous rather than marvelous. Drawing from diverse sources, literary evidence, psychological and psychoanalytic theory, new insights in neuroscience, marketing literature, robotics, and new testimony from survey respondents, this article pinpoints a moment when surprise turns to shock and play drains away. Play is surely difficult to define, but demarcating its porous boundary—where what one moment creates joy can, in the next, cause dread—is a useful step toward describing this shifting phenomenon.

PLAY IS NOTORIOUSLY HARD to define, and it is yet harder to demarcate. The task challenges even the sharpest thinkers.[1] Because play is so various, because playful situations diverge so widely over place and time, and because players vary so much from one to the next, it is difficult to mark confidently the most basic thing: where play leaves off and where something else less pleasurable or less wholesome begins. As a practical result of the hazy nature of play, the several disciplines interested in the subject often retreat to their corners where their specialties allow them to speak with assurance about only a narrow slice of play. Thus the discussion of this broad subject itself tends to narrow. And a narrowed view brings us no nearer to drawing a boundary for play. Play is so labile and our views are so particular that when the premier scholar of play, the folklorist Brian Sutton-Smith, observed the problem, he surmised that we can hope to know play only by the purposes we ascribe to it; we can see in play only our own ideologies, biases, disciplinary training, and "rhetorics" reflected. "We fall into silliness," he concluded.[2] Avoiding silliness is perhaps not the least of the difficulties that studying play presents; before we can define play, we must locate it. But finding the fuzzy border of play is not impossible if we

have recourse to an instrument that is sensitive enough to divide the territory between that which is play and that which is not.

This article searches for the outer edge of play by using a cluster of emotions as a surveying tool. We start with the feeling of "the uncanny." The uncanny lies just astride the boundary of play. This disquieting, unnerving, spooky, and somewhat sickly sensation contrasts with the pleasure and ease we feel at play; beginning to feel unnerved and spooked is to start to feel the sense of play draining away. Noticing where play leaves off also offers a view of where play begins. Understanding the uncanny (and so marking off a region for play) is a problem beyond any single discipline, in fact it requires some casting about. Instead of a short trip back to the old neighborhood, exploring the disputed horizon between play and nonplay requires an excursion abroad through etymology, the intellectual history of psychology and psychoanalysis, literature, art history, robotics, ethology and evolutionary biology, the history of the advertising and marketing of dolls, the recent insights of neuroscience and perceptual psychology, the perceptions of everyday players themselves, and the recent inventions of popular culture. However winding, the journey in the end rewards the traveler with a surer sense of the territory of play.

Locating the Uncanny

The first step into the borderland between play and nonplay begins with the slightly peculiar word *uncanny* itself. The English word is often used to render a more specific and, for our purposes, useful German adjective *unheimlich,* whose root *heimlich*—which translates as "homely"—when negated becomes, literally, "the unhomely," *das Unheimliche*. The unhomely carries the sense of the unfamiliar, the strange, or the disquietingly (but not quite) familiar. We would say "uncanny." For an English speaker, to be canny is to be cagey, or to be cagey and wise. But to add the prefix "un" does not make one uncagey or unwise. And then to add the definite article is to make of it a substantivized adjective putting "the uncanny" on a conceptual par with "the beautiful," or "the sublime."[3] Used this way, the words describe the odd sense that arises from an encounter with an object that looks real enough to be real, or that moves realistically enough to seem real, but that is nevertheless not real or that seems not quite real. Looking to the Scots variant of English is helpful; the alternate definition of the word canny is "pleasant;" knowledge is a pleasant, anchoring

asset, but to disturb the familiar sense of what we know to be true is unpleasant and *unsettling*. Some of us will feel unsettled and insecure when we come upon things or images that carry the sense of the unhomely. For example, we know the haunted feeling when an artist has painted a portrait looking forward; because of the play of shadow and light, when viewed from the side, the eyes foreshorten and appear to track observers moving through a room or gallery.[4] This illusion gives us the sense of sharing the space with an uninvited, prying guest whom we are not "at home" with.

The strangeness and richness of the word *unheimlich* attracted two early twentieth-century German-speaking psychological thinkers. Ernst Jentsch, the pioneer of the uncanny, is mostly forgotten, but we have no trouble remembering the Viennese critic who popularized his idea, Sigmund Freud, whose theories dominated clinical psychology in the twentieth century. Freud's celebrity notwithstanding, Jentsch still warrants close consideration. In 1906 he published "On the Psychology of the Uncanny," ("*Zur Psychologie des Unheimlichen*"), and in the essay he noticed how words themselves, particularly German words, sometimes build in concepts that reveal a profound but accessible insight into "everyday psychology." In the case of this word *unheimlich*, Jentsch noted how a "lack of orientation" was bound up with the sense of oddness that a thing could leave us with. This "awkward impression" was easiest to observe in the presence of "imitations of the human form [that] appear to be united with certain bodily or mental functions."[5]

Jentsch had in mind the "uncanny effect" of clever automata that so fascinated eighteenth- and nineteenth-century Europeans, those "life-size machines that perform complicated tasks, blow trumpets, dance and so forth." The devices mimicked human action, and the act of imitation, Jentsch observed, made it easy to "cross the boundary between the pathological and the normal." It was hard to know in which realm these unusual things belonged or to what category they belonged, so in their presence, it was hard for the narrowly empirical Positivists of Jentsch's era to know where they stood. This ambiguity worried Jentsch because "intellectual certainty provides psychical shelter in the struggle for existence." In "On the Psychology of the Uncanny," Jentsch was also the first to note that viewers were likely to grow more uneasy as these contraptions became more lifelike and capable.

The story of how automata became more realistic goes back centuries. Archytus of Tarantum fashioned machines that mimicked live action in the fifth century BCE, and the toys became more sophisticated over time. More

than a hundred years before Jentsch wrote about the uncanny, in fact, French craftsmen designed clockwork mechanisms to drive the most ingenious of these machines, the *écrivain-dessinateurs,* which could transcribe poems or reproduce sketches.[6] A few of these devices from that era still exist, and if they fail to call out a feeling of the uncanny now as they once did, their ingenuity continues to stir museum audiences although animatronic toys such as Furby and Tickle Me Elmo have made robotic movements commonplace. These automata, which continue to impress us, stunned contemporary audiences with their audacity and near authenticity. And for Jentsch, this was where the trouble began. The more marvelous the device, the less confidence a spectator would have in drawing a line separating the animate from the inanimate. The technology created a brand new malaise because unease grew as confidence fell. "The finer the mechanism and the truer to nature the formal reproduction," Jentsch wrote, "the more strongly will the special effect also make its appearance."

For Jentsch, automata were not the only source of the uncanny. He noted that the odd movements of someone undergoing an epileptic seizure usually made those witnessing such a seizure for the first time uncomfortable. The sight of corpses, skeletons, and skulls could be even more unnerving, said Jentsch, because thoughts of a "latent animate state always lies close to these things." Popular gothic tales from the later eighteenth and early nineteenth centuries had made it especially hard to think of these as simply body parts belonging to the departed. Stories of the day were full with ghosts, the revivified dead, vampires, mysterious doubles, drug fiends, sleepwalkers, catatonic victims of premature burial, and evil automata. These literary creatures of the postrevolutionary era probably reflected the still-fresh psychic trauma of recent European political upheavals and reigns of terror. It is no accident that the most famous and most portentous political tract of the nineteenth century, *The Communist Manifesto*, begins with the ringing phrase "A spectre is haunting Europe" and refers to unfolding political events as an "exorcism."[7] But once unleashed, the genre of gothic tales needed no especially large sociopolitical disruption to keep it fresh. Indeed the genre remains vibrant even in our own time with any number of short stories, novels, and (maybe especially) movies. Think for example—just to name a few—of *Shawn of the Dead* (2004), *The Invasion* (2006), and *The Mummy: Tomb of the Dragon Emperor* (2008), which treat us respectively to stories of zombies, alien replicas, and ambulating preserved bodies.

