MA Major Research Paper

Robo Ludens:
Conceptualizing Robots as Playmates and Playthings

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Abstract

In the twenty-first century, socially proficient robots are entering homes, hospitals, and businesses for the first time. Contrary to the aspirations of roboticists, the average person has greeted these autonomous machines with skepticism and anxiety rather than futurist enthusiasm. This paper proposes that these tumultuous early human-robot interactions can be eased by acknowledging an unsung ancestor of these machines: the toy. Common dolls and action figures share the caricatured form and synthetic components of robots yet have routinely been embraced as cherished objects and companions. A critical analysis of toys and the general concept of play consequently offers a template to improve the design and ease the acceptance of these intimidating new automata. This analysis begins with an historical review of how icons of the human form have been conceived of in ancient ritual, modern childhood, and science fiction. The latter half of the paper advocates an embrace of the latent toy-like qualities of robots in order to better human-robot interaction using methods drawn from the fields of cultural anthropology and play theory. These methods are grounded by the author's own practical experiences operating the NAO robot developed by Aldebaran Robotics in a research setting. The robot-as-toy metaphor forwarded throughout this paper is tentatively offered as an alternative perspective to the engineering-based solutions that often dominate the field of robotics.

I. Introduction

The concept of the robot is not novel to this era. The idea of a mechanical being dates back to the Enlightenment, where inventors such as Jacques de Vaucanson tinkered with clockwork automata and philosophers such as René Descartes conceived of the living body as nothing more than a mechanism governed by electrical impulses. However, the term “robot” was not coined in its modern sense until 1920 at the pen of Czechoslovak playwright Karel Čapek (Levy 2). Čapek reinvented the word, which had previously referred to a system of serfdom perpetuated in Austria (“robot, n.1.”), through the popularity of his play *Rossum's Universal Robots* – the premise of which tells a now familiar fable. Several decades into the future, the titular Rossum's Universal Robots corporation specializes in “[t]he manufacture of artificial people” (Levy 3). These robots are designed to work in mining, factory labour, and other vocations deemed too menial or dangerous for modern citizens, a purpose recalling both the word's Austrian lineage as well as the parallel Czech term *robota*, broadly translating to “forced labour” in English (2). Although Čapek's automata were merely human actors in lavish silver costumes, the playwright defined the modern archetype of the robot: a machine resembling a human being in appearance and labouring for the benefit of a human master.

Despite the century-spanning legacy of robots, it is only recently that such machines have appeared in everyday life. It is true that industrial robots were a driving force behind reductions in factory personnel in the 1960s and 1970s and that American military drones have monopolized newspaper headlines over the past decade. However, in each of these instances, robots have been secluded from the general populace – whether in the sterility of the assembly line or the ambiguous geography of a foreign battlefield. As a consequence, the average person's practical experiences with autonomous technologies have been limited to digital appliances, smart phones, interactive toys, and other subtle reconfigurations of familiar products. The domestic presence of true robots in the twenty-first century has only been ushered in by socially assistive robots, humanoid automata that "provide assistance to human users" through both physical and social interaction (Feil-Seifer & Matarić 465). Unlike Čapek's scenario, where a handful of human beings supervised the work of thousands of robots, socially assistive robots are intended to enter schools, hospitals, and homes to assist human beings one-on-one. A few noteworthy examples include the ASIMO, capable of guiding people through complex environments; the TUG, used to deliver clinical supplies to hospital patients; and the NAO, designed to play games with children in a classroom setting. Collectively, these socially assistive robots represent the first mass migration of machines emulating both human form and proficiency from the assembly line to the domestic sphere.

Contrary to the optimism of roboticists, there has been an underlying human hesitance in welcoming this migration. Technology theorist Kazuhiro Taniguchi et al. note that engineers have long envisioned a gilded future akin to cartoons such as *Astro Boy* and *The Jetsons*, where robots have "human-like social skills" and physical capabilities that allow them to live alongside the average person without difficulty (141). However, the robots of the early twenty-first century are "quite different from these fictional creations" (141). They often stumble and fall when attempting to navigate human dwellings; speak in unconvincing and uncaring monotone; and struggle to demonstrate a degree of artificial intelligence that would permit them to pass Alan Turing's eponymous test. Furthermore, individuals approach these primordial human-robot interactions encumbered by various negative cultural biases against machines that impersonate the human form. These biases are inflected by general anxieties towards technology as well as religious belief and superstition – not to mention images of robots in modern science fiction films that are distinctly less candy-coated than the Saturday morning antics of *Astro Boy* (Nomura et al. 275). Although engineers have designed socially assistive robots solely for the betterment of humankind, entrenched expectations of, and biases towards, these alien automata cause the average person to harbour reservations about accepting their aid.

However, a means of improving these early human-robot interactions can be found in a quintessential feature of childhood: the toy. Although robots have only recently entered everyday lives, playful icons of the human form such as dolls and action figures have long preceded their arrival. During the Edo period (1603-1868) in Japanese history, centuries prior to the stage debut of *Rossum's Universal Robots,* small spring-loaded dolls known as *karakuri* were built to playfully ferry tea cups between a host and their guest (Levy 5). By the 1830s, European toy makers were constructing tiny cherubic beings equipped with clockwork gears that allowed them not only to walk but also to "eat, drink, dance, breathe, and swim" (5). Some of the first speaking machines were in fact Thomas Edison's dolls, which hid miniaturized versions of the inventor's phonograph in their pepper-pot chests (Wood 143). By the 1970s, when true robots were little more than disembodied steel arms occupying factories, colourful plastic automata that regurgitated sparks and transformed into planes monopolized the shelves of Japanese toy stores (Mori 98). Finally, during the 1990s – when the introduction of socially assistive robots into homes was still a pipe dream – doting virtual pets such as the Tamagotchi and Furby spurred Yuletide mayhem as frantic parents raced to adopt them. These elaborate playthings, while seemingly inconsequential tokens of childhood, represent the average person's first encounter with entities that imitate the human form, whether through childlike appearance, mimetic sound, or bipedal locomotion.

This likening of automata to playthings provides an invaluable template for improving human-robot interaction. Unlike robots, who instill anxiety and confusion in human beings, these miniaturized icons of the human form are often cherished as intimate and enduring belongings. Children eagerly welcome dolls and plush toys into their bedrooms, coddle them to sleep, engage in involved conversations with them, and treasure them long into adulthood. As noted by Granville Hall and Alexander Ellis, human beings are possessed of an inexplicable “animistic fancy” towards their favourite toys, causing them to treat these items as “sentient thing[s]” (8). Although humanoid robots often share the plastic frame and caricatured form of these childhood items, these machines have struggled to duplicate the miraculous affinity felt towards them. Retracing the playful lineage of robotics could provide clues as to why this disconnect occurs and how to resolve it. A historical analysis of dolls and other icons of the human form will be undertaken to this end, bolstered by an extended literature review of childhood psychology and sociology studies investigating the complex relationships individuals have with these items.

This re-appraisal of the robot as both playmate and plaything furthermore permits the established disciplines of cultural anthropology and play theory to be leveraged within the field of robotics. These disciplines bring alternate design perspectives to a field that is perhaps encumbered by tunnel vision toward strictly engineering-based solutions. Within this new vision of the robot, concepts such as Johan Huizinga's magic circle and Mihaly Csikszentmihalyi's flow state – both indispensable for the evaluation of social encounters between human actors – can be employed to rethink the manner in which robots are designed and programmed to behave. This approach will be anchored by accounts of my own experiences as a member of the "Studying Autism Through the NAO Robot" project at Ryerson University. The aim of this project was to observe the communication skills of children with autism spectrum disorder using the NAO robot developed by Aldebaran Robotics. Although ethical considerations limit disclosure of my field observations solely to robot functionality and behaviour, my experiences handling this commonly used socially assistive robot provide a means of framing theory within tangible hardware and software considerations.

The merit of the robot-as-toy hypothesis will be tested through a synthesis of these diverse research methods, spanning six major topics: the often uncanny perception of iconic representations of the human form; the propensity of playthings to subvert this uncanny pitfall; the success of virtual pets in blending toy-like affinity with technology; the formal framing of human-robot interaction within play theory; the use of a video game-based framework to improve these interactions; and the design of playful behaviours to mitigate the repercussions of malfunction. It is not the intent of this paper to posit that the comparison of robots to playthings is the definitive methodology for evaluating human-robot interaction; however, I will suggest that when looking for inspiration towards the design of automata for the homes, schools, and hospitals of the future, engineers may need only to look back to their own childhoods.

II. Vaucanson's Monster: The Uncanny Aura of Human Icons

It is telling that Karel Čapek's play *Rossum's Universal Robots* culminates in a robot uprising. Having grown weary of their indentured servitude and treatment as household appliances, the robots collectively and violently revolt, leading to the near-extinction of the human race. Radius, one of countless robot servitors, utters the final line of the third act while vaulted on the precipice of a balcony, adopting a Vaticanian stature. "Robots of the world," he decries, "The power of man has fallen! A new world has arisen: the Rule of the Robots! March!" (88). A "thunderous tramping of thousands of feet" is heard (89) as both the legacy of mankind and the curtain of the proscenium fall.

The ambition to develop automata that serve human beings as unquestioning and untiring servants has always been tempered by this Čapekian fear, a suspicion that the mechanical eidola conjured in equal parts from human ingenuity and hedonism might one day cast off their shackles and usurp their creators. Western popular culture of the twentieth century is particularly encumbered by these premonitions. Literary scholar and media historian Ron Tanner notes that American movies often denigrate the progressive technological leaps made during the Industrial Revolution and subsequent digital age through "nightmarish visions of a technology gone mad" (127). Scenes of "robots running amok" constitute many of the formative science fiction works of the modern era (127): a robot disguised as a beautiful woman is employed to deceive subaltern workers in the industrial factory that backdrops Fritz Lang's *Metropolis*; Harrison Ford, clad in the drapery of a hard-boiled film noir detective, chews cigarettes and chases down rogue androids in *Blade Runner*; the battle against the machines has already been lost to silicon doppelgangers in *The Terminator*; and in the climax of *Ex Machina*, the mesmerizing robot Ava slays her creator and infiltrates human society. Contrary to the Victorian era master-servant relationship roboticists have long aspired for, these works of fiction unanimously imbue robots with the "will to deceive and revolt" (133) against their creators.

