The Prevalence and Potential Problem of Cuteness in Zoomorphic Robots

ISOBEL VOYSEY, School of Informatics, University of Edinburgh, United Kingdom and Department of Computer Science, University of Oxford, United Kingdom
LYNNE BAILLIE, School of Mathematical and Computer Sciences, Heriot-Watt University, United Kingdom
JOANNE WILLIAMS, School of Health in Social Science, University of Edinburgh, United Kingdom
MICHAEL HERRMANN, School of Informatics, University of Edinburgh, United Kingdom

Cuteness is a powerful aesthetic, and psychological research shows that cute things such as infants, baby animals, and toys capture and secure our attention, promote nurturing behaviour, and influence our preferences. Therefore, cuteness is a common design outcome in many consumer products, including robotics. However, we suggest that making cute zoomorphic robots may not be without its issues due to the complexities introduced by the analogies they make to various animals. We summarise the impact of cuteness in animals and robotics and analyse the intersection of the two domains by comparing the presence of baby schema features in different canine zoomorphic robots and dog breeds. Finally, we speculate on the benefits and drawbacks to cute zoomorphic robots, and provide suggestions for a new design approach that centres animals' well-being. The aim of this work is to synthesise research on cuteness from different disciplines and prompt robot designers to be more conscious of cuteness and its potentially detrimental consequences in zoomorphic robots.

CCS Concepts: • **Computer systems organization** → **Robotics**; • **Human-centered computing** → *HCI design and evaluation methods*.

Additional Key Words and Phrases: Human-Robot Interaction, Zoomorphic Robots, Cute, Baby Schema, Animal Welfare Education

1 PREFACE

In order to inform the design of a zoomorphic robot for animal welfare education, we conducted two participatory design workshops, one with 11 members of the Education Team of an animal welfare charity, immediately followed by one with 24 8–11-year-old schoolchildren. In the children's workshop, the use of a particular word stood out to us—namely, *cute*. It was one of the most common words used in two distinct contexts, first to describe the robots seen in the demonstration session of the workshop (see Figure 1) and second to describe the appearance and behaviour of pets during the design session (see Voysey et al. [150] for details on the workshops). In contrast, while the educators had used words like *toy-like*, *appealing*, and *attractive* to describe the robots, they had not used *cute*.

Authors' addresses: Isobel Voysey, isobel.voysey@cs.ox.ac.uk, School of Informatics, University of Edinburgh, Edinburgh, United Kingdom and Department of Computer Science, University of Oxford, Oxford, United Kingdom; Lynne Baillie, l.baillie@hw.ac.uk, School of Mathematical and Computer Sciences, Heriot-Watt University, Edinburgh, United Kingdom; Joanne Williams, jo.williams@ed.ac.uk, School of Health in Social Science, University of Edinburgh, Edinburgh, United Kingdom; Michael Herrmann, michael.herrmann@ed.ac.uk, School of Informatics, University of Edinburgh, Edinburgh, United Kingdom.

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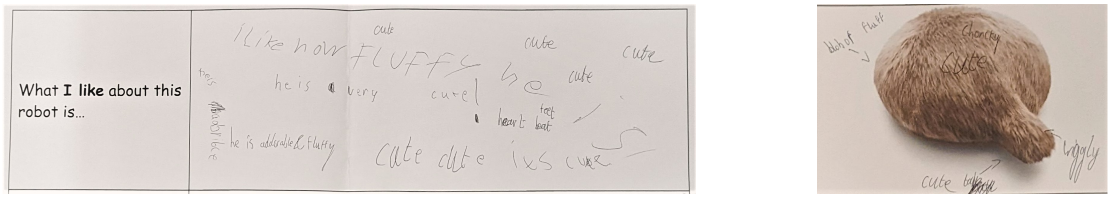


Fig. 1. Ten uses of the word "cute" in feedback on a zoomorphic robot, Qoobo, from a group of five 8–11-year-olds.

Given the children's focus on cuteness, we had an interdisciplinary follow-up discussion involving animal welfare educators on the place for cuteness in the design of zoomorphic robots for animal welfare education and in zoomorphic robots more broadly. The educators voiced concerns that cute-centric design could have a detrimental impact on children's perceptions of animals and increase the pressure to breed cute animals, which often have negative health outcomes. This discussion highlighted the need to synthesise knowledge and perspectives on cuteness from different disciplines when designing zoomorphic robots, particularly psychology, human-animal interaction, and human-robot interaction, and has led to the position and approach that we present in this work.