Jentsch pointed out how authors writing in this tradition had consistently evoked a feeling of the uncanny by delaying the revelation that an apparently real

character was artificial or mechanical. He alluded to the "virtuosic" work of the long-popular early nineteenth-century writer and sometime composer E. T. A. Hoffmann. In Hoffmann's "The Nutcracker and the Mouse King" (*"Nussknacker und Mausekönig"*) from 1816, toys come to life to battle malevolent mice. We know the story best as the classic Tchaikovsky ballet *The Nutcracker*, which was based on Hoffmann's tale and composed three quarters of a century later. The effect of the story is still mostly comic. But a more unsettling tale, "Automata" (*"Die Automata"*), which Hoffmann wrote in 1814, is more to our point. In the story, the inanimate assumes a weird, liminal life. One character denounces the "travesty" of mechanical men as "images of living death or inanimate life" and then describes a similar experience he had as a child when he fled a wax museum because of the "horrible, eerie, shuddery feeling" the place evoked.[8] The weirdest and most disturbing of Hoffmann's tales, "The Sandman" (*"Der Sandman"*), followed these lines. Written as diary entries, the story chronicles the diarist's creeping, obsessive suspicion; his betrayal by mysterious doppelgangers; and his subsequent descent into madness and suicide. In the tale's creepiest twist, the diarist discovers that he has become the victim of a monstrous deception when he encounters two of his betrayers as they argue over the lifeless and eyeless body of the object of his infatuation, the beautiful but enigmatic Olimpia. The exposed cogs and gears of her dismantled, wind-up innards divulge her true, horrifyingly nonhuman nature.

Freud v. Jentsch

Sigmund Freud began to write about the uncanny in 1901 in *The Psychopathology of Everyday Life*, a treatise that became central to psychoanalysis. There he included among uncanny experiences the puzzling but common phenomenon of déjà vu, the unsettling feeling that current events are actually recurrences. Mystics had explained déjà vu as evidence of reincarnation or prophecy, but Freud, who wished to replace superstition with scientific judgment, soberly called déjà vu a "riddle" and complained that psychologists had ignored the phenomenon.[9] Eighteen years later, Hoffmann's strange story received Freud's attention in "The Uncanny" (*"Das Unheimlich"*). In this article, which one biographer has labeled "curious," Freud looked once more for a solution to the riddle.[10] Criticizing Jentsch for his shallow reading of the uncanny, Freud called Jentsch's handling of the subject "incomplete," and "fertile but not exhaustive." Both thinkers agreed that the uncanny was a variety of anxiety, but unlike Jentsch, Freud found everyday psychology interesting only insofar as

it revealed the deeper turmoil and psychopathology he believed lay beneath. Freud did not regard almost-real objects simply as disturbing and dissonant; he saw that these—like art, "slips of the tongue," and errors of forgetfulness— were rebuses ready to be decrypted, puzzles waiting to be fitted together. The jumbled pieces of the unconscious—unacknowledged drives, half-suppressed fears, and sublimated memories—could only be appreciated when they were analyzed and reassembled or when they were decoded from a mysterious end-product like a story or a painting.[11]

So Hoffmann's tale provided Freud with an occasion to argue for his theory that the feeling of the uncanny came not from the odd disjuncture between appearance and reality, as Jentsch thought. Instead, Freud said that the uncanny experience occurs either when repressed infantile complexes (like the fear of castration) have been revived by some impression or when primitive beliefs we think we long ago put behind us suddenly seem to be confirmed. Freud's roundabout conclusions turn on a detail. Hoffmann's protagonist is most unhinged when he discovers his love object prone and partially dismantled with its eyes popped out. If the eyes could be removed so easily from a being that had seemed so alive, Freud reasoned, other sensitive organs must surely be equally vulnerable. Given such unconscious fear of castration, Freud surmised, "it is understandable that so precious an organ as the eye should be guarded by a proportionate dread." The circumstance that gave rise to the uncanny feeling, then, was a variation of a more famous Freudian concept, the "return of the repressed"—in this case, again, a submerged fear of castration that survived from early childhood and then resurfaced. Freud, who confessed he could not at the moment summon a feeling of the uncanny in himself, was at pains to show that no occult forces were at work and that the uncanny held nothing in common with superstitious fear. He explained that "this uncanny is in reality nothing new or alien, but something which is familiar and old-established in the mind and which has become alienated from it only through the process of repression." The world was knowable and "understandable" after all, and could, by rational means, be saved from fright even at its spookiest.[12]

That Old Uneasy Feeling

Having failed to discover the uncanny in his current emotional repertoire, Freud recalled how the feeling of the uncanny crept upon him as he became lost and

disoriented in a misty forest. A similar feeling, he said, occurred when one was caught in a maze of interlocking alleys or when one groped around in a dark room only to circle and return to bump into the same furniture again. It was, in short, the feeling that came with being snared in helpless, disquieting repetition. Freud noted how mirrors are disorienting or unsettling when one tries to correlate movements or contemplates one's own face. It was as if some part of the self had hived off.[13] This inventory of uncanny experiences actually points more surely back to the conflict that Jentsch noted, and as we will shortly see, to more modern explanations. In fact, we can easily add more jarring experiences to Freud's list. Think of transparent Halloween masks, seasonal accessories that allow only blurred, disturbing views of the face beneath. Runway models who are trained to avoid competing with the fashion they display stare with blank, depersonalized, unnerving stares. Twins strike people in many cultures as uncanny. Contortionists whose heads appear detached from their bodies when they bring their feet around to frame their ears will leave an audience with the disturbing impression of decapitation and dismemberment.

Artists, choreographers, and film *auteurs* have discovered how readily evoking a sense of the uncanny grips their audiences. In a succession of canvases painted in the 1910s, the Italian surrealist Gerogio de Cirico offered compelling geometrical landscapes with sinister shadows but empty of human presence.[14] The New York photographer Diane Arbus left a body of disturbing photographs mostly from the 1960s. In stark images made starker by her use of a daylight flash, Arbus served up a grimacing child with a toy hand grenade, a pair of austerely dressed identical twins, and an assortment of stout transvestites, tattooed circus performers, masked revelers, unhappy beach goers, and dejected senior citizens costumed as royalty.[15] Cirque du Soleil's ethereal acrobats and stilt walkers purposefully call out uneasy feelings in their spectators. The acrobats themselves experience a version of what the French theorist Roger Caillois called *ilinx*, a Greek word meaning whirlpool, which he applied to the delicious and precarious sensation of dizziness that players crave in the "attempt to momentarily destroy perception and inflict a kind of voluptuous panic on an otherwise lucid mind."[16] Half-mime and half-somnambulist, they seem dreamy and distracted even though their feats of balance require undivided focus. All these artists—de Cirio, Arbus, and Cirque du Soliel—exploited a species of the uncanny.

Knowing how entertaining it is to observe the odd and the disquieting from the security of a theater seat, film makers have also shrewdly created many memorable uncanny scenarios. In Fritz Lang's *Metropolis* (1927), for example,

an unnerving robot version of the virginal Maria turns evil without a moral soul to guide it. Over the next seventy years, the soulless duplicate would become a staple of the science-fiction film. Most famously, in the classic *The Invasion of the Body Snatchers* (1956), the stand-in pod people are distinguished by their bizarre lack of affect. Stephen King, whose entertaining horror fiction often turns toward the uncanny, noted that Jack Finney (who wrote *The Body Snatchers*—the 1955 novel that inspired the film) often relied on just such an "off-key note" to rouse an "incipient paranoia quite deliberately to manipulate our emotions." The key word here is incipient. Finney well knew how keenly readers anticipate teetering at that fascinating, wobbly point between understanding and uncertainty where familiarity and the alien meet. Readers, like filmgoers, enjoy engaging the suspense, and they expect surprises. They tarry at the edge of play in an intellectual and emotional version of Caillois's *ilinx*—a pleasing vertigo.[17] Finney also knew how far to take his readers without scaring them off; he slyly validated a growing sense of the uncanny and removed his readers another step away by having his troubled characters report on the fears of others. And so Wilma, talking of Betty and her distress over the strange change that has come over her uncle Ira, gives us an almost perfect description of the kind of uncanny feeling we are talking about here: "She says he looks exactly like Uncle Ira—talks like him—acts just like him, everything. She knows it isn't Ira, that's all. Miles, I'm worried sick. . . ."

It is easy to call to mind other examples. In *The Stepford Wives* (1975), husbands threatened by assertive spouses trade in their difficult real-life next-of-kin for eerily perfect robotic duplicates. In Ridley Scott's *Blade Runner* (1981), the beautiful and murderous replicant, Pris, disguises herself as a mechanical doll and lays in wait for Deckard, her assassin.[18] In *The Terminator* (1984), a flesh-and-steel android methodically flays his forearm to expose a faulty mechanism beneath the skin. Though the uncanny is alien, as Freud said, these are instances where the alien arises from the familiar.