A broad modernist narrative collectively underpins these fictional examples. In her book *Living Dolls*, author Gaby Wood details that the fear of machines replacing human beings traces as far back in history as the eighteenth century. She relates the life of Jacques de Vaucanson, a French inventor and artist who gained renown among kings and scientists alike for perfecting a clockwork automaton that was able to the play the flute (15). Although Vaucanson's flute player was little more than a high-society spectacle powered by fireplace bellows, the inventor was commissioned by Louis XV in 1741 to use his technological acumen to revolutionize the manufacture of silk in the kingdom (37). The result was the automated loom, one of the first devices that could emulate the trained capabilities of a human artisan. Wood points out that by perfecting his loom, Vaucanson "played a significant role in the widespread replacement of men with their artificial counterparts" (37). This simple invention kindled the flames of the Industrial Revolution, an era marked by the devaluation of labourers in favour of machines. Pertinently, although he received various accolades from his patron Louis XV, Vaucanson found himself demonized by the weavers of Lyon (38). Whenever he showed his face in public, the inventor was pelted by salvos of stones and insults hurled by craftsmen who maintained that "their skills were needed, that no machine could replace them" (38). This scene has been restaged countless times in the two centuries since Vaucanson's death, from the righteous picketing of automotive workers who have been cast out by unyielding mechanical arms to the less celebrated discarding of telephone operators and marketers in exchange for auto-dialing computers.

Tanner emphasizes that outrage at this forfeiture of human elbow grease for rigid automation exceeds simple resentment at the loss of one's livelihood. He elaborates that the "dog-eat-dog credo of Western capitalism" in fact indentures modern citizens to perpetual rivalry with their neighbours and co-workers for pay cheques and parcels of land (134). The true problem lies in the absence of a soul beneath the blinking lights and whirring servos of these mechanical competitors. It is not simply that humanity cannot match pace with these advanced machines, it is that "we can't even reason with them" (134). As progress marches on in the West, individuals are haunted by a looming fear of the "too-brainy computer" that not only eradicates jobs but also responds to human entreaties with a monotone missive of "does not compute" (134). As the character Hallemeier in *Rossum's Universal Robots* laments, "Robot's don't love. Not even themselves" (23).

This speculative fear has recently trickled down to reality. In 2015 an international coalition of activists, experts, and academics founded the Campaign to Stop Killer Robots, a movement calling for a United Nations ban on lethal autonomous weapons systems (LAWS) such as unmanned drones (Harris). Steve Groves, a political consultant and opponent of the campaign, argues the advantages of deploying such machines on the battlefield: "They don't get scared. They don't get mad. They don't respond to a situation with rage." Although Groves' intent was to highlight the efficiency of LAWS, he unwittingly conjures the quintessential Čapekian narrative that has haunted inventions such as the automated loom and autonomous drone throughout history. As campaign forerunner Alex Neve punctuates, the domination of a living being by an unfeeling machine is an "ultimate indignity."

However, distrust of robots extends even further back in history than Vaucanson's dabblings in the French court. Effigies, statues, and other artifacts mimicking the human form have in fact been regarded with unease across the ages. Semiotician Marcel Danesi notes that such items have often served as vessels for animism, the belief that “spirits either inhabit or communicate with humans through material objects” (207). The most powerful of these items, known as fetishes or idols, were modeled after deified entities or sacral figureheads in order to draw on the spiritual power of these venerated beings (207). French historian Philippe Ariès relates that clay, wood, or stone idols of this ilk are found in “wellnigh industrial quantities” in archaeological excavations of tombs and temples (69). What first may be mistaken for benign trinkets reveal themselves to be religious accoutrements, such as “objects of a funerary cult” or “relics from a pilgrimage” (69). Danesi elaborates that in the oft-caricatured practice of voodoo originating in Haiti and the Dominican Republic, it is believed that one can even harm another person by “doing something injurious to a doll constructed to resemble that person” (208). Scholar Kenneth Gross notes that homemade puppets fulfilled a similarly unhallowed role in the European and American witchcraft mythos, allegedly being used to inflict hexes and ailments on the hapless (4). Despite the waning of animistic beliefs in contemporary times, Gross notes that the “complex genealogy” of puppets and other graven human icons cause them to be regarded with instinctual fright (50). The robot, staring back at its creator with octarine eyes that flicker with human-like intelligence, could be conceived as only the latest offspring of this genealogy.

This uneasy feeling has been translated from the realm of the mystical to the field of psychology through the concept of the uncanny. German psychiatrist Ernst Jentsch coined the foundational definition of the uncanny in his 1906 essay “On the Psychology of the Uncanny.” Jentsch describes the uncanny as a powerful “lack of orientation” (8) that arises from a situation where a human being is in “doubt as to whether an apparently living being is animate” or conversely “whether a lifeless object may not in fact be animate” (11). He singles out elaborate “imitations of the human form” – such as wax figures and life-size clockwork automata – as producing specific unease (12). Although artificial in nature, such constructs “appear to be united with certain bodily or mental functions” unique to human beings (12). Jentsch pertinently relates that the sensation of the uncanny originates in the aforementioned human tendency toward animism. Although human beings rationalize that objects of the external world cannot be “animate in the same way” as themselves, when a human facsimile is encountered or doubt is experienced over the nature of a perceived movement, an individual often reverts to this “naive analogy” (13). In his 1919 response to Jentsch's paper, Sigmund Freud strengthens this spiritual connection by means of a brief etymological analysis. The psychoanalyst notes that the German word *unheimlich* – the source for the English term uncanny – is often connoted with “spirits and ghosts” in the German language (241). A location or object that was once familiar but has succumbed to “ghostly influences” (225) or other “secret and hidden” powers (224) is described as *unheimlich*. Through analysis of these formative works by Jentsch and Freud, it is demonstrated that the psychological concept of the uncanny has been indebted to the human affinity for animism since its conception.

However, the stigma of the uncanny is rooted as much in superstition as it is in survival instinct. Japanese roboticist Masahiro Mori initiates this thesis by noting how the uncanny is often strongly experienced when a human being encounters a corpse (100). Jentsch observes this innate reflex as well, noting that dead bodies and skeletons provoke horror owing to the “latent animatedness” they seem to possess (15). As demonstrated by the enduring spiritualist tradition of mediums and table tippers, human beings are prone to suspect these sepulchral entities might spring to life at any time – like a clockwork mechanism waiting to be wound. Diverging from the realm of superstition, Mori asserts that the human capacity to discern living from dead bodies is in fact "an integral part of our instinct for self-preservation" (100). Corpses represent a proximal source of danger, a memento of disease, conflict, or other immediate hazards. If a person is unable to discern between the living and the dead – between animate and inanimate – their ability to approach and control their environment is compromised. Theorist Donald Norman elaborates that this ambiguity handicaps a person's ability to viscerally respond to a situation (22). When a human being encounters something new, the visceral level of their brain makes a rapid judgment about whether it is "good or bad, safe or dangerous" governed by innate and automatic animal instincts (22). This visceral response instantaneously prepares them for "running, attacking, or freezing," as appropriate for the situation (21). The ambiguous status of a prone body confuses this reflex, producing the unease and hesitance commensurate with the uncanny. Building on Norman's theoretical rubric, it can be asserted that robots and automata acutely vex this visceral response owing to their unnatural and often jarring ability to lie still, spring to life, break, and be repaired. By unceremoniously trespassing the boundary between animacy and inanimacy in this manner, these machines become powerful icons of the uncanny.

The propensity for robots to invoke the uncanny constitutes the thesis of Mori's 1970 essay, "The Uncanny Valley," from which his previous remarks were gleaned. Mori opens his text by affirming that the creation of an artificial human being has long been the holy grail of robotics (98). As a consequence, although a robot's body need only be composed of steel and servos to function, roboticists frequently indulge in human-like flourishes. Artificial skin, hair, wrinkles, and even facial muscles that permit affective expression are employed to yield a "heightened sense of affinity" for the automaton (98). However, Mori tempers this Promethean ambition by introducing the uncanny valley, the concept that "in climbing toward the goal of making robots appear like a human, our affinity for them increases until we come to a valley" (98). He acknowledges that the addition of "human likeness" to a construct or machine indeed has the potential to produce a "considerable sense of affinity" (100). A prosthetic hand crafted by a wood carver, although lacking fingerprints and maintaining the "natural colour of wood," elicits amiable human qualities and subsequent appreciation of its "beautiful curves" (100). Yet when a construct such as this achieves a "degree of resemblance to the human form" where it appears real at first sight but quickly reveals itself as artificial, the onlooker becomes startled (98). In the same manner as a prone body, the "limp boneless grip" of a prosthetic hand wrapped in fleshy pink latex produces a muddled visceral response (99). Affinity for the prosthesis falls into the proverbial uncanny valley at this point, unexpectedly dropping lower than affinity for a carved wooden hand or even a sterile mechanical arm occupying a factory (99). The roboticist, in his ambition to breath life into a robot, instead deadens it through this nuance of the uncanny.

In his eulogy to Vaucanson, the Enlightenment philosopher Condorcet heralded the inventor's ability to make "machines perform operations which were previously forced to be reliant on the intelligence of men" as his greatest achievement (Wood 38). Vaucanson, in his simple ambition to curry favour with Louis XV, could not have imagined the superstitions and biases his automated loom was destined to inherit and perpetuate. The unhallowed aura of the idol, the uncanny inertness of the prone body, and the unblinking demeanor of the clockwork automaton all inform common appraisals of and interactions with robots in the twenty-first century. These detrimental cultural mores must be grappled with in order for social robots to be smoothly assimilated into the vulnerable spaces in which they are needed, such as hospitals, schools, and long-term care facilities. Perhaps in doing so, modern roboticists can avoid the bruises and vitriol endured by visionaries such as Vaucanson.

III. The Doll Instinct: Toys as Playmates and Playthings

Towards the end of his 1906 essay, Ernst Jentsch makes an offhand observation that a certain class of objects seems impenetrable to the sensation of the uncanny: items that are "very small or very familiar in the course of daily usage," he claims, cause "no notable sensation of this kind" (12). The psychologist highlights toys as a culminating example. According to Jentsch, a "doll which closes and opens its eyes by itself" does not evoke the same feeling of unease as "automata that perform complicated tasks" (12). This observation provides a possible loophole to the uncanny, one that lies in the playrooms and toy boxes of childhood. Despite their simple construction and limited human likeness, toys seemingly lend themselves to a degree of amiable anthropomorphism not yet achieved by robots and other ersatz doppelgangers of the human form – a feature that warrants further investigation.