2 INTRODUCTION

Cuteness captures attention [15, 67] and influences behaviour [99, 133]. It also has a strong positive impact on preferences [50], including consumer behaviour [98, 152], which may be why we see a proliferation of cute designs across a range of products and, increasingly, in social robots.

Lacey and Caudwell [70] have started an important critical discussion on cuteness in robotics. They argue design for cuteness in robots is a 'dark pattern'—a phenomenon where design patterns are used in ways that deceive the user [14]. The work by Lacey and Caudwell [70] is focused on home robots, but we feel there is a need to discuss cuteness in zoomorphic robots specifically, due to the complexities introduced by their connection to animals. It is increasingly relevant to have this discussion as designers try to avoid the uncanny valley and biases by using animal inspirations [42]. On top of this, with the rise of domestic robots, more designers may choose to draw upon the established role of pets within the household to facilitate the acceptance of social robots [78].

As we look at cuteness in zoomorphic robots there are questions that need to be considered. How has our innate love of cuteness shaped our relationship to animals and the design of robots? How might a preponderance of cute zoomorphic robots impact people and their interactions with animals? To what extent should we design for cuteness in zoomorphic robots? These questions motivated a review of the existing literature across relevant disciplines, namely psychology, human-animal interaction, and human-robot interaction. We searched Google Scholar and discipline-specific databases (e.g., ACM DL), combining the term cute and related terms like *kawaii* and baby schema with animal and/or robot, in order to identify key papers. We followed this up with reference list searching and citation tracking to assemble a collection of relevant work for synthesis.

We begin this paper by discussing the research on cuteness and the baby schema, and where we see a pull towards cuteness in domesticated animals and robotics. There is a paucity of literature on cuteness in zoomorphic robots, but we wanted to get a sense of how prevalent cuteness is in zoomorphic robots. Therefore, we conducted a case study into the baby schema features of a set of existing dog-inspired zoomorphic robots and compared these to the features of various dog breeds.

Subsequently, we speculate on the benefits and risks of cute zoomorphic robots, with particular reference to children's interactions with animals, based on the discussion that initiated this work. Finally, we give some thoughts on the purpose of cuteness in zoomorphic robots and suggest an alternative, zoocentric design approach.

The overall aim of this paper is to provoke designers to think about the problem of cuteness in zoomorphic robots and make conscious, informed decisions in their designs, rather than mindlessly following the cute.

3 BACKGROUND

The meaning of *cute* has shifted over time but now generally refers to something attractive, pretty, or charming, and is highly associated with the pleasing appearance and behaviour of youth, in both humans and animals [104]. The perception and impact of cuteness has long been investigated, with Lorenz's proposal of a *kindchenschema* (commonly translated as baby schema) being a seminal work in the field. Lorenz [79] argued that the positive, nurturing feelings invoked by infantile features was an evolutionary adaptation that ensured adults cared for their vulnerable young. More recent work by Sherman and Haidt [132] has described cuteness as a 'releaser' of prosocial behaviour.

Cuteness serves to capture and secure attention on vulnerable infants, which can facilitate sustained caregiving behaviours. For example, adults spend longer looking at photos of infants they perceive as cute [56] and will expend effort to increase the duration looking at photos of cute infants [51, 110]. Babies' faces and cries capture adults' attention via 'fast' pathways in the brain [15, 67, 109, 111]. Cute infant faces activate regions in the brain associated with the learning and anticipation of reward, including the orbitofrontal cortex [67, 111] and the nucleus accumbens [48].