If photographers, choreographers, and storytellers have wittingly flirted with the uncanny to hold their audiences spellbound, animators have also blundered past its playful borders. Setting out for delight, animators have wandered into disgust instead. The *Village Voice* critic Michael Atkinson, for instance, denounced one animated bomb, *The Final Fantasy: The Spirits Within* (2001), as a "soulless mimeograph of humanity," and when the *New York Times* reviewer David Gallagher finished watching a much more accomplished *Beowulf* (2007), he still felt "relieved to be back in the company of un-creepy flesh-and-blood

humans again."[19] Misfortunes like these are instructive, however, if one is look-ing for the horizon where pleasure and play begin to drain away.

The animated film *The Polar Express* (2004) presents one of the best op-portunities to observe this process at the margin of play. Based on the award-winning children's Christmas book, the movie was a technical marvel, and the work deserved the Academy Award it received for the new "motion capture" technology that allowed the animated figures to move so fluidly and plausibly. But because the train's conductor, a character voiced by Tom Hanks, looked both too much and not enough like the actor himself, audiences found the presentation disquieting. The film's visual fidelity also failed to extend all the way to the shadings of emotional nuance that facial expressions reveal, and this, too, was disturbing. Audiences were not simply let down aesthetically.

Raised eyebrows and wrinkled foreheads are easy to spot and interpret, but the human ability to perceive nonverbal emotional cues is so much more finely tuned that we can even recognize pupil dilation as a signal of attractiveness, health, and fitness.[20] However sophisticated, the latest animation tools could not capture or replay the slight and subtle details that enable us to distinguish between mirth, delight, indulgence, irony, and many other emotions and states of mind. And as a result, audiences found the characters' expressionless eyes especially unsettling. Kurt Loder, the resident critic for MTV, disparaged the figures as "humanesque" and wrote that "they look like real people dipped in vinyl," as if a "human residue" glinted "creepily beneath the surface."[21] *The Polar Express* failed so miserably at the box office mostly because discomfited audiences encountered an emotional region that has been called "the uncanny valley." Let us explore that terrain.

Exploring the Uncanny Valley

Ernst Jentsch noted the strange feeling that observers experienced when they crossed an emotional frontier, but the Japanese roboticist Mashihiro Mori ex-pressed that boundary more precisely as a mathematical function in a brief but noteworthy article in 1970, in which he coined the term "the uncanny valley." He graphed the phenomenon to describe the relationship of familiarity and similarity in human likenesses and the positive or negative feelings that they engendered. According to Mori, our reaction to robots and other simulacra can be described as a steep curve that peaks in pleasurable appreciation and then
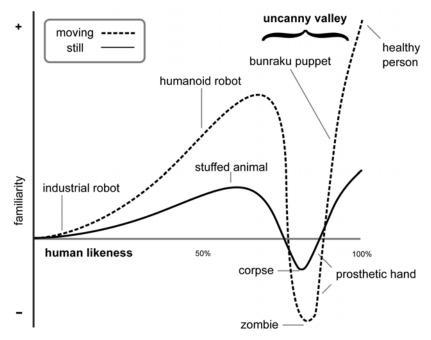
Figure 1. The Uncanny Valley, Mashihiro Mori (1970)

sharply plummets toward alienation. The more like a human a robot appears, the more favorably we are likely to respond, but, again, only to the point at which we begin to notice the small details that are not quite right. Then, according to Mori, we are likely to be deeply repelled and revolted. As the graph of the uncanny valley flattens toward its peak, it depicts Mori's assumption that there is very little distance between the last instance where we still appreciate the robot's clever mimicry and the first dizzying moment we feel betrayed by its imperfections. This is the moment when, like Hoffmann's protagonist, we realize we have been baited and switched. Modern social psychology will see in the reaction a form of dissonance, as if the figure stuck between believability and implausibility had sounded a wrong and sickly note. "You can imagine going to a workplace where there are many mannequins; if a mannequin started to move, you might be shocked. This is a kind of horror," Mori reasonably explained.[22]

Unlike a roomful of mannequins, it is unlikely that an array of industrial robots would give us much worry—machines that weld car bodies, disarm terrorist bombs, or cleverly sweep the living-room carpet still look like machines. A clanking toy robot will look more anthropomorphic, yet it plainly remains a toy.

But Mori, who hoped to avoid the pitfall of the uncanny in designing believable humanoid robots, understood the challenges engineers faced as they began to add capabilities and features that seemed human. The almost-real robot could fail in a number of ways. Disappointing us not just by looking wrong, it could also feel wrong and move inauthentically. For example, Mori noted that if a woman encountered a prosthetic hand in the dark, she might be shocked by its cold, hard, unhuman feel. If a perfect robot could reenact a complex sequence like a laugh—and robots stood on the verge of this capability in 1970—the result would still seem unnatural if the robot could not chuckle and grin at human speed. And in fact, the millions who stood in line to see "Great Moments with Mr. Lincoln" at the Illinois State pavilion at the 1964 New York World's Fair learned the shortcomings of just such an "uncanny appeal."[23] Disney tried to immunize its audio-animatronic figure from criticism by having it deliver a disquisition on liberty assembled from the President's speeches and addresses, and the designers reverently framed the presentation with choirs singing the "Battle Hymn of the Republic." But the figure's masklike expression and clunky gesturing made it unpersuasive. Normally we count on natural movement to authenticate humanity. Mori's 1970 aricle diagnosed the problem this way: "[S]light variations in movement can cause a robot, puppet, or prosthetic hand to tumble down into the uncanny valley." These variations Mori mentions indicate that the uncanny arises here in the departures from the way we expect humans to look, to move, to feel.

Mirror Neurons in the Uncanny Valley
Mori's thought-picture of the uncanny valley helped him visualize a three-dimensional space. In a striking image, he imagines how a living being, having died, plummets through the uncanny valley and comes to rest, cold and still, near the bottom of the gorge where things are least familiar and most disturbing. (Unblinking zombies move in jerky, unnatural, unthinking ways in our imaginations, and so lay near the nadir of Mori's uncanny valley.) And this picture leads him to the second important insight of his paper: Mori wonders if this "feeling of strangeness"—of the uncanny—might be necessary "to our self-preservation." In fact, recent discoveries and speculations in neuroscience suggest that his hunch may be correct because our ability to "impute animacy" is not just helpful in distinguishing sleepers from the dead and robots from people but, over the long haul, may actually have held survival value for us social humans. Our nervous systems have learned to help us avoid others who

look strange or behave oddly. This reasoning is based on discoveries about the remarkable mirror-neuron system of the primate brain that allows us to understand the feelings, motives, and intentions of others by simulating their actions. When we observe others picking up a cup or throwing a football, the same areas that light up in their brains begin to light up in ours. Our ability to distinguish between threats and friendly gestures or to separate healthy from unhealthy states are two obvious dividends of the mirror-neuron system. Mirror neurons may be at the root of empathy. A few other discoveries are crucial for the point here. Mirror-neuron systems help us to assess normal biological movement. Further, it seems likely that our ability to identify normal movement—part of what is called motor cognition—is closely associated with our social cognition. When we perceive that an object is animate, the social networks of our brains activate and we become attuned to its reactions. We can read not just fearfulness or joy on each other's faces, but we can also pucker along with a taster's reaction to a sour lemon or gag sympathetically when observing a swig of sour milk. Our mirror-neuron system predisposes us to be attentive to distaste and disgust in others. That disgust should be so closely related to empathy suggests that a feeling for the uncanny is a protective reaction and a social skill rather than a neurosis to be overcome.[24]

So to return to the problem that intrigued Jentsch and Freud, when it comes to our feelings about androids, why do we sometimes get that sickly feeling, and from what does the sensation help to protect us? The modern answer that comes both from robot engineers and experimental psychologists inclines sharply toward Jentsch's thinking: lifelike but flawed machines do indeed, as Jentsch put it, "cross the boundary between the pathological and the normal," but not for the reason Freud had claimed. In fact, we have begun to learn about the neuroscience of the earliest example of the uncanny that Freud had noticed: déjà vu. Cognitive neuroscientists surmise that this eerie feeling arises as a memory glitch where the present is mistaken for the past. People will experience an interlude of déjà vu when the brain's familiarity circuits in the parahippocampal gyrus (an area located behind the ears that handles encoding memories) switch on by mistake.[25]

Some of Mori's followers have picked up his suggestion that the ability to perceive the uncanny yields survival value. Karl F. MacDorman, a robotics engineer at Japan's Osaka University, speculates that because lifelike machines jar our beliefs about how living things should look and move, they cause a "breach of expectation" that gives rise not merely to the uncertainty and "lack

of orientation" that Jentsch discussed, but to a more fraught perception of a "category disturbance" that blurs the distinction between life and nonlife. This disturbance, in turn, engages a warning system that has evolved to alert us to the danger of contagious disease.