Prior to proceeding with this line of inquiry, it is prudent to establish a foundational definition of the term "anthropomorphism." Behavioural scientists Nicholas Epley et al. define anthropomorphism as the perception of "humanlike characteristics in either real or imagined nonhuman agents" (144). These projected characteristics can include simple physical appearance, uniquely human emotional states, or mental biases and motivations. Donald Norman adds that, rather than reserving this habit for doppelgangers of the human form, individuals are "predisposed to anthropomorphize" anything they encounter (138):

> We are anthropomorphic toward animals in general, especially our pets, and toward toys such as a dolls, and anything we may interact with, such as computers, appliances, and automobiles. We treat tennis rackets, balls, and hand tools as animate beings, verbally praising them when they do a good job for us,

blaming them when they refuse to perform as we had wished. (136)

The human tendency toward anthropomorphism can be likened to (and perhaps considered an analogical extension of) the psychological concept of theory of mind. Theory of mind refers to the basic human capacity to "make inferences about what others may be thinking or feeling" and to predict their behaviour "based on these inferences" (Schlinger 435). This innate aptitude for classifying "perceptual stimuli" in social encounters is a pivotal component of how *Homo sapiens* empathize, communicate, and avoid conflict with one another (437). Epley et al. explain that the propensity to make similar inferences about dolls, appliances, and other nonhuman entities can be attributed to two motivational factors: sociality motivation and effectance motivation. Sociality motivation refers to the "fundamental need for social connection with other humans" (146). When lonely or lacking a satisfactory social circle, an individual may compensate by "creating humans out of nonhuman agents" (146). The authors recollect the stereotype of the "introvert who becomes just a bit too enamored with her cat" as a jovial example (147). Effectance motivation subsequently refers to the human need "to understand, control, and interact competently with one's environment" (146). Drawing from one's "egocentric experience" as a human being provides a "useful knowledge structure" when appraising foreign agents (146), such as wild animals or the machinations of modern man. As seen in the potent interplay between these two motivations (and their joint similitude to an individual's theory of mind), a human being's tendency towards anthropomorphism is not merely a quirk of perception but rather an important component of how they comprehend the world around them.

Returning to Jentsch's playful observation, toys seem to serve as particularly potent vessels for anthropomorphism. It is not uncommon for a "child playing with a toy to act toward it as if it were a companion" (Lakoff & Johnson 134). Young children often stage elaborate tea parties with their stuffed animals, take Cabbage Patch Kids for walks in miniaturized carriages, or divulge their deepest secrets to a sock monkey. This phenomenon is analyzed by anthropologists Granville Hall and Alexander Ellis in their pertinent 1897 essay, "A Study of Dolls." The two argue that dolls provoke a degree of anthropomorphism beyond the norm, a compulsion they refer to as the "doll instinct" (8). It is commonplace for children to invest "psychic qualities" in their toys, bordering on the "animistic fancy" ascribed to ancient graven idols (8). The children interviewed by Hall and Ellis claimed that their dolls were capable of emotional states, such as jealousy, anger, and pride; biological states, such a hunger, cold, and weariness; and even basic moral alignments, such as good and bad (15). One young interviewee decried, "[w]hen I saw dolly lying out on the ground I thought I could see tears in her eyes, she was so hungry and cold" (17). The doll instinct is so potent that even the "rudest doll" can stimulate the imagination (11). Childhood development researchers John and Elizabeth Newson provide wooden peg-men as a corroborating example. Although these diminutive toys are little more than "lumps of wood" adorned with "a few blobs of paint to suggest eyes, mouth, and hair," children eagerly ascribe human thoughts and feelings to them (102) – marching them through imagined cities and giving them names, professions, and families. Through the vigor of the doll instinct, these simple playthings garner an intimate and comprehensive degree of anthropomorphism unseen in other human icons.

At first appraisal, the doll instinct can in part be attributed to the entrenchment of the instrument-as-companion metaphor in the English language. Social anthropologist Andrew Pawley observes that gendered pronouns such as "he" or "she" are often used to refer to inanimate entities, a practice he refers to as “grammatical animation” (111). Within any given dialect of English, there are complicated rules as to which referents receive this animation; some have a “fixed animate gender” (whereby they *must* be masculine or feminine) while others have a “variable animate gender” (whereby they *may* be masculine or feminine) (115). Regardless of these stipulations, this propensity towards grammatical animation is strongest when referring to tools and other instruments. According to linguists George Lakoff and Mark Johnson, there is in fact a conventionalized metaphor of “an instrument is a companion” within the human conceptual system (135). Certain “significant instruments” – such as guns, cars, and tools – are referred to as not only being used as objects but also providing accompaniment as companions (135). Owners who are particularly prone to whimsy may even give these everyday items pet names, talk to them, and grow distressed when they fall into disrepair – often to the chagrin of neglected family members or significant others. The propensity for children to refer to dolls in similarly affable terms is thus unsurprising; as Lakoff and Johnson note, “[d]olls are toys designed especially for this purpose” (135). Tools and dolls in fact share the essential quality of being “very small or very familiar in the course of daily usage” that Jentsch outlines as a prerequisite for garnering affinity and circumventing the uncanny. When a child dotes over a doll that has fallen prone to the ground, it could be argued that he or she is partially indulging in the instrument-as-companion metaphor that colours English vernacular.

However, in attempting to comprehend the specificity of the doll instinct – and perhaps bottle its power for use in the field of human-robot interaction – there are further explanations that can be drawn upon. The minimalist form of a toy, for example, appears to play a large role in its affability. John and Elizabeth Newson note that most toys are “simplified transformations of the objects they represent" (120). A distinctive quality of dolls, action figures, and other playful effigies is in fact their collective ability to garner empathy through suggestion rather than flawless replication – a phenomenon the two refer to as "toyishness" (120). Mori attributes the success of toys that are only "roughly human-looking" to their circumvention of the uncanny valley (98). The uncanniness felt towards advanced robots and realistic prostheses is symptomatic of an imperative to reach a hypothetical plateau on the opposite side of the uncanny valley, where affinity is curried from flawless human likeness (98). Modern roboticists are essentially vaulting themselves into the uncanny valley in hopes of eventually being able to claw their way back out on the opposite side – an ambition that has yet to be realized four decades since the publication of Mori's paper. Humanoid toys, on the other hand, are able to sidestep the precipice of the uncanny valley by only striving for a "moderate degree of human likeness" (100). As a consequence, these trinkets yield a "considerable sense of affinity" without invoking the various cultural mores of the uncanny (100). Mori proves so enamored by this so-called first plateau that he suggests engineers might "create a safe level of affinity by deliberately pursuing a nonhuman design" (99). Rather than fixating on "pitiful-looking" imitations of living beings, he advocates for "charming" and "stylish" curvatures of plastic (100). Within the rubric of toyishness, it is the tradition of the toymaker to craft dolls and playthings that reminisce the human form rather than replicate it that yields strong anthropomorphism.

In addition to the amenable simplicity of a toy, there is also a strong cultural motivation to transform playthings into playmates. Cultural anthropologist Brian Sutton-Smith notes that modern toys are often designed to "decrease the sociability of play" (39). He recollects that the predominant nature of play until the eighteenth century was "play with others, not play with toys" (26). Traditionally, if a game entailed the use of playthings, these items were solely intended to promote interaction – such as balls or other sporting equipment. When the Industrial Revolution occurred, toys were re-appropriated as vessels for the "solitariness on which modern civilization relies" (37). Although the gifting of a toy from parent to child on Christmas or a birthday is often portrayed as a warm and fuzzy family moment, modern playthings are designed with isolated play in mind (25-26). Early commercially produced toys such as construction blocks, dolls, and clockwork contraptions were as much intended to delight as they were to preoccupy children as their parents pursued "work, chores or leisure" (26). In the twenty-first century, this observation has been reiterated by alarmist newscasts and groups of concerned parents decrying that children today are being raised by video games. Recalling Epley et al., the solitary nature of these playthings instills a high sociality motivation for anthropomorphism in their young owners. Children, deprived of their "fundamental need for social connection" by being cloistered in the playroom (146), are compelled to turn their cadre of plastic and wooden roommates into companions. As Sutton-Smith affirms, a lonely child has "a way of doing things with toys over and beyond the apparent character of the toy" (38). Toys – rather than siblings, parents, or peers – have consequently become the modern child's most stalwart friends.

This kinship with toys is deeply ingrained in human beings, a point that is further demonstrated through the psychological phenomenon of the transitional object. The idea of the transitional object was conceived by British psychoanalyst Donald Winnicott in 1951. Winnicott observed that children between six to eight months of age often become deeply attached to a comforting item such as a security blanket, teddy bear, or doll (1). These playthings are gently sucked on, babbled to, or snuggled with, becoming vitally important to the infant "at the time of going to sleep" or as a "defence against anxiety" (3). According to Winnicott, the purpose of a transitional item is to substitute for the mother, serving as a means for the child to wean themselves from their caregiver and slowly become independent (1). Because of the temporary purpose of these objects, the psychoanalyst states that it is their ultimate fate to be "gradually allowed to be decathected" (4). Although affection for the favoured teddy bear is "not forgotten," it loses its essential quality as the child matures – being relegated to the "limbo" of a shelf or toy box (4). However, psychoanalyst Robert Young notes in his text *Mental Space* that the transitional impulse reemerges throughout adulthood in subtle ways. The "sense of something that is favorite and to which one turns when in danger of [succumbing to] depressive anxiety" applies to a myriad of modern commodities. Having "abandoned the blanket, doll, or teddy" of infancy, individuals instead covet "portable computer games," "mountain bikes," and "Timberland shoes." The popular Apple iPhone – glowing with arcane warmth, checked in on habitually, and nestled lovingly in one's pocket – aptly fulfills this role as well. Toys and other intimate possessions thus collectively inherit a primordial form of anthropomorphism from the transitional objects that watch over the cradles and playrooms of early childhood.

In his essay "The Philosophy of Toys," French essayist Charles Baudelaire cites an overriding desire within most children to "get at and see the soul" of their favoured toys (17). After a certain period of use, a child "twists and turns the toy, scratches it, shakes it, bangs it on the wall, [and] hurls it on the ground" in order to break it open and witness the living creature or primordial essence that gives it life (17). Baudelaire's observation expresses the strong presumption of anthropomorphism that shapes a person's interaction with toys – a perception honed through their sleights of language, modern upbringing, and early childhood experiences.

The toy consequentially becomes a powerful template to consider when designing socially inclined robots. If these automata are to be accepted into hospitals and homes with the same eagerness as these coddled (and, as Baudelaire laments, occasionally manhandled) playthings, there must be some impression of a proverbial ghost in the machine.

IV. The Tamagotchi Parable: Transcribing Toyishness onto Plastic and Steel

In May of 1997, a new trinket appeared on North American toy shelves: the Tamagotchi virtual pet. Shaped like a plastic egg, the palm-sized device came equipped with a simple LCD screen that displayed a representation of a cute pixelated monster. As summarized by artificial intelligence theorist David Levy, the premise behind the toy was that the owner must "care for the Tamagotchi in its virtual world," responding to the bleeps and bloops of the device with Pavlovian acumen by pressing buttons that simulate the provision of food and affection (90). Levy jocularly compares the Tamagotchi fad of 1997 to the Pet Rock fad of 1975, noting the tandem enthusiasm for "inanimate, amorphous pets with which their owners could enjoy no real interaction" (90). However, despite the limitations of its PalmPilot-era hardware, the Tamagotchi represented one of the first successful intersections of toyishness and digital technology. This innovation – along with the fact that Bandai shipped nearly 40 million Tamagotchis by Christmas of that year – makes the virtual pet a meritorious model to review.

It is pertinent to clarify precisely what a virtual pet is, given that familiarity with these esoteric relics of popular culture cannot be assumed. Levy defines a virtual pet as a "computer representation of a model of pet behaviour," one that incorporates interactive software and hardware in order to afford communication between user and pet (64). In the case of the Tamagotchi, these technological affordances include its LCD screen and simple rubber buttons; however, a virtual pet's interface need not conform to this pocket-sized template. Virtual pets may be ephemeral programs that exploit the capabilities of a home computer or game console to project the digital companion onto a screen (64). Media theorist Machiko Kusahara examples the PostPet computer program released in 1998, which allowed users to prompt a pink teddy bear on their desktop to eat, sleep, or send emails for them using the mouse and keyboard (301). In more recent decades, microprocessor-based virtual pets have arrived that are designed to not only "look like an animal or a robot" but also respond to voice or gestural commands (Levy 64). The Furby, an owl-like virtual pet, interacts with its owner through a babbling pseudo-language known as Furbish; AIBO, Sony's chrome-tinted artificial dog, can be trained to obey over 100 voice commands; and the Fijit Friend, a rubberized purple alien, happily dances along to music on the radio. Whether a virtual pet be constrained to the screen or granted the freedom of a perambulating body, these playthings all fulfill the same purpose – to simulate pet-like companionship through some manner of computing device.

Given the hesitance towards accepting socially assistive robots into the domestic sphere, the proliferation of virtual pets may seem astounding. This paradox is well-illustrated by attempts to introduce the former technology into long-term care facilities. In a 2011 study, gerontologist Ya-Huei Wu et al. asked 15 individuals (all over the age of 65) to appraise the appearance of therapeutic robots designed to aid them with "performing necessary daily activities" (121). After reviewing their interview data, the researchers conclude with startling unanimity that these machines "were not appreciated by the majority of participants" (125). One individual described the exhibited robots as "caricature[s] of humans" that possessed a distinctly "unpleasant aspect" (123). More pressingly, all participants expressed strong "social and ethical" opposition toward a robot "conceived as a substitute" for a living breathing presence (125) – echoing the modernist parable originated in Vaucanson's day. A particularly concerned volunteer punctuated this sentiment by stating how cruel it was to offer robots to the "frail elderly who are isolated and do not have much human contact" (124). It seems that although humanoid robots are now equipped to enter these long-term care facilities and assist with day-to-day tasks, their residents are unwilling to let them in.

Interestingly, the virtual pet AIBO has seen widespread popularity within this same demographic, both as a companion and a therapeutic tool. Computer scientist Alan Dorin notes that the canine AIBO is routinely treated as a “legitimate artificial companion” by its adult owners, with acceptance being “especially high for elderly people” (109). During the heyday of the AIBO in the early 2000s, retirees and others who could afford the product's hefty price tag would often form clubs where they swapped stories about and showed off tricks learned by their virtual pets (Levy 194). As a consequence of this popularity, psychologists Marian Banks et al. tested the AIBO as a substitute for a real dog in animal-assisted therapy – the practice of scheduling regular visits with pets in long-term care facilities to reduce habitual loneliness (173). Despite initial skepticism on the part of both therapists and the residents of these facilities, the results of this study found “no difference between the effectiveness of a living and a robotic dog” in reducing loneliness during these therapy sessions (175-176). The embrace of the AIBO by this reluctant demographic demonstrates a unique power held by virtual pets – one that could be harnessed by the socially assistive robots the artificial canine has unexpectedly outperformed.

The source of this power lies in a virtual pet's leveraging of new technologies to enhance and exaggerate the quality of toyishness. One means by which virtual pets accomplish this feat is the employment of wishful mnemonics. Computer scientist Drew McDermott defines wishful mnemonics as the use of semantically charged variables when designing artificial intelligence, resulting in individuals ascribing heightened cognitive capacity to these machines (4). He provides the simple example of a programmer naming the main loop of his program

"UNDERSTAND" (4); by choosing this mnemonic, he misleads users (and even himself) into assuming the program he has created is genuinely capable of the act of understanding. McDermott bemoans wishful mnemonics, arguing that "[w]e have lived so long with the conviction that robots are possible... that we can't help hastening their arrival with magic incantations" (5). Although wishful mnemonics prove an impediment to those striving for the singularity, cognitive scientist Diane Proudfoot argues that they can be used to deliberately garner anthropomorphism for machines (952). Designers of virtual pets engage notoriously in this practice, using adjectives such as hungry, thirsty, happy, or lonely to enliven the fluctuation of arbitrary programmed variables. Proudfoot provides another example in the form of Kismet, a robot created by MIT that was advertised as being able to smile and frown (951). Although these emotive expressions were only a product of mechanical reproduction – as Proudfoot notes, "like an emoticon or photograph" – the use of the terms "smile" and "frown" ascribed a heightened communicative power to the machine (952). In the case of both the Tamagotchi and Kismet, these wishful mnemonics embellish the preexisting grammatical animation these humanoid icons have inherited from tools and playthings. Although a simple ploy, this lexical masquerade helps to imbue a collection of pixels or an assemblage of servos with the spark of life.

A Tamagotchi's whimpering bleeps and bloops furthermore play to its owner's innate sociality motivation towards anthropomorphism. Granville Hall and Alexander Ellis recount that children not only talk to their dolls as companions but also coddle them as infants – spanking them, kissing them, and fretting over them when they imagine them "tired, or sick, or hungry" (17). Sociologist Jen Wrye explains that the transcription of childlike characteristics onto non-human entities exploits "innate human tendencies to care for and nurture young humans" (1042).

The “proportionally large heads” and “big circular eyes” of dolls and plush toys arouse a visceral maternal response in their owners (1042); these entities are subsequently perceived as capable of providing “love and companionship” in the manner of an infant or baby animal, regardless of the fact that these affective qualities are impossible in inanimate objects (1042). The clarion call of these infantile characteristics proves so potent that even adults succumb to it. John and Elizabeth Newson muse that parents often find themselves putting clothes back on dolls that have been stripped naked by errant children – not simply to tidy up but because they “look so cold” (90). Virtual pets further succeed at appealing to the sociality motivation of their owners because they are capable of complimenting these childlike characteristics with corresponding behaviours. The AIBO replicates the qualities of “astonishment at small wonders” and “spontaneous inquisitive character” inherent to young children (Wrye 1042) through its motion sensors and carefully scripted animations. The beeping of a hungry Tamagotchi, although much cruder a display, pushes the Darwinian buttons of its handler with similar vigor. While dolls that cry and wet themselves are not novel to this century, virtual pets and robots possess a unique capacity to enthrall one's attention by emulating complex and nuanced infantile behaviours.

The power of virtual pets lies not merely in their childlike characteristics but also in the infantile precariousness of their lives. Although young children often imagine their dolls as falling ill, Levy points out that if an owner neglects to tend to their Tamagotchi, it is actually programmed to die (93). The image of one's beloved companion on the toy's LCD screen disappears, replaced by a sullen pixelated ghost. Owing to this macabre design feature, Levy observes that owners often went to great lengths to preserve the well-being of their Tamagotchi during the acme of the toy's popularity (92). He offers the anecdote of a Japanese woman who "boarded a flight but felt compelled to leave the aircraft prior to takeoff... because a flight attendant insisted she turn off her Tamagotchi" (92). Kusahara muses that a virtual cemetery was even founded online to memorialize dead Tamagotchis and "comfort the poor users who had lost their pets" (301). Technology theorist Sherry Turkle relates an anecdote where this critical parental concern was transcribed into the field of robotics, albeit inadvertently. Prior to a classroom session with the playful Cog robot developed by MIT, one of the automaton's arms superficially broke (504). At the sight of this apparent injury, the children participating in the study immediately grew concerned. They tried to make Cog more comfortable, wanted to sing and dance to cheer it up, and were consistently solicitous of its "wounds" (504). Although the children had previously "delighted in its presence" as a plaything, the facsimile injury caused them to care for Cog as a sick child (504). The precarious mortality of a Tamagotchi might prove an obtuse design feature for robots designed for education, therapy, or other sensitive fields; however, the tears shed for Cog demonstrate that the nurturing instinct can be transplanted into more elaborate manifestations of plastic and steel.

Rather than fixating on mortality, the robots of the future could perhaps induce this nurturing compulsion by being designed to age. As previously noted, although young children grow deeply attached to the transitional objects that adorn their cradles, these items are inevitably "decathected" as the child matures (Winnicott 4). Children leave their security blankets and ragged teddy bears in the playrooms of their infancy as they enter the schoolyards of their adolescence. However, digital technology provides the opportunity to craft companions that mature alongside of their owners. Virtual pets have previously demonstrated this capability, albeit in a rudimentary fashion. Kusahara notes that an AIBO not only emulates the frolicking of a puppy but also is “programmed in such a manner that the pet's behaviour changes gradually... to that of a grown-up dog” (301). The temperament of an adult AIBO in fact “reflects the way the user raises it,” allowing an owner to “feel satisfaction and pride” when their virtual pet obeys a command (301). Contemporary robots, with their superior hardware and software, could be programmed to simulate more advanced feats of aging: gradually learning the names of people and objects; adjusting the timbre and prosody of their synthetic voice to mature over time; and even toning down the colour and intensity of their LEDs in allusion to graying hairs. Donald Norman adds that simply constructing the chassis of these machines out of materials that “age gracefully” through “dents and markings of use” – such as wood or ceramic – can further transform these mass-produced items into personal mementos (221). A holistic emulation of the aging process could produce robots that are embraced as long-term companions rather than sterile and disposable appliances, providing them more welcome residency in homes (and perhaps even in photo albums).