But the issue is more complex. Researchers who asked if attractiveness predicted health found no special correlation. Nevertheless, they also found that potential mates were more likely to select those they thought beautiful. And further investigation revealed that, in areas of the world plagued by high rates of sickness, mate seekers regarded the attractiveness of eligible partners as signs of freedom from disease.

Still, MacDorman's point is both more speculative and more circumspect than this. He maintains that we are troubled in a special way when we see the not-quite-living thing. It is likely that the uncanny is a variety of the unpleasant feelings that arise in connection with "death salience"—notably dread, shock, displeasure, and again, disgust. Recent research into a field of study called "terror management" suggests that our fear of death, too, is a survival mechanism.[26] The idea is that those among our forebears who were not in some measure repelled by death were reckless and less likely to leave numerous descendants. Because the cautious more often survived, fear and avoidance became reasonable and normal.

The Uncanny v. The Adorable

The gothic genre to which Hoffmann's "The Sandman" belongs later expanded to include an assortment of evil, possessed, not-quite-living dolls. Because dolls, of all toys, seem to best exemplify the innocence of child's play, we find it particularly unsettling when they betray those expectations, and authors made good use of the device. These days, possessed dolls appear on television and in film, too, ranging from the sweet-voiced, freckle-faced Talky Tina who gave Telly Savalas what was coming to him in the "Living Doll" episode of television's *Twilight Zone* in 1963 to the nasty Chuckie of horror-film fame who first began wielding an axe in *Child's Play* in 1988. The creators of these works mean to give their audiences chills and thrills. But that a toy should live does not guarantee it will be sinister.

In fact, we can easily call to mind the much-loved animated stuffed animals from children's stories such as *The Velveteen Rabbit*, *The Skin Horse*, *Winnie the*

Pooh, and *Corduroy*. Nursery magic also brought dolls and human figurines to life. On his pilgrim's progress to become a real boy, the marionette Pinocchio did not entirely escape strange circumstances—he began his tale fearfully as a vulnerable talking log amid the sharp saws of the woodcarver's workshop. In the course of the story, his feet are burned off, he is turned into a donkey, and he is hanged. But his ultimate humanization is a happy, family event as Geppetto and the Turquoise Fairy become his father and mother.

Another object-turned-human, the Gingerbread Man, was jolly and not much more trouble than a perky real boy would have been in 1910. The most famous rag doll, Raggedy Ann, first marketed just a year before Freud wrote his essay, calls up no uncanny feelings at all, even though her imperturbable smile persists despite entanglement in laundry wringers, entrapment in drainpipes, and entombment in snowbanks. Many other living dolls are similarly charming, plucky, and sturdy. Rachel Field's *Hitty: Her First Hundred Years* (1929) also features an appealing main character who survives many scrapes. Rumer Godden's *The Doll's House* (1947) gives readers the loveable Tottie, who is proud to be made from the good wood of a strong tree. The animated film *Toy Story* (1995) and its sequel *Toy Story 2* (1999) feature the adventures of Sheriff Woody—a boy's favorite action figure who comes to life with his sidekicks, the spaceman Buzz Lightyear and a wise-cracking Mr. Potato Head. These characters are quirky, silly, and funny, but though whimsical and playful, they are not uncanny.[27]

Stuffed toys and dolls like these seem far removed from the uncanny because they promote active fantasy and set off social scenarios of nurture in children's play. It has long been known that fanaticizing and storytelling are important parts of a child's normal development.[28] At the end of the nineteenth century, the American psychologist of childhood and adolescence, G. Stanley Hall, teamed with his student A. Caswell Ellis to pioneer the study of doll and doll play. Hall's was a psychology of the normal. He noted in the course of their investigation how few baby dolls they discovered among children's playthings.[29] Turn-of-the-century children toted improvised "babies" unlike the manufactured baby dolls we know now, but that rapidly changed as baby dolls became both more common and truer to life.

A cultural change in the favored imagery of childhood opened the gates to a flood of toys that were both realistic and cute. The Kewpies and the Campbell Kids served as cherub-faced and chubby models for the baby dolls of the twentieth century. Cultural historian Gary Cross has called this romantic, com-

mercial, visual genre "the cute." Twentieth-century baby dolls can be listed under another substantivized adjective: "the adorable." Baby Dimples, from the 1920s, is like the blue-eyed and red-lipped doll most of us probably call to mind when we think baby doll. Other dolls of the 1920s, Pat o Pat, Patsy, Baby Evelyn, Lovums, and the Bye-Lo Baby are also designed first to melt the hearts of adults and then to empty their wallets. Sales of the Bye-Lo Baby, introduced in 1924 and eventually very popular, lagged at first, however. One doll historian accounts for its slow start by observing that it may have been "too realistic for some buyers at first look."[30]

Perhaps advertisers sensed that they had something more fundamental to overcome than sales resistance, because for decades to come, advertising, marketing, and design strategies insisted upon equating increasing realism with normality. Advertising for the Tee-Wee Hand Babe of 1928, for example, promised that "the living doll does everything a living baby does." In the following decade, doll manufacturers such as Effanbee Doll Company and Ideal Toys introduced rubber dolls like the Dy-Dee Baby and Betsy Wetsy that could be fed water and afterward wet realistically. A promotional film featuring Ideal's renowned marketer Benjamin Michtom later explained that the company wanted to create "a doll that could do all the things a little girl could do" from a material that "could be put into hot water over and over because babies must take a bath." The advertising copy for Effanbee's Bubbles, from 1926, spoke for all baby doll advertisers when it concluded that this doll was "modeled after an adorable real baby who laughed and cooed all day. No little girl can be cross or unhappy with this doll in her arms."[31] This sentiment squares with Mori's observation that placed dolls far from the rim of the uncanny valley.

And, in fact, no trace of the uncanny surfaced in doll advertising over the next decades even as dolls became more clever and realistic. Indeed, this record runs in the opposite direction as advertisers aggressively linked verisimilitude with warm feelings and sold baby dolls on the strength of the way realistic designs would encourage girls to play at mothering. Shari Lewis, the television puppeteer who helped introduce Tiny Tears in 1950, promised that she was "all new and more wonderful than ever, just like a real baby." The television commercial for Betsy Wetsy (still selling well in 1959) featured the voice of a little girl: "When I grow up, I want to be a mommy." Also in 1959, in a message to toy-store owners, the manufacturers of Playtex Dryper Baby promised that "every little mother will be crowding around your window making a mental note of what she wants for Christmas." Remco's Baby Laugh-A-Lot, introduced

a few years later, played back hearty recorded laughter that encouraged others to laugh along. The ad for Baby Alive, first introduced in 1973, featured a little girl's voice addressing the doll: "I love the way you make me feel, you're so real." In 1977 the commercial for Baby Needs You advised "pick her up, she laughs," and "when her eyes open, she'll cry again." Baby So Real, offered by Irwin in the 1980s, realistically reproduced eye, hair, and skin color, as well as other features associated with national origin. "She's so like you!" the commercial declared in open acknowledgement of the little girl's feelings; "she makes you feel like a real mommy, the little hands and feet are so real."[32]

If at first doll manufacturers simply dyed a baby doll's skin in varying shades of brown to capture an African American market—like Effanbee's Baby Marilee, which appeared in a black version in the mid-1920s and 1930s—over time designers made features more believably African American.[33] Other African American baby dolls included Mattel's Baby Small Talk (1969), Whitman/Shindana's Baby Nancy (1971), Middleton Original's My Own Baby (1994), and Mme. Alexander Lifelike Baby Victoria (1998). In these dolls, realism meant legitimacy, and it was authenticity that sold the dolls. The quest for legitimacy extended to other groups, too. In 2009 Lakeshore Learning's Feels Real Baby Dolls offered a set of baby dolls black, Asian, white, and Latino that retailed for sixty-nine dollars for the set. Advertising copy alerted buyers that the dolls were "remarkably lifelike."[34]