Norman argues that the widespread acceptance of any new technology requires a “coevolutionary process of adaptation” on the part of both machine and human being (171). He provides the example of the automobile. It was not enough that these machines were designed to appeal to consumers with their padded seats, AM/FM radios, and sensual curvatures of steel. Homes had to be altered to include “garages and driveways” and terrestrial landscapes rearranged to accommodate a “worldwide highway system” (171). The theorist underlines that successful cyborg companionship with robots will require a similarly radical co-evolution. However, virtual pets have demonstrated a means of jump-starting this process by transferring the entrenched affinity felt towards dolls and other playthings onto digital hardware and software. The Tamagotchi, although oft-remembered as an over-hyped collectible, represents an essential link in the evolutionary chain between mechanical arm and mechanical being.

V. The Magic Circle and the Mechanical Arm: Applying Play Theory to Robotics

As demonstrated by virtual pets, the robot-as-toy metaphor offers a novel means of appraising human-robot interaction. Understanding the quality of toyishness hidden within the servos of automata provides an opportunity for roboticists to exchange long entrenched modernist mores for the endearment felt towards teddy bears, Tamagotchis, transitional objects, and other treasured inhabitants of childhood toy boxes. However, playthings themselves are not a class of artifacts bereft of cultural baggage. As noted by anthropologist Johan Huizinga in his 1938 book *Homo Ludens* – which serves as the namesake of this paper – play is “more than a mere physiological phenomenon or a psychological reflex” (1). A person's trapezing across elementary school blacktops, competition in sporting events, and practical jokes all perform a “significant function” in their lives (1) and are activities governed by “special rules” (10), both explicit and arcane. If robots are to be appraised as a form of plaything, then it is necessary to appraise human-robot interaction as a form of play – with everything that comparison entails.

Defining the activity of play has proven a contentious endeavour, fostering a long debate between anthropologist, psychologist, and sociologist alike. This paper will rely on Johan Huizinga's definition of play, established in his aforementioned 1938 book. The anthropologist begins by noting that “[p]lay is older than culture” (1), preceding the crudest of dolls and even the earthen idols that Philippe Ariès describes as littering primordial temples and dwellings. He observes that “[a]nimals play just like men” and that the advent of stadiums, commercial plastic, and microprocessors has “added no essential feature to the general idea of play” (1). According to Huizinga, play possesses three main characteristics. First, play is a “free activity” (13). Child and adult alike engage in games and jocularity for no apparent reason other than that they “enjoy playing," and such activities are "never imposed by physical necessity or moral duty" (8). Second, play is apart from the "ordinary" (13). It represents a "stepping out" of the seriousness of real life into a "temporary sphere of activity with a disposition all of its own," requiring that participants agree that their actions are "only for fun" (8). Third, play possesses an innate "secludedness" and "limitedness" (9). It occurs within "certain limits of time and space," possessing not only a well-defined beginning and end but also a "playground marked off beforehand either materially or ideally" (10). Although conceived half a century prior to the digital age, Huizinga's tripartite definition of play has long been incorporated into the fields of ludology and media studies by theorists such as Bernard Suits, Katie Salen, and Eric Zimmerman. This contemporaneous appropriation, coupled with the innate versatility of the definition, make it an ideal rubric for appraising the robot-as-toy metaphor.

The comparison of human-robot interaction to play is not an unfathomable leap. Huizinga argues that because the activity of play existed "before culture itself existed," the "great archetypal activities of human society are all permeated with play" (4). The structures of "[l]aw and order, commerce and profit, craft and art, poetry, wisdom, and science" – although often regarded with stoicism and austerity – all possess playful "impulses and habits" inherited from this lineage (4). Huizinga provides the broad example of language to clarify this point. Language is the "first and supreme instrument" of human beings, a capacity that allows individuals "to communicate, to teach, [and] to command" (4). Yet despite the seriousness in which language is regarded – demonstrated by both the academic field of linguistics and the push towards national literacy in Western countries – everyday speech is peppered with abstract expression, bold metaphors, whimsical puns, and other "play upon words" (4). A similarly lusory attitude reveals itself in the inner-workings of modern business: clients are won and lost; key players are moved between teams; and a clear demarcation is made between office space and the real world. Huizinga emphasizes that play and culture are invariably “interwoven with one another,” having grown from the same “primaeval soil” (5). Therefore, human-robot interaction – modeled on human social behaviour and enacted within the constraints of hospitals, businesses, and other archetypal cultural institutions – can be scrutinized through the lens of play theory as well.

The play-concept, whether expressed plaintively through a game or more subtly in the machinations of a cultural institution, is one governed by rules. Huizinga notes that all play has rules that are “absolutely binding and allow no doubt” among players (11). These stipulations hold together the “temporary world circumscribed by play” (11) as well as its “locality and duration” (9) – referencing the anthropologist's second and third characteristics of play respectively. Adopting the vernacular of ritual, Huizinga refers to the playground constituted by these rules as the “magic circle” (10). This “consecrated spot” (10) can manifest itself as a physical demarcation, such as “the stage, the screen, the tennis court, [or] the court of justice” (11), or an ephemeral demarcation, such as a corner of a backyard transformed into a fantastical locale in the imagination of a child. Regardless of form, the magic circle only persists as long as the rules constituting it are observed. The cry of the referee or revelation of the card shark “breaks the spell” of the magic circle, causing the whole play-world to collapse (11). Video game theorist Rowan Tulloch affirms Huizinga's assertion by noting how without rules “certain possibilities simply do not exist” in a game (339). In the domain of chess, it is the rules attached to the movement of pieces that allow a player to perform a checkmate (339); in the domain of language, it is the rules of grammar and syntax that make both simple sentences and complex metaphors possible; and in the domain of business, it is the rules of commerce that make dramatic *Mad Men*-style dealings possible. The order of the magic circle, although an “absolute and peculiar order” (Huizinga 10), is what allows play to occur.

Human-robot interaction is bound by its own magic circle, one consecrated by rules indentured to a robot's hardware and software. My aforementioned experiences with the NAO robot developed by Aldebaran Robotics provide a firsthand example of such technological stipulations. To quickly summarize, the NAO is a 58-cm tall socially assistive robot “intended to be a friendly companion around the house” as well as a therapeutic tool in schools and autism centres (“Who is NAO?”). The aim of the “Studying Autism Through the NAO Robot” project was to examine the speech patterns of autistic children by having them play interactive games (generally involving flash cards and verbal responses) with this automaton. The project was headed by principal investigator Dr. Stéphanie Walsh Matthews and co-investigator Dr. Jamin Pelkey, both scholars in the fields of language and semiotics at Ryerson University. My primary responsibilities with the project entailed not only preparing our pair of NAO robots (nicknamed Max and Rob) for weekly visits to autism centres in southern Ontario but also monitoring, controlling, and troubleshooting their behaviour during these visits using a laptop equipped with Choregraphe, a graphical user interface software suite.

It is gleefully advertised on Aldebaran's website that the NAO robot “moves, recognises you, hears you and even talks to you” (“Who is NAO?”). Although the impression of a lifelike “daily companion” is endorsed in the manufacturer's marketing materials, I have observed that the technological limitations of the NAO cause these social and sensory capabilities to be bound by precise rules. The robot's ability to “recognize images and faces” requires that these items be held a specific distance away from its ocular cameras – a sweet spot of about 30 centimetres ("More About NAO"). In addition, the vast majority of applications available on Aldebaran's online store only permit a window of several seconds for this recognition to take place. This window is denoted by an answering machine-like beep, with the robot ignoring anything placed in its field of vision prior to this punctuating sound. The NAO's ability to comprehend verbal commands relies on similarly regimented prompting in tandem with the clear and nonnegotiable articulation of monosyllabic words such as "yes" and "no" (a prosodical requirement that often made team members feel like robots themselves). Finally, when the robot is speaking, verbal commands and other forms of communication are ignored, representing an unannounced and often inconvenient downtime of interaction. Mastery of these rules – based in simple technological nuance – was essential for conversation, play, and general interaction to occur between the NAO robot, my team, and the autistic children we worked with.

Whether discussing traditional folk game or technological parlance, when the rules of play are clearly understood and easily followed, a state of flow can be achieved. Psychologist Mihaly Csikszentmihalyi defines flow as the "the holistic sensation that people feel when they act with total involvement" in an activity (36). The flow state is garnered when a person is presented "unambiguous" and "noncontradictory" demands (46) that are "evenly matched" by their current skill level and capabilities (50). Csikszentmihalyi references the recreational activity of rock climbing to illustrate this experience. If the difficulty of a climb exceeds the skill of a climber, he or she will feel "anxious" or "worried" (51), even when nestled in the safety of a polyester harness. The climber will be unable to enter the flow state because they do not feel "in control of [their] actions and of the environment" around them (44). However, if difficulty and skill level are evenly matched, the flow state is granted. The climber experiences a “centering of attention” toward their pursuit (40) and a “loss of self-consciousness” over possible anxieties (42), becoming entirely subsumed by the act of scaling the wall:

> One tends to get immersed in what is going on around him, in the rock, in the moves that are involved.... search for handholds... proper position of body – so involved he might lose the consciousness of his own identity and melt into the rock. (43)

The flow state outlined by Csikszentmihalyi represents an even matching of the rules constituting play with the skill level of the players themselves. Master chess champions squaring off, Olympic athletes in training, and even needle workers absentmindedly looping bolts of thread often experience this holistic immersion. In human-robot interaction, the flow state is epitomized by a reciprocal and effortless conversation between a human and a complex machine.

Achieving this state of flow in robotics – apart from simply easing interaction – helps cement the automaton as an active and aware contributor to play. This is well-expressed through the rules of irrelevance, introduced by sociologist Erving Goffman in his 1961 book *Encounters*. Goffman explains that when a participant is immersed in a game, they “forswear for the duration of the play any apparent interest in the esthetic, sentimental, or monetary value of the equipment employed” (19). In the sociologist's own example, one does not call attention to the pieces in checkers, whether they are constructed of “bottle tops” or “inlaid marble” (20). Within the magic circle, these tokens are disassociated from the “relevant reality” of their form and generate the “same contour of excitement” as one another (20). These rules of irrelevance are integral to human-robot interaction as well. Although socially assistive robots such as the NAO are endorsed as stalwart companions, the field of robotics is still eons away from true artificial intelligence. In the interim, every human-robot interaction relies on either a permutation of the Turing Test or an elaborate "Wizard of Oz" charade, where a robot is controlled by proxy (Kim et al. 279). (My role on the "Studying Autism Through the NAO Robot" team, as previously elaborated, was to play this proverbial wizard, frantically queuing up dialogue and actions for the robot to perform from behind the "curtain" of my laptop screen). Like the checkers player who must accept a bottle top as a game piece, a participant in a human-robot interaction must accept an assemblage of plastic and wires as a companion. Misheard instructions, mistimed responses, or malfunctions prevent an individual from approaching a social automaton with the same absent-mindedness as the experienced rock climber guided by unconscious muscle movements, causing the rules of irrelevance to collapse alongside the magic circle. In human-robot interaction, the sustenance of flow consequentially becomes a sustenance of belief in the agentive animacy of a machine.

Johan Huizinga's observation that play and culture are "interwoven with one another" (5) provides the foundation for an appraisal of human-robot interaction as play; however, it is the impetus of roboticists to ensure that these ludic threads do not become frayed. As socially assistive robots enter the domestic sphere, ordinary people must be able to understand, trust, and communicate with these machines with the same effortlessness as they do other human beings. In short, they should be able to cast aside their Čapekian hesitance and entrench themselves in a state of cybernetic flow. The remainder of this paper will explore two tactics for maintaining flow in human-robot interaction. The first borrows the principles of video game design in order to make the rules and technological literacies inherent to human-robot interaction easier to acquire. The second involves the choreographing of playful behaviours with the intent of diminishing disruptions to flow resulting from malfunction. Although born from a prehistoric tradition of play, these strategies may serve to usher humanity into the next frontier of human-robot interaction.

VI. Missed Kinections: Appraising a Video Game-based Framework for Robotics

In the previous section, the daring rock climber, quizzical chess champion, and stalwart Olympic athlete were all exampled as paragons of the flow experience. However, there is another cultural archetype that supersedes these individuals in ubiquity (if not grandiosity) – the video game player. Mihaly Csikszentmihalyi's treatise on flow did not address the medium of video games, likely owing to its publication prior to the "golden age" of gaming that began in the late 1970s (Whalen & Taylor 6). However, the concept of flow has since been appropriated by scholars such as Jesper Juul, John Sherry, and Mark Wolf to analyze both the fervor in which arcade athletes strive for new high scores in *Donkey Kong* as well as the absentmindedness in which smart phone users coast through long transit rides on a game of *Angry Birds*. Given the apparent success video games have sustained in achieving flow – as well as their blinking lights, artificial intelligence, and other distinctly robotic features – a comparison of Xbox to automaton seems both inevitable and beneficial.

At a cursory glance, a general similarity can be observed between the literacies required to achieve flow in human-robot interaction and in video games. As previously conveyed through my experiences with the NAO robot, human-robot interaction makes specific demands of its participants. An individual must internalize the rules of gesture, timing, proximity, and verbal clarity that govern Aldebaran Robotic's playful creation prior to being able to comfortably and quickly succeed at interaction with it. Ludologist Espen Aarseth notes that video games require a similar "nontrivial effort" to traverse successfully (1). A video game – regardless of whether it be a kid-friendly jaunt like *Super Mario Bros* or a competitive juggernaut like *League of Legends* – offers a "risk of rejection" unheard of in other texts (4). As affect theorist Graeme Kirkpatrick summarizes, if mastery of the video game apparatus lapses, the player's avatar onscreen "can die" (51). Brian Sutton-Smith elaborates that this mastery requires a menagerie of intersecting competencies that can take years of one's life to acquire (70). A player must rehearse difficult "motor responses" in order to effectively manipulate a joystick or controller (71); intensive "visual scanning" to process the rapid "cuts, pans, [and] dissolves" of the digital screen (70); and quick "auditory discriminations" to recognize sound effects that might signify danger (71). These literacies, although defined through monitors and controllers rather than the body of an automaton, possess similar rules of timing and dexterity as human-robot interaction. While failure to achieve these competencies with a robot such as the NAO will not result in one's untimely death – at least not until the Čapekian uprising occurs – a parity between video game literacy and robot literacy is easily acknowledged.

Though governed by similar literacies as video games, contemporary robots are impaired by a perpetual negligence towards the clear presentation of their rules of interaction. Technology theorists Justin Richer and Jill Drury argue that until recently, most robots were used exclusively in "the laboratory by their own engineers" (226). This segregation from everyday life permitted the interfaces of these automata to "be complex and require significant training" to operate (266), often relying on nuanced operating systems or nonstandard input devices. However, with the recent push towards the introduction of socially assistive automata, new audiences are using robots "without direct help from their developers" (226). The technological proficiency of a skilled engineer unfortunately cannot be guaranteed among these new "intended end-users" (266), whether it be the frantic graduate student relaying a command to the NAO or the avid housewife or househusband unboxing their brand new Roomba. Theorists James Young et al.

affirm that these complex new automata consequently raise “serious accessibility concerns” in both the hospital and home (105). The same issues that hindered the widespread adoption of personal computers in the 1990s will doubtlessly perpetuate themselves in human-robot interaction: a “lack of knowledge, usability, and... control” (105). Like so many VCRs, cell phones, and tablets given as well-meaning gifts to hesitant relatives, these intimidating humanoid machines may be left to collect dust in their original packaging because their new owners are “dubious about the capabilities of robots” and the “practical benefits” they offer (105). The engineering-first bias inherent to the fledgling field of robotics thus proves a recurring handicap of flow, fostering confusion and eventual disuse owing substantially to technical illiteracy.

The principles of modern video game design provide a means of leveling the steep learning curve associated with social robotics. This capacity is evidenced through the video game-based framework for analyzing human-robot interaction proposed by Richer and Drury in a 2006 conference presentation. The two theorists note that despite the equitable literacies required of both robots and video games, the latter has consistently succeeded at “provid[ing] players with needed information and control capabilities in an engaging and enjoyable fashion” (266). This success has been tempered by two major factors. First, a vast amount of scholarship has been dedicated to the “mature field of video gaming” (266). Over the past two decades, landmark texts such as Espen Aarseth's previously referenced *Cybertext: Perspectives on Ergodic Literature* and Katie Salen and Eric Zimmerman's *Rules of Play* anthology have offered a theoretical rubric to appraise and improve the playability of digital games. Second, there persists a “strong impetus for game interfaces to be well-designed” in order to attract a wider player base (266). As Richer and Drury note, while obtusely designed robots are often perpetuated through the beneficence of research grants, video games with “frustrating or cumbersome interfaces” seldom succeed or warrant sequels (266). Tellingly, one of the key selling features of Nintendo's blockbuster Wii console – rather than impressive graphics or processing power – was that it offered “intuitive gameplay” and “experiences for everyone” (“What is Wii Mini?”). Commercials for the Wii often depicted grandparents and toddlers effortlessly playing together using the console's iconic motion controller. Owing to the tandem maturation of video game scholarship in academia and proliferation of the Nintendo Wii in living rooms worldwide, Richer and Drury affirm that there is a strong motivation for roboticists to “mine the world of video games” (266) for potential improvements to human-robot interaction.

Although Richer and Drury make a comprehensive argument in favour of the video game-based framework, they do not present a thorough example of how this framework could be applied to interaction with socially assistive robots. In their own admission, the aim of their paper was to “generalize the framework as much as possible” in hopes of it being “non-application-specific” and compatible with future generations of video game and robotic technologies (271). Building on the broad framework laid out by Richer and Drury, the remainder of this section will identify two specific problems that have arisen and been addressed in the domain of video game design that can be referenced to solve parallel problems in the domain of human-robot interaction.

The first problem pertains to the presentation of meta-information to video game player and human-robot interaction participant alike. Richer and Drury plainly describe video games as “streamlined input-output systems” (266). Unlike most computer applications in which “the interface serves as a means of interacting with some underlying functionality,” the singular purpose of a video game is the act of interaction itself through the deft maneuvering of a controller or joystick (266). It is thus paramount that “[s]tatus and meta-information about the game” is communicated clearly and quickly in response to the player's actions (266). This meta-information includes game constructs (such as the player's current score and health) as well as hardware concerns (such as whether or not an input device is plugged in). Researchers Cynthia Breazeal and Brian Scassellati note that contemporary roboticists, like video game designers, must be conscientious of lackluster meta-information. The two point out that when awaiting a response or further instruction from a human being, many contemporary robots rest in an ambiguous state of idleness (268). When in this state, the robot does not convey any system information and ignores “critical social cues” – such as gestures and facial expressions – unless they correspond with specific commands it is programmed to recognize (268). Like a clockwork toy, the automaton never meets an “onlooker's gaze” or moves until the human participant turns a proverbial key (Newson 243). This idleness represents a critical collapse of meta-information conveyance in a human-robot interaction, one that often results in a participant questioning whether a robot is working properly or even turned on.

Contemporary video games remedy this problem by offering a deluge of meta-information through the visual output of the television screen. Richer and Drury note that heads-up displays have become the status quo in gaming. They provide the 1991 classic *Super Mario World* as an example, illustrating how the “score is displayed in the top corner of the screen” at all times alongside a tally of coins collected, lives remaining, and items stashed (268). Even greater indulgences in meta-information have been included in more modern games. In the 2014 title *WildStar*, the graphical user interface conjures luminous arrows to guide a player to quest objectives and pairs each press of the attack button with floating red numbers that indicate the amount of damage dealt. The clarity of meta-information possible on the digital screen can be emulated in robotics through the addition of an autonomous state. Roboticists Sjef Fransen and Panos Markopoulos defines an autonomous state as one where a robot will "move its head and blink its eye lids" at a frequency that seems "normal" and "alive" without any prompting (62). This state provides the simple meta-information that the robot is turned on and ready to receive commands. Breazeal and Scassellati propose that this autonomous state can be further embellished through the addition of embedded affective and regulatory responses (862). These responses could be as straightforward as "changing facial expressions in response to stimulus" – such as smiling when a familiar person enters a room – or producing compensatory eye and neck movements in reaction to gestures and offered objects (862). A comprehensive autonomous state, inline with the heads-up display of the modern video game, thus provides a pertinent solution to the black boxing of meta-information common in human-robot interaction.