The Nursery of the Uncanny Valley

But how much of the remarkably lifelike can the doll market absorb before a doll nears the rim of the uncanny valley? In 2000 an interactive doll called My Real Baby helped answer this question. Hasbro teamed with iRobot, the company famous for producing the unmanned Roomba vacuum cleaner, to design a doll that ingeniously smiled, cooed, yawned, expressed boredom and delight, and otherwise emulated natural emotional responses as the owner played with it. The doll was truly remarkable. My Real Baby technology had leaped so far beyond the President Lincoln figure of four decades earlier that the two mechanisms seem to belong to different lineages. The sequence of expressions and vocalizations that the team engineered for the prototype of My Real Baby proved so credible during development, in fact, that the chief electrical engineer found himself unthinkingly rushing from his office to find a bottle to soothe the robot-baby's insistent cries. The toy's emotions were not real, needless to say, but the strong emotional responses they triggered surely

were. The team determined that the production doll's realism should be dialed back in order to "let children have the initiative in play patterns so that they could exercise their imaginations."[35]

This gesture toward spontaneous play and "intelligent unpredictability" resulted in a product that amazed all who saw it, but one industry observer asked the hardest relevant question: "Do little girls even *want* their dolls to act so real? That's something the market will sort out." And indeed the market soon did. Hasbro quickly discontinued production. The doll's price tag at nearly one hundred dollars may have contributed to its failure to thrive, and company analysts also blamed factors as diverse as insufficient advertising and the distractions of the concurrent presidential election. It is more likely, however, that My Real Baby in mass production fell short of sales expectations because the doll teetered over the edge of the uncanny valley. Clever animatronic movement and intelligent responses were not of themselves to blame for the doll's failure. After all, the adorable Furby and Tickle Me Elmo—both nonhuman animatronic figures—had recently flourished. Still, something was wrong. Citing this doll's "uncannily human movements," one critic denounced My Real Baby as "a creepy sock-puppet wrapped in a yarn blankie" and the footage the company produced of a six-year-old pretending to nurse the doll as "deeply unsettling."[36]

Not incidentally, a doll that stands at the brink of the uncanny valley will also likely sap play and undermine creativity.[37] Little has changed since G. Stanley Hall's meticulous study from 1896 noted how, for both girls and boys, the barest suggestion of a doll's outline—a pillow tied with string at the middle, for example, or even a bunch of celery, a potato, or a Porterhouse steak—could be "dollified" and would suffice for doll play. "The rudest doll has the advantage of stimulating the imagination by giving it more to do than does the elaborately finished doll," Hall wrote. And the doll play he noted included feeding, naming, dressing, putting to bed, disciplining and teaching, comforting with songs and stories, confiding in and entertaining with poetry, washing, grooming, doctoring and dosing with medicine, executing by hanging and crucifixion, mourning, and burying, and even deifying. An adorable doll, it seems, merits adoration. "A doll microcosm," Hall observed, "opens up a world of relationship so large, and simplifies things so complex as to be otherwise closed to the infant mind."[38] Even the most capable and cunningly programmed machine cannot match the scenarios that children can invent as they play.

Encountering Baby Dolls at Valley's Edge

We have an opportunity to observe some of the most cunningly prepared likenesses—the opposite of Hall's "rudest" doll and "dollified" objects—in the handcrafted "reborn" newborn baby dolls that are now sold under such names as Reborn Baby Celine and Micro Premie. They are more "elaborately finished" than Hall could have imagined. Craft workers alter these dolls by painting in realistic fingernail beds, attaching human hair to the heads and brows, and adding weight to approximate the mass of an infant. Convincing skin effects (such as baby acne and rosacea) and mechanisms that mimic respiration and heartbeat further help to make these dolls so astoundingly true to life that alarmed passersby have dialed 911 when they have seen the dolls lolling in the seats of parked cars.[39]

Remember that Jentsch, Freud, and Mori all assumed that as ordinary and familiar objects, dolls stood outside the uncanny. But is this true? Do dolls receive a special dispensation in this regard? Staff at Strong National Museum of Play in Rochester, New York, pursued the answer to this question for this article by asking more than 120 visitors to the museum, which

Photograph 1. The baby doll on the left, made about 2008 by Euro Berenguet, is designed to look like a newborn infant. The baby doll on the right, manufactured as Sweet Tears in the mid-1960s by the Alexander Doll Company, has idealized facial features.

is noted for its large doll collection, to react to two very different dolls. Staff presented visitors with two dolls—first a classic Mme. Alexander doll from 1965 and then a reborn doll from the Berenguer Company marketed under the name William James.

We should acknowledge that emotional responses are tricky to gauge in any setting, much less in a busy museum. The questionnaire that museum guests completed was more like an opinion-sample than a randomized survey. The visitors did not play with the dolls. Instead, staff showed respondents each doll, and the survey asked them if—given the opportunity—they would choose to play with the doll in question or not. Thus, the survey also could not hope to record feelings of the uncanny that might follow from feeling (or smelling) the artificial skin or holding the unmoving limbs of the dolls, the kind of thing that most fascinated Mashihiro Mori. It would be misleading and presumptuous to claim too much for the responses as psychometrics, and this exercise should not be mistaken for an experiment. Still the results do suggest a rich opportunity for further research. Indeed researchers who could give subjects the opportunity to touch and smell similar dolls might find that they have called out the uncanny more sharply than simple viewing does. In any case, here instead, it is more useful to regard these gathered responses more like the anecdotes and observations that lucky historians find scattered in letters and diaries. Clearly, the respondents included a broad range of visitors from kindergartners to retirees, though most respondents fell closer to the middle of that range. Only a small number of children responded—but they offered some of the strongest opinions. (The text that follows quotes nearly all of them.) Taken together, the opinions and responses demonstrated an instructive consistency that helps us understand where feelings of the uncanny arise. This, in turn, helps us find the horizon where play begins to disappear.

To prompt feelings and reactions, the staff uncovered each doll in turn. After guests had a moment to react, staff asked respondents to mark their responses on a sliding scale between positive and negative or favorable and unfavorable reactions. Each of these questions also allowed visitors to mark a spot in the middle indicating "no opinion."

The first of the questions—How would you describe this doll?—gave participants a range of choices that fell between *Adorable* and *Creepy*. *Sweet*, *Cute*, *Appealing*, *Unpleasant*, and *Eerie* made up the scale between. The next statement looked for feelings that the dolls would inspire: "This doll makes me feel . . ." asking for completion with choices that included *Loving*, *Warm*, *Tender*, *Fond*, *Lukewarm*, *Uneasy*, *Queasy*, and *Troubled*. The third question prompted

respondents to locate the doll on a line running from *Familiar* through *Natural*, *Normal*, *Ordinary*, *Strange*, *Weird*, *Too Real*, and *Eerie* to *Peculiar*. The next question, redundant for good measure, began with "This doll is . . ." and offered choices to complete the sentence that started with "*Just Fine*" and then trailed along to *Nice*, *Good*, *OK*, *Unpleasant*, *Euww!* and *Disturbing*. A fifth question searched for play itself and asked directly for a yes or no answer to the question "Would you play with this doll?" And finally, respondents were invited to write how they reacted to the dolls and to speculate about why they felt as they did. Staff did not pretend that by presenting two dolls that one would act as a control for the other. In fact, they frankly hoped that presenting two dolls to the respondents in sequence, the first cute and cuddly, would enhance the reaction and help gather articulate responses to the second, highly realistic doll that struck us as strange.