The second problem pertains to the disconnect felt between human being and machine in the absence of a physical interface. Media theorists Paul Skalski et al. note that many contemporary video game consoles have embraced "kinesic natural mapping" (228). Rather than providing a "tangible controller," devices such as the Microsoft Kinect track body movements using cameras and motion sensors (228). The movements requested by the Kinect "correspond to real-life actions" in order to draw on "mental models for real-life behavior" during play (228), such as emulating the swing of a tennis racket in *Kinect Sports* in order to hit a virtual ball onscreen. Human-robot interaction, as previously discussed, involves similarly disembodied gestural commands. Although the intent of these naturalized interfaces is to secure flow, game consultant James Portnow argues that they often prove jarring for players. He elaborates that because the action takes place in the player's body – as advertised on Microsoft's website, “you are the controller” – one runs into the problem of their “body knowing how those actions are supposed to go” (“Extra Credits: Kinect Disconnect”). Although a player knows that a person does not run forward by “pressing a stick forward” on a controller, they recognize that a joystick is an arbitrary construct designed for efficiency rather than realism. In the case of pantomiming the swing of a tennis racket or waving an object precisely 30 centimetres in front of the NAO robot's eyes, these actions are similar enough to their source activities without perfectly emulating them that the participant cannot suspend the intrusive sensation that something does not “feel right.” In essence, the gestural interactions required by these technologies feel uncanny; as Portnow elegantly summarizes, the “Kinect has reached the uncanny valley of input devices.”

A solution to this problem of uncanniness can again be gleaned from Masahiro Mori's prescient essay on the topic. As previously discussed, there is a strong impetus to rest on the first plateau prior to the uncanny valley. Within the context of video games, this strategy entails the exchange of kinesic natural mapping for “incomplete tangible natural mapping” (Skalski et al. 228). This alternate form of natural mapping involves providing players with a controller that “partially simulates the 'feel' of an object on screen” (228). This is the modus operandi of the Nintendo Wii, whose handle-shaped input device urges players to “grasp it similarly to how they would grasp real objects” – such as a sword, baseball bat, or tennis racket. Although drawing on mental models of real-life behaviour like the Kinect, the arbitrary shape and weight of the Wii controller combined with its plethora of buttons create a degree of separation from the source activity (228). Akin to the caricatured design of a doll, the provision of an input device that reminisces rather than replicates human motion prevents play with the Wii from feeling uncanny. This atavistic approach of reinserting the controller is perhaps a difficult sell within the futurist field of robotics; however, wearable input devices could offer the benefits of incomplete tangible natural mapping without relying on analog joysticks and buttons. For example, a smartwatch that tracks the arm movements of a participant through its gyroscopic sensors would preserve the referencing of conversational gestures in human-robot interaction while separating their enactment from a person's body, reminiscing the methodology of the Wii controller. In addition, by providing visual or haptic confirmation through the device when a command is received by the robot, it could be used to subtly recreate the satisfying tactile feedback provided by a button press. Riffing on Portnow's commentary, a temporary remedy to the uncanny interfaces plaguing both robots and video games may be found on the first plateau of input devices.

Media theorist Derek Burill notes that when learning how to play a new video game, one of the greatest tools at a player's disposal is their preexisting “videogame praxis” (226). Although not everyone grew up with a Nintendo console in their living rooms, the modern ubiquity of smartphones and tablets – tantalizing consumers with free-to-play games such as *Angry Birds* and *Cut the Rope* – have granted individuals a “previous knowledge” of game constructs to draw upon (226). Given the widespread proliferation of this praxis – as well as the maturation of the field of game design scholarship – the video game-based framework proves an amenable approach for improving human-robot interaction. In the coming decades, robots may become so ubiquitous that human beings develop a parallel “automaton praxis”; however, until then, flow may be secured through the appropriation of video game theory and other ludic discourses.

VII. Does Not Compute: Trust, Malfunction, and Flow in Human-Robot Interaction

In Stanley Kubrick's 1968 film *2001: A Space Odyssey*, a team of astronauts bound for Jupiter are accompanied on their journey by an advanced artificial intelligence known as HAL 9000. Despite claims that the computer is "foolproof and incapable of error," malfunctions soon arise that result in the death of all but one of the astronauts aboard. This fear of catastrophic malfunction – popularized in Kubrick's classic but perpetuated ad nauseam in contemporary science fiction – colours common appraisals of robots. Although more likely to fall over, garble words, and misinterpret commands than launch their operators out of an airlock, malfunctioning automata kindle anxieties that they may damage household objects or even injure people – perhaps while repeating the monotone mantra of "does not compute." These anxieties, asides from stirring modernist mores, prove critical saboteurs of flow. Thankfully, solutions for maintaining flow in the face of malfunction can be derived from playful sources.

Malfunctions, in the most rudimentary sense, cause an operator to lose trust in the competency of a machine. In his foundational text *The Logic and Limits of Trust*, sociologist Bernard Barber notes that one of the fundamental expectations of trust in typical human social relationships is "technically competent role performance" (19). In order to trust family members, friends, and coworkers, an individual must be able to anticipate that their behaviour will be dependable and that this dependability will remain a predictable fixture in the future. Psychologist Bonnie Muir notes that this expectation of dependability is pivotal in human-machine relationships as well (529). Human operators anticipate "expert knowledge" and "competencies in a particular domain" from their technology (529). Put simply, if a machine cannot reliably and effectively complete the task it was designed for – whether it be conversation, minesweeping, or chopping vegetables – it is deemed a derelict and untrustworthy tool. A malfunction represents the utmost collapse of this perceived technical competency. As noted by theorists Peter Hancock et al., a malfunction not only affects the "willingness of people to accept robot-produced information" but may also result in "disuse of a system entirely" (518). The researchers cite the example of the SWORD robot, a machine designed to aid combat operations during the 2007 conflict in Iraq. Although the SWORD was fully operational, its propensity to make slight "unexpected movements" resulted in it never being used in the field (518). This malfunction, while entirely benign, caused soldiers to "not trust it to function appropriately and safely" during stressful operations (518). As socially assistive robots enter similarly sensitive situations – such as long-term care facilities or hospital wards – the general aptitude for malfunction to destroy trust and dissuade use must be acknowledged.

Given that a robot is not only a tool in the home but also a player within the magic circle, these malfunctions further serve to jeopardize flow within a human-robot interaction. In one sense, malfunction can collapse the magic circle by framing the robot as a spoilsport. Johan Huizinga defines a spoilsport as a player who "trespasses against the rules or ignores them" (11). Unlike a cheater, who "pretends to be playing the game" and "acknowledges the magic circle" to an extent, the spoilsport "reveals the relative fragility of the play-world" by explicitly trampling on its constituting rules (11). An angry child who vacates the soccer field with the ball in hand or a bored chess player who wantonly moves her pawns like checkers pieces to goad her opponent are both examples of spoilsports. Huizinga warns that the spoilsport "must be cast out" of the magic circle for he or she "threatens the very existence" of the play-world (11). As the anthropologist elegantly surmises, the "umpire's whistle breaks the spell and sets 'real' life going again" (11). When a robot malfunctions, it similarly evokes the ethos of the spoilsport. Each missed vocal command or garbled response is an explicit trespassing of the rules of human-robot interaction. Like the referee, the human operator must suspend the magic circle temporarily, wearily troubleshooting why the robot ignored them, what caused it to fall over, or whether or not its batteries are charged. Repeated instances of malfunction can even result in the robot being cast out of the play community permanently, coinciding with Huizinga's suggested fate for the spoilsport; as Donald Norman warns, "today's sophistication runs the risk of becoming tomorrow's discard" if discordance overwhelms intended design (67). The spoilsport, whether it be the intentionally anarchic player or inadvertently malfunctioning machine, "robs play of its illusion" (Huizinga 11) and dismembers flow.

Malfunction further disrupts flow by impairing the rules of irrelevance. Briefly revisiting Erving Goffman's previously discussed concept, the rules of irrelevance dictate that players immersed in a game forswear any interest in the physical or sentimental value of the equipment employed (19). As previously mentioned, these rules are integral to the promotion of a robot from an inanimate object to an agent in the magic circle. However, Goffman notes that the rules of irrelevance can be fractured when meanings that are "part of other frames in which game equipment can be handled" assert themselves (20). For example, a chess set that is "cherished as an heirloom" or "given as an expensive gift" might have its material context supersede the rules of irrelevance if a piece is knocked onto the floor or handled roughly by an opposing player (20). As the owner preoccupies herself with recovering the coveted item, she breaks the magic circle of the chess match by asserting a mundane concern when a playful discourse "was expected to hold sway" (20). A malfunction on the part of the robot causes a similar dissolution of the rules of irrelevance. Each successive misstep removes the robot further from a playful mindset by drawing attention to the fragile and expensive elements of its manufacture – wires and motors that are possibly short-circuiting or overheating. Hancock et al. describe this problematic side effect of malfunction as an absence of "neglect tolerance" (518). When a robot malfunctions frequently, a human operator loses faith in its autonomous performance and instead becomes preoccupied in monitoring its status or saving it from damage. This inability to neglect the robot, asides from producing "suboptimal system performance" (518), sabotages the flow state; unconscious interaction with a potential companion is replaced with a fixation on the material and monetary concerns of a haywire machine.

The programming of a robot to respond to malfunction with playful and self-effacing behaviours proves a potential means of preserving flow in these instances of malfunction. Psychologist Cornelia Wendt and computer scientist Guy Berg note that humour is not simply a trivial social activity but rather a "useful and widespread tool in our society" (183). Humour enables people to "handle anxiety or interpersonal tensions" and to "solve conflicts... in situations when other means might fail" (183). Goffman affirms Wendt and Berg's claims through his sociological concept of integration. The scholar notes that when incidents threaten the integrity of a play encounter, it is "possible for a participant to blend these embarrassing matters smoothly" within the prevailing order (48). By conjugating "apt words and deeds" or leveraging particular "charm, tact, or presence of mind," a troublesome event can be deftly redefined and reconstituted (48). Often these integrations take the form of "apologies, little excuses, or disclaimers" that are possessed of a well-meaning or humourous quality (51). As Goffman illustrates, a bowler that accidentally trespasses the foul line or launches the ball into an adjacent alley might flash a comic expression, indicating "that the shot was not a fair or serious measure of [his] skill" (51). By rolling his eyes and laughing off the lapse of his abilities, the player aims "to save his face," assuring his peers that they need not "doubt their prior evaluation of him" and rebrand him a spoilsport (51). Human error is integrated into the prevailing order through self-deprecating humour, and flow is consequently more easily sustained.

The self-effacing behaviours prevalent in human play encounters can be transcribed to human-robot interaction. Wendt and Berg conjecture that humour could be used as a means to afford "lenience towards technical errors" and generally "increase the likability of a robot" that does not perform as intended (187). Specifically, when an automaton succumbs to "annoying delays or repeated misunderstandings," it could be programmed to make subtle attempts at self-irony (187). This could involve the delivery of a self-effacing apology, the articulation of a pie-eyed expression of disappointment, or even the emission of a silly sound effect to cartoonishly punctuate the moment. These attempts at self-irony, much like the eye rolling of the bowler, serve to integrate a participant's error into the magic circle. Although Wendt and Berg question whether it is even "possible to let a robot do something that is perceived as humor at all" (183), the latent childlike characteristics of a robot seem to complement this self-effacing disposition. Just as users might respond amiably to robots that demonstrate childlike "astonishment at small wonders" and "spontaneous inquisitive character" (Wrye 1042), they might easily forgive machines that demonstrate the clumsiness and fallibility symptomatic of childhood. As playfully noted by Norman, part of the charm of R2D2 and C3PO of the *Star Wars* films is "the way they display their limitations" (164). The latter in particular is "pretty incompetent" at everything except translating languages and has "limited physical capabilities" (164); however, C3PO is regarded as an endearing character owing to his “well-meaning” attitude and his seemingly bottomless reservoir of platitudes (164). In a galaxy less far away, where malfunctions are far more prolific but perhaps less inherently entertaining, Wendt and Berg's suggestion for self-irony seems a simple but effective means of downplaying error and ensuring the resumption of a playful flow state in human-robot interaction.

Another playful solution to the problem of malfunction involves the design of trust-building games. The application of such games is motivated by the impact of the primacy effect in human-machine interaction. Psychologists Kenji Noguchi et al. define the primacy effect as “the tendency to weigh initial information more heavily” (208). The theorists specifically frame this tendency within the domain of interpersonal perception, noting that “first impressions have a disproportionate influence on judgments of others” (208). As a consequence, individuals – particularly in North American culture – are “slow to revise their impressions once formed” (208); job interviews, speed dating, and other abbreviated human social rituals all demonstrate the decisiveness of one's first remark. However, computer scientist Munjal Desai et al. elaborate that the primacy effect is integral to human-machine interaction as well. The researchers assert that periods of low reliability *earlier* in an interaction have a more detrimental impact on trust than equivalent lapses *later* in an interaction (255). A “positive primacy experience” is in fact capable of masking minor incidents and malfunctions that might subsequently occur (256). Referring back to Muir, if the appearance of “expert knowledge” and “competencies in a particular domain” is solidified within the first few minutes of a human-machine interaction (19), the user may be predisposed towards conceiving of the machine as generally trustworthy overall. This would bias them to hand-wave later lapses of competency (as long as they pose no immediate danger) as anomalous. Whether pertaining to a job interview with a potential employer or a therapy session with a socially assistive robot, a positive primacy experience thereby serves to preemptively integrate troublesome events into the magic circle.

Trust-building games provide a means of harnessing the primacy effect within human-robot interaction. Hancock et al. note that trust-building exercises are "used frequently in the human-interpersonal trust literature" (524). Although often derided as fluffy initiatives endorsed by office managers, these exercises provide a means to "prepare an individual for [a] coming interaction" with a teammate (525). Information scientist Sirkka Jarvenpaa et al. provide evidence for this assertion in their 1998 study on team building. The scholars observe that a two-week regiment of trust-building exercises (involving the guided exchange of professional aspirations and personal anecdotes over email) had "a significant effect on the team members' perceptions of the other members' ability, integrity, and benevolence" (29). Unfortunately, neither of these referenced studies provide a conception of how such an exercise might be translated from the office worker to the looming automaton; however, I can again offer my own experiences with the NAO robot as guidance.

The Aldebaran Robotics website advertises the game "Touch My Head" as a good example of an application to use when introducing the NAO to a classroom of children ("Ask NAO!, Material"). When the application is launched, the robot "reinforces body awareness and instruction following [skills] by asking the child to touch his head, hands or feet tactile sensors." During classroom sessions, I observed that these tactile sensors have a much lower margin of error than the voice and gesture recognition capabilities most commonly employed by the NAO. (The foot sensors in particular depress and bounce back in similar fashion to a plastic button on a game controller.) The simplified nature of the “Touch My Head” game made it a caricature of general interaction with the NAO. As a consequence, it provided an opportunity for our young participants to orient themselves to the intimidating new entity in their classroom with a negligible chance of malfunction – ensuring a positive primacy experience. Reciprocal trust-building exercises could be designed for other socially assistive robots, introducing an automaton to its user and cementing its perceived competency through precisely choreographed and foolproof routines. These trust-building exercises may be used to better flow in a general human-robot interaction by ensuring flow in a simplified microcosm of that interaction – serving tandemly as moral assurant and tutorial.

At a 2006 trade show in Tokyo, Honda gave a technical demonstration of its flagship robot ASIMO. During a showcasing of the automaton's mobility (chronicled in Brian Lam's coverage of the event in *Gizmodo*), an error caused it to dramatically tumble down a flight of stairs, drawing gasps and laughter from the audience. The twenty-first century represents an awkward adolescence for robotics, where malfunctions are frequent and inevitable even among sophisticated machines such as the ASIMO. Given the detrimental repercussions these errors have on the flow state, it is imperative that strategies be developed to mitigate their impact on human-robot interaction. The provision of playful self-effacing behaviours and trust-building games are preliminary examples of such strategies, ensuring that the competency, trustworthiness, and animacy of a robot are not put into question during these proverbial and actual missteps towards the future.

VIII. Conclusion

In July of 2006, noted Japanese roboticist Hiroshi Ishiguro showcased a new humanoid robot his laboratory had developed known as the Geminoid HI-1 (Robertson 26). The android was strikingly constructed to be a doppelganger of its creator: its silicon and steel frame shaped from casts taken of Ishiguro's body; its facial expressions and gestures based on motion capture data of his movements; and its hair "plucked from Ishiguro's own head" (26). Anthropologist Jennifer Robertson muses that the robot was even clothed in its creator's "unfashionable beige shirt, dark trousers and black windbreaker" (26). Although Ishiguro's goal of twinning himself is somewhat of an eccentricity – the roboticist jokingly relates that he would like the Geminoid HI-1 to teach his classes at Osaka University for him – it is symptomatic of the omnipresent drive within the field of robotics to flawlessly replicate human beings. From Jacques de Vaucanson's flute-playing marvel, to Alan Turing's thinking computer, to Honda's perambulating ASIMO, roboticists have long pined to see genuine human movement and experience emerge from a chrysalis of plastic and steel.

The quest for a synthetic human being has proven so all-encompassing that perhaps, in the ides of the 2010s, it is time to take a step back and reappraise this trajectory. Technology theorist Brian Duffy notes that engineers have become so infatuated with the goal of making a robot that can "walk and talk" in the manner of an adult human being that they have never stopped to question whether or not this should be the "ultimate challenge" the field of robotics commits itself to (188). He notes that an automaton able to "fool a person" into thinking it is intelligent and socially competent will remain an "elusive goal for many years to come" (188). Masahiro Mori similarly affirms that the additions of pink latex skin, artificial facial expressions, and articulating hands often only serve to thrust these machines deeper into the uncanny valley (99-100). In a telling anecdote, Ishiguro's attempt to create a second Geminoid based on the appearance of his own daughter proved catastrophic. His daughter was so terrified by her "uncanny look-alike" that she refused to set foot in her father's lab for months (Robertson 22). This uncanny anxiety felt towards androids – exacerbated by the modernist fear of a robot uprising envisioned by playwright Karel Čapek – proves a recurring impediment to the embrace of these machines as servants and companions. Although roboticists may consider "anything less than a fully functional synthetic human robot" a failure (Duffy 188), it is imperative to explore alternate models of design to ease acceptance of these alien automata.

As reiterated throughout the eight chapters of this text, the robot-as-toy metaphor provides a useful rubric for the design of amiable and intuitive machines. Through a rigorous historical analysis, the childlike qualities and moderate human likeness of humanoid toys have been demonstrated to yield a high affinity among adults and children alike. Robots modeled after these childhood playthings are consequently permitted to sit on the first plateau prior to the uncanny valley, eschewing the troublesome modernist mores and ancient superstitions tethered to icons of the human form. Jumping into the digital age, virtual pets such as the Tamagotchi – despite their relatively primitive technology – provide evidence of how the doll instinct can be effectively transcribed into the sterile wires and microprocessors of digital technology. By recognizing this ludic possibility, the vast academic reservoirs of play theory and cultural anthropology can be drawn from to empower the design of social robotics. Playful concepts such as the magic circle and flow not only permit a holistic appraisal of the rules and social dynamics governing human-robot interaction but also provide possible solutions to commonplace issues such as technical illiteracy and malfunction. As articulated by sociologist Johan Huizinga, the "great archetypal activities of human society are all permeated with play" (4). It is apt then that the field of robotics – both a fledgling cultural institution in itself and a technology predestined to intersect with the cultural spheres of medicine, business, and education – should be appraised through a similarly playful rubric.

This paper is not a call for robotic atavism. Simplified toy-like automata will never replace advanced humanoid designs, and the second plateau after the uncanny valley will continue to be the aspiration of engineer and science fiction writer alike. However, through an extensive synthesis of historical record, contemporary theory, and autoethnography, this paper has showcased the advantages of embracing an automaton's heritage of toyishness for the enhancement of human-robot interaction. Crying dolls, plush animals, and virtual pets have long resided comfortably within the domestic sphere as cherished playthings and cherubic playmates. By acknowledging these toys as ancestors to robots, their playful affinity can be reincarnated within the bodies of plastic and steel destined to occupy the twenty-first century alongside human beings.

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