The results surprised the staff. The exercise revealed that a high proportion of museum visitors—almost exactly three to one—responded to each of the dolls favorably. For three in four respondents, the baby dolls came nowhere near the uncanny valley, just as Jentch, Freud, and Mori predicted. Exclamation points abounded in the responses. Respondents found that both dolls looked familiar, nice, and "neat!" They said the doll made them feel warm and tender. In several instances, the tenderness was of a "motherly" or "nurturing" character. Further, positive reactions to the Mme. Alexander doll varied little in evocative content. "So sweet!," wrote forty-year-old Stacy S., from Fairport, New York. When asked to complete the sentence "this doll makes me feel . . ." another Fairport resident, Bernadette D., who did not record her age, circled *Loving*, *Warm*, *Tender*, and *Fond*—all the positive descriptors that one line offered. "I love baby dolls," she concluded. Other respondents described the Mme. Alexander doll as "delicate," "cuddly," and "adorable." For several, the doll helped them reminisce about childhood play with sisters. Sixty-nine-year-old Marilyn C. wrote that the doll "brought back memories of the fun I had with my dolls as a child."

Nostalgia, nurture, and realism figured into some of the positive answers for the reborn doll as well, indicating that some had not much differentiated their feelings between the two. Patricia D., a forty-two-year-old woman from Massachusetts, wrote for several others when she said "it reminded me of my babies; I wanted to hold it." David S., a Russian émigré, felt that the doll looked "needy." Young Louisa L., a ten-year-old from Texas, could not fully account for her estimation: "I thought it was the cutest thing. I don't know why I thought

that—maybe because it looks so real." Curators had placed the doll in an infant car seat to make it appear more naturally situated, and just as baby-doll advertisers hoped it might, this striking verisimilitude accounted for the tender feelings of many others who admired the doll's authenticity. Shane M., forty-year-old suburbanite from New York, thought it looked "real in a good way." For Kathy M., a Canadian, the realistic doll represented an educational opportunity: "I'd love it for my daughter—to play and learn!" An adult evidently helped six-year-old Rebecca S.—also from Canada—to write "it looks new!" Several found the doll's "fussy" or "grumpy" expression charming. Sandra W., forty-three, another Rochestererian, summed up the feelings of the large majority of those who responded positively to the doll: "Wow!," she wrote, and added in all capitals, "I LIKE THIS BABY!"

But again, though these people had come to visit a museum famed for its doll collection and were therefore presumably most likely to favor the dolls, more than a quarter found the likenesses of both dolls unsettling. The way they reacted negatively differed, however. Negative reactions to the Mme. Alexander doll sometimes revealed nothing more surprising than gender bias or aesthetic preference. Two boys, ages twelve and sixteen, enticed to respond to the questionnaires by free carousel tokens, plainly disliked dolls in general—one dismissed the doll with a horse's neigh (which he spelled "nieh"). Two women specifically objected to the doll because its pacifier raised a childrearing issue. Nearly half of the negative responses simply noted (as consumers might) that the doll, a museum collections item, was old, used, or old-fashioned. There is no way of telling if, or how, these issues speak to the issue of the uncanny.

But significantly and surprisingly, eleven of those who could not imagine themselves playing with the Mme. Alexander doll did nevertheless describe this cute, cuddly, and adorable doll in sharp language that fits an understanding of the uncanny. To some few, even the adorable seemed creepy. Thirty eight-year-old Denise G., for example, didn't like the eyes; "she [sic] looks like she's really looking at me." Another wrote that it looked "like a doll from a scary movie." A forty-two-year-old man who felt the kind of creeping dread Mori had predicted wrote that the doll "seems cold, not alive." He had entered the uncanny valley. An uneasy seven-year-old Vietnamese American boy wrote: "I reacted weird. I reacted weird because it looked weird." The doll shocked a twenty-five-year-old woman who, literally taken aback, wrote "I took a step back." Two more women wrote that they were so repelled that they would not let their daughters play with the doll. A queasy six-year-old boy visiting from

Canada reported a physical reaction to the doll: "It made me sweaty because I don't want to look at it anymore." He was overtaken by a sense of the uncanny. The responses suggest that advertisers, who for many decades had insisted that realism equaled normality, may have rightly understood that a substantial fraction of potential buyers would react this way and that advertising needed to overcome the inclinations to apprehend the real as the uncanny.

When respondents reacted negatively to the very realistic reborn doll, they often revealed even more explicitly uncanny feelings. The realism, in fact, seemed to focus their sense of the uncanny. Thirty-five-year-old Sarah P., a fence sitter, thought she would play with the doll, but circled *Euww!* and noted, "OMG it looks *so real*." Her own mixed feelings fascinated thirty-nine-year-old Erin L. She wanted to play with the doll, but she also found it "too real" and thought it looked "disturbed." The rest of the negative responders could not imagine playing with the doll at all, and language that indicates their unease, shock, dread, and even disgust often surfaced.

Thirty-two-year-old Brandy S., from Sydenham, Ontario, for example, thought the doll was eerie, and wrote simply, "yikes!" The doll troubled Jody M., from Palmyra, New York, "Lifelike babies should look happier," she advised. Emily D., seven, from Massachusetts, recorded that the doll looked "sorta weird to me." The doll bothered twelve-year-old Marshall too, and he circled every negative word but *Unpleasant.* The oddity of the doll crept up on several others. Terrance F., who declined to specify his age, believed the doll "looked like an experiment." The doll struck thirty-five-year-old Natasha O. from Syracuse, New York, in a similar way. To her it also looked vaguely medical, like "something they would use to teach sex-ed to teenagers." Kristen G., a Canadian aged thirty-four, marked the doll as *Strange,* adding that it was "odd looking," and "kind of creepy." An anonymous respondent, too disgusted to leave a name, wrote that the figure looked "sick" and "not well." Jessica C., a nine-year-old Chinese American girl, described the experience of comparing the first cuddly baby doll to the second realistic one: "it felt strange because . . . I saw a cute doll, then I turn around and see this doll and it was a huge difference because of the face." Jessica found the true-to-life doll *Disturbing.* Twenty-four-year-old Andrew appreciated the attention to realism, especially the faithfully reproduced hair but "like the statues in a wax museum, something about it makes it creepy." The doll led sixty-year-old Judith A. to circle *Uneasy,* and its realism accounted for her uneasiness. "I thought it was a real baby," she wrote. The doll troubled Darlene G., sixty-

seven-years-old and from Rochester. "It is too close to being real," she wrote, "almost like a deceased baby." The fixed quality of the eyes disturbed several more, a connection to the uncanny that Jentsch and Freud had also noted. Thirty-four-year-old Kari P., from Brockport, New York, wrote that the doll is "unsuitable for play." Richard B, a sixty-one-year-old African American from Rochester, marked the doll "unappealing," and summed up his position emphatically with one word and two exclamation points: "Cyborg!!"

Though Jentsch, Freud, and Mori held that dolls lay outside the uncanny, negative reactions to the two toys, one that was conventionally cuddly, the other that was uncannily lifelike, help us see that, however varied (or even ambiguous) play can be, individuals dependably find play inconsistent with unease, shock, dread, and disgust. Novelists, pictorial artists, performers, photographers, and film animators show us how play teeters at the edge of the uncanny valley as we tease ourselves with mock horror, controlled risk, and temporary discomfort. But play stops as the pleasant, the secure, and the comforting drops away. We can observe the end of play here at the edge of the uncanny valley.

A Final Twist

Human emotions are notoriously protean and adaptable, and they may even be erratic. Notions of play, too, can change over time. Gladiatorial contests in ancient Rome, bearbaiting and cockshying in the Elizabethan era, and bullfighting in modern Spain offer familiar examples of once-amusing and surprising contests that now deeply offend or disturb modern sensibilities. In contemporary America, dodge ball (once a gym-class standard) is rapidly disappearing as critics see the contest not as fun but as a form of bullying.[40] But it works the other way, too, and some things we find pleasant or playful once seemed odd.

As it happens, this proposition—that exposure and habituation to the strange and uncanny lessens its creepiness—is testable. Recent research has revealed that the uncanny valley may be bridged by familiarity and by cultural preference. Japanese researchers, who (with Photoshop techniques) weirdly altered and morphed the eyes in photographs of faces, found that their subjects were surprisingly tolerant of the change. They speculated that exaggerated cartoon faces from the popular anime and manga comics had conditioned their subjects to accept eyes that had been separated and enlarged monstrously.[41] These people adjusted to bulging, insectlike eyes the way we, over the years, have found ourselves fully comfortable with windup automata. In both cases, monstrosity and oddity gave way to a fascination with the cute. So, it is not

with increasing perfection and greater verisimilitude that the uncanny object ceases to unnerve us as Mori imagined it would. It is rather with greater familiarity and conversance that we adjust.

Anticipation replaces fear in time, surprise replaces shock, pleasure replaces queasiness, and soon players exchange confusion for a familiar understanding. Play hovers at this edge as we substitute a psychology of the normal for pathology. We look forward to jokes that disorient us and breach our expectations, for example.[42] But they remain jokes by avoiding fear, shock, and unease and by framing the sense of uncertainty and immanence with positive emotions—anticipation, surprise, and the pleasure of a punch line. And so it also goes with anime faces and the movements of automata. With exposure, even the uncanny can be incorporated into play. But at that point, of course, as players nimbly vault the chasm, it has ceased to be felt as uncanny.

NOTES

1. See, for example, Gregory Bateson, "Play and Paradigm," *The Association for the Anthropological Study of Play Newsletter* 4 (1977): 2–8; Patrick Bateson, "The Role of Play in the Evolution of Great Apes and Humans," in *The Nature of Play: Great Apes and Humans*, ed. Anthony D. Pellegrini and Peter K. Smith (2004), 13–14; Frank A. Beach, "Current Concepts of Play in Animals," *The American Naturalist* 79 (1945): 539; Gordon M. Burghardt, *The Genesis of Animal Play: Testing the Limits* (2005), 9; Roger Caillois, *Man, Play, and Games*, trans. Meyer Barash (2001, first published 1958), 3–6; Mihaly Csikszentmihalyi, "Play and Intrinsic Rewards," *Journal of Humanistic Psychology* 15 (1975): 41–63; Robert Fagen, "Selective and Evolutionary Aspects of Animal Play," *The American Naturalist* 108 (1974): 850–58; Robert Fagen, *Animal Play Behavior* (1981): 42–51, 500–4; Karl Groos, *The Play of Man*, trans. Elizabeth L. Baldwin (1912, first published 1901), 1; Bernd Heinrich and Rachel Smolker, "Play in Common Ravens (*Corvus corax*)," in *Animal Play: Evolutionary, Comparative, and Ecological Perspectives*, ed. Marc Bekoff and John Byers (1998), 29; Thomas S. Henricks, *Play Reconsidered: Sociological Perspectives on Human Expression* (2006); Robyn M. Holmes, "Parental Notions about Their Children's Playfulness and Children's Notions of Play in the United States and Hong Kong," in *Theory In Context and Out*, Play and Culture Studies, vol. 3, ed. Stuart Reifel (2001), 306–7; Johan Huizinga, *Homo Ludens: A Study of the Play Element in Culture*, trans. Karl Mannheim (1998, repr. of 1949 ed., first published 1938), 1–2, 7, 14, 28–29; Anna K. Nardo, *The Ludic Self in Seventeenth-Century English Literature* (1991), 10–11; Peter K. Smith, "Play, Ethology, and Education: A Personal Account," in *The Future of Play Theory: A Multidisciplinary Inquiry into the Contributions of Brian Sutton-*

Smith, ed. Anthony D. Pellegrini (1995), 14–15; William John Smith, *The Behavior of Communicating: An Ethological Approach* (1977), 147.

2. Brian Sutton-Smith, *The Ambiguity of Play* (2001, first published 1997), 1.

3. Anneleen Masschelein, "A Homeless Concept: Shapes of the Uncanny in Twentieth-Century Theory and Culture," *Image and Narrative: The Online Magazine of Visual Narrative*, January 2003, http://www.imageandnarrative.be/uncanny/uncanny .htm.

4. Jan J. Koenderink, Andrea J. van Doorn, Astrid M. L, Kappers, and James T. Todd, "Pointing Out of the Picture," *Perception* 33 (2004): 513.

5. Ernst Jentsch, "On the Psychology of the Uncanny," *Angelaki: Journal of the Theoretical Humanities* 2 (1997, first published 1906): 7–16. Additional quotes of Jentsch also come from his article on the uncanny.

6. Paul Metzner, *Crescendo of the Virtuoso: Spectacle, Skill, and Self-Promotion in Paris during the Age of Revolution* (1998), 174–75; Silvio A. Bedini, "The Role of Automata in the History of Technology," *Technology and Culture* 5 (1964): 24–42.

7. See, for example, Horace Walpole, *The Castle of Otranto* (1996, first published 1764), 23; Mary Wollstonecraft Shelley, *Frankenstein, or The Modern Prometheus* (1818), ix; John William Polidori, "The Vampyre: A Tale," *New Monthly Magazine* (1819), http:// www.gutenberg.org/etext/6087; Thomas De Quincey, "Confessions of an English Opium-Eater," *London Magazine* 4 (1821): 353–79; Edgar Allen Poe, "Life in Death," *Graham's Magazine* 20 (1842): 201–2; Bram Stoker, *Dracula* (1897), 12–13, 81; Karl Marx and Friedrich Engels (1848) *The Communist Manifesto* repr. (1971), 55.

8. E.T.A. Hoffmann, "Automata," *The Best Tales of Hoffmann* (New York: 1967), 81.

9. Sigmund Freud, *The Psychopathology of Everyday Life*, trans. Anthea Bell (2002, first published 1901), 250.

10. Sigmund Freud, "The Uncanny," in *The Standard Edition of the Complete Psychological Works of Sigmund Freud*, Vol. XVII, trans. James Strachey (1955, first published 1919), 217–56; Peter Gay, *Freud: A Life for Our Time* (1998), 703.

11. Sigmund Freud, *Leonardo da Vinci and a Memory of his Childhood*, trans. Alan Tyson (1989, repr. of 1963 ed., first published 1910), 73–74; Sigmund Freud, *The Psychopathology of Everyday Life*, trans. James Strachey (1989, repr. of 1960 ed., first published 1901), 14.

12. Freud, "The Uncanny," *Standard Edition,* 231, 240–43; Philip Rieff, *Freud: The Mind of the Moralist*, 3rd ed. (1979), 125.

13. Bernard Rubin, "Freud and Hoffmann: 'The Sandman,'" in *Introducing Psychoanalytic Theory*, ed. Sander L. Gilman (1982), 206.

14. Celia Rabinovitch, *Surrealism and the Sacred: Power, Eros, and the Occult in Modern Art* (2004, first published 2002), 150–53.

15. Patricia Bosworth, *Diane Arbus: A Biography* (2005, first published 1984), 235.

16. Caillois, *Man, Play, and Games,* 24, 44, 97. Caillois supposed that the pleasures of voluntary vertigo diminished with age (and declined as civilizations advanced, too), but it is more likely that fiction and film help *ilinx* assume a less physical form as vestibular-system aging otherwise makes spinning and whirling disagreeable. See also Stuart Brown,

Play: How It Shapes the Brain, Opens the Imagination, and Invigorates the Soul (2009), 84–85, 152.

17. Mihaly Csikszentmihalyi, *Creativity: Flow and the Psychology of Discovery and Invention* (1996), 44, 77, 101; Mihaly Csikszentmihalyi, *Flow: The Psychology of Optimal Experience* (1990), 60; Antonio Damasio, *The Feeling of What Happens: Body and Emotion in the Making of Consciousness* (1999), 52.

18. Stephen King, *Danse Macabre* (1981), 312; Jack Finney, *The Body Snatchers* (1998, first published 1955), 20–22; Paul M. Sammon, *Future Noir: The Making of Blade Runner* (1996), 121–22.

19. Michael Atkinson, "Abuse Your Illusion," *The Village Voice*, July 17, 2001, http://www.villagevoice.com/2001–07–17/film/abuse-your-illusion/1; David F. Gallagher, "Digital Actors in *Beowulf* Are Just Uncanny," *New York Times*, November 14, 2007, http://bits.blogs.nytimes.com/2007/11/14/digital-actors-in-beowulf-are-just-uncanny/; Peter Plantec, "Crossing the Great Uncanny Valley," *VFXWorld*, December 19, 2007, http://vfxworld.com/?atype=articles&id=3494.

20. Kathryn E. Demos, William M. Kelley, Sophia L. Ryan, F. Caroline Davis, and Paul J. Whelan, "Human Amygdala Sensitivity to the Pupil Size of Others," *Cerebral Cortex* 18 (2008): 2729–34; Laura K. Guerrero and Kory Floyd, *Nonverbal Communication in Close Relationships* (2006), 75; Eckhard H. Hess and James M. Polt, "Pupil Size as Related to Interest Value of Visual Stimuli," *Science* 132 (1960): 349–50.

21. Kurt Loder, "*The Polar Express* is All Too Human," MTV, November 10, 2004, http://www.mtv.com/movies/news/articles/1493616/11102004/story.jhtml; Chris Van Allsburg, *The Polar Express* (1985).

22. Mashihiro Mori, "The Uncanny Valley," trans. Karl F. MacDorman and Takashi Minato, *Energy* 7 (1970): 33–35.

23. J. P. Telotte, *The Mouse Machine: Disney and Technology* (2008), 122–23; Nigel Rothfels, *Representing Animals* (2002), 171.

24. Thalia Wheatley, Shawn C. Milleville, and Alex Martin, "Understanding Animate Agents: Distinct Roles for the Social Network and Mirror System," *Psychological Science* 18 (2007): 469–74; Mbemba Jabbi, Marte Swart, and Christian Keysers, "Empathy for Positive and Negative Emotions in the Gustatory Cortex," *Neuroimage* 34 (2007): 1744–53; Christian Keysers and Valeria Gazzola, "Towards a Unifying Neural Theory of Social Cognition," *Progress in Brain Research* 156 (2006): 379–401.

25. Akira O'Connor and Christopher Moulin, "The Persistence of Erroneous Familiarity in an Epileptic Male: Challenging Perceptual Theories of Déjà Vu Activation," *Brain and Cognition* 68 (2008): 144–47; Akira O'Connor and Christopher Moulin, "Normal Patterns of Déjà Experience in a Healthy, Blind Male: Challenging Optical Pathway Delay Theory," *Brain and Cognition* 62 (2006): 246–49.

26. Karl F. MacDorman, "Androids as an Experimental Apparatus: Why Is There an Uncanny Valley and Can We Exploit It?" Toward Social Mechanisms of Android Science, http://www.androidscience.com/proceedings2005/MacDormanCogSci2005AS.pdf; S. Michael Kalick, Leslie A. Zebrowitz, Judith H. Langlois, and Robert M. Johnson, "Does Human Facial Attractiveness Honestly Advertise Health?" *Psychological Science*

9 (1998) 10–11; Stephen W. Gangestad and David M. Buss, "Pathogen Prevalence and Human Mate Preferences," *Ethology and Sociobiology* 14 (1993): 89.

27. Carlo Collodi, *The Story of a Puppet, or The Adventures of Pinocchio*, trans. Mary Alice Murray (1892); George Haven Putnam and Robert Gaston Herbert, *The Little Gingerbread Man* (1910); Johnny Gruelle, *Raggedy Ann Stories* (1918); Margery Williams Bianco, *The Skin Horse* (1927); Johnny Gruelle, *Marcella Stories* (1929); Rumer Godden, *The Doll's House* (1948, first published 1947); Lynne Reid Banks, *The Indian in the Cupboard* (1980); Don Freeman, *Corduroy: 40th Anniversary Edition* (2008).

28. See, for example, Jerome L. Singer, *The Inner World of Daydreaming* (1966), 101–22; Eric Klinger, *Structure and Functions of Fantasy* (1971), 17–48; Vivian Gussin Paley, *The Boy Who Would Be a Helicopter: The Uses of Storytelling in the Classroom* (1990), 1–12; and R. Keith Sawyer, "Play as Improvisational Rehearsal: Multiple Levels of Analysis in Children's Play," in *Children in Play, Story, and School*, ed. Artin Göncü and Elisa L Klein (2001), 19–38.

29. A. Caswell Ellis and G. Stanley Hall, "A Study of Dolls," in *Aspects of Child Life and Education*, G. Stanley Hall (1921, first published 1907), 165.

30. Jan Foulke, "Young Baby Dolls," *Doll Reader* 11 (1983): 75.

31. Gary S. Cross, *The Cute and the Cool: Wondrous Innocence and Modern American Children's Culture* (2004), 44–47; "Tee-Wee Hand Babe, Sensational Beyond Compare," *Playthings* (1928): 46; John Clendenien and Janet Clendenien, "The Babies," *Doll News* (1982): 37–42; Miriam Formanek-Brunell, *Made to Play House: Dolls and the Commercialization of American Girlhood, 1830–1930* (1993), 124–30; Gary S. Cross, *Kids' Stuff: Toys and the Changing World of American Childhood* (1999, first published 1997), 77.

32. Many of the original television commercials and industry films are accessible and featured in full as videos on YouTube; see for example Shari Lewis and Lamb Chop promote Tiny Tears from American Toys at http://www.youtube.com/watch?v=lsa07ilO2cQ; and Remco's Baby Laugh-a-Lot appears at http://www.youtube.com/watch?v=VYSGVvA4ojE; and Baby Alive at http://www.youtube.com/watch?v=HA8RsYEr_J8; Benjamin Michtom explained why Betsy Wetsy was made to look realistic and the manufacturing process that made that realism possible in http://www.youtube.com/watch?v=Mb6QuMZ5OCc&feature=related.

33. Magda Byfield, "Realistic Baby Dolls," *Doll Reader* 7 (1978–1979): 8–9.

34. Feels Real Baby Dolls at Lakeshore Learning Materials at http://www.lakeshorelearning.com/seo/ca%7CproductSubCat~~p%7C2534374302095552~~f%7C/Assortments/Lakeshore/ShopByCategory/dramaticplay/dollplay.jsp.

35. Rodney Brooks, *Flesh and Machines: How Robots Will Change Us* (2002), 112, 157–58.

36. David Hanson, Daniela Rus, Steven Canvin, and Gernot Schmierer, "Biologically Inspired Robotic Applications," in *Biologically Inspired Intelligent Robots,* Yoseph Bar-Cohen and Cynthia Breazeal (2003), 305; "Hasbro's MY REAL BABY Arrives at Retail: Facial and Emotive Expressions Make MY REAL BABY the Most Realistic Baby Doll," *Business Wire* (2000), http://findarticles.com/p/articles/mi_m0EIN/is_2000_Nov_20/ai_67166486 ; Erik Davis, "Congratulations, It's a Bot," *Wired* (September 8,

2000), http://www.wired.com/wired/archive/8.09/robobaby_pr.html; David Schmader, "Last Days," *The Stranger* (December 21, 2000), http://www.thestranger.com/seattle/Content?oid=5960.

37. See, for example, Anthony D. Pellegrini and David F. Bjorklund, *Applied Child Study: A Developmental Approach* (1998), 32–33; Dorothy G. Singer and Jerome L. Singer, *The House of Make-Believe: Children's Play and the Developing Imagination* (1990),11–18; Jeffrey L. Dansky, "Make-Believe: A Mediator of the Relationship between Play and Associative Fluency," *Child Development* 51 (1980): 576–79.

38. Hall, *Study of Dolls*, 162, 190.

39. Lisa Nocks, *The Robot: The Life Story of a Technology* (2007), 156; Glenis Green, "Frantic Rescue Effort Saves Doll, Not Baby," *The Courier-Mail* (Queensland), July 15, 2008, http://www.news.com.au/story/0,23599,24019578–1248,00.html; Nancy J. White, "Are These Baby Dolls Cute or Creepy?," *Toronto Star*, November 25, 2008, http://www.parentcentral.ca/parent/article/542819.

40. Thomas S. Henricks, *Disputed Pleasures: Sport and Society in Preindustrial England* (1991), 15–16; Ernest Hemingway, *Death in the Afternoon* (1996, first published 1932), 5–6; Christina Hoff Sommers and Sally L. Satel, *One Nation Under Therapy: How the Helping Culture Is Eroding Self-Reliance* (2005), 12–13; Sandy Coleman, "A Dodgy Issue Traditional Phys-Ed Activity Sparks Debate in Schools across the Nation," *Boston Globe*, March 29, 2001, B1.

41. Ruth S. Nagayama, "The Uncanny Valley: Effect of Realism on the Impression of Artificial Human Faces," *Presence* 16 (2007): 349; Kathy Merlock Jackson, "Hello Kitty in America," in *The Japanification of Children's Popular Culture*, ed. Mark L. West (2009), 27–33; Malena Watrous "Hello Kitties," *Salon*, March 8, 2000, http://archive.salon.com/people/feature/2000/03/08/kogaru/index.html.

42. Elliott Oring, *Jokes and their Relations* (1992), 25.