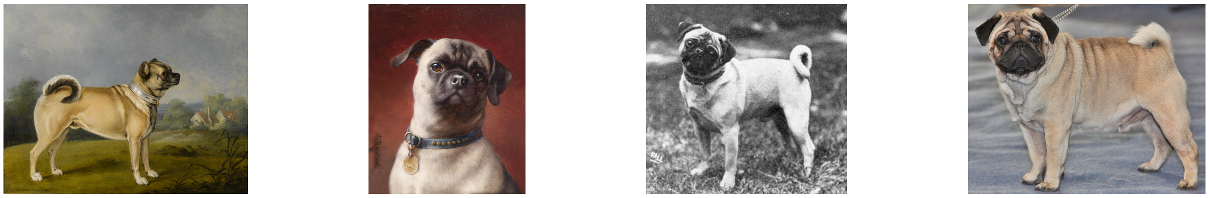
Along with capturing and securing our attention, cuteness can also change our behaviour. Viewing cute images of animals can result in increased performance in fine-motor [99, 133] and visual search [99] tasks, which suggests an increased carefulness induced by the presence of cute, infantile creatures. Further research has also shown greater intention to donate to and adopt cuter infants, transcending in-group preference [50]. However, the overwhelming feelings of cute can lead to aggressive expressions, as well as those of care, such as the desire some report when faced with a cute chubby baby to pinch their cheeks or say "I want to eat you up!" through gritted teeth [3, 140].

The *kindchenschema*, or baby schema, is a set of features that typify cuteness, first proposed by Konrad Lorenz in 1943 [79]. The features include a relatively large head, high forehead, retreating chin, large, bulging eyes, and truncated limbs, which together elicit affection in human viewers. Studies have found evidence that these features do contribute to the perception of cuteness. For example, one study found that Caucasian children rated as more attractive had larger foreheads and smaller jaws than reference children [131], while other research that manipulated babies' faces according to the baby schema has seen cuteness ratings and brain activation changing as expected [9, 47, 48].

Infantile cat and dog faces have been rated as similarly cute to infant human faces [5, 76], so it is not surprising that many of the effects of cuteness outlined above apply not only to infant humans, but also to infant animals. Both children and adults have been shown to have a preference for baby schema features in animals [126], and a study that manipulated images of cats and dogs according to the baby schema found those images were rated as cuter and young children spent more time looking at these cuter faces across all species tested (humans, cats, and dogs) [9]. Studies have used images of puppies and kittens as 'cute' stimuli to provoke careful behaviour [99, 133] and intentions to care for infants are positively correlated with cuteness for human, cat, and dog infants [50].

4 CUTENESS IN ANIMALS

Our preference for cuteness pervades our interactions with animals. Cuteness has even been suggested as a key driving force behind the keeping of domestic pets [4]. Cute animals get greater interest from zoos [37] and the scientific community [145], which can leverage governmental spending for cute or 'charismatic' species [90] but hinder conservation efforts for 'ugly' ones [35, 94]. Cuteness also emerges as an important factor behind people's preferences for different animals [80, 156].



(a) 1802 [20] (b) c. 1890 [114] (c) 1915 [84] (d) 2009 [16]

Fig. 2. Pugs through the last two centuries. Note the face getting shorter and wider.

Our love of cute features seems to have played an important role in the evolution of domestic pets. Neoteny is the retention of juvenile morphological and behavioural characteristics into adulthood and is particularly seen in domesticated animals. This may be due to selective breeding for juvenile, non-aggressive behaviours that facilitate domestication and then further selective breeding for attractive appearances [25]. As we have bred for these features, we have seen the rise of several elements of the baby schema in certain pet breeds: wide, flat faces (see, e.g., French bulldogs, Persian cats); high foreheads (e.g., Cavalier King Charles spaniels); large, bulging eyes (e.g., pugs); and truncated limbs (e.g., dachshunds). This has become even more exaggerated over the last few centuries with the establishment of kennel clubs and dog shows in the mid-19th century [153]—see Figure 2 for an example of the changes to pugs in this time period.

Pugs are one example of brachycephalic (short-faced) pets; a group that are particularly suffering as a result of this selective breeding. Brachycephalic breeds are seen in multiple species, including dogs, cats, and rabbits. These breeds are more and more popular [142], with research by Packer et al. [106] finding that appearance is a major factor behind their selection. However, brachycephalic breeds are associated with multiple health risks including respiratory problems, eye problems, and skin infections, among others [105, 107, 118, 125]. In recent years there has been a push to move away from breeding these dogs, or to take them back to their historical roots. Ian Futter, Chief Veterinary Officer at the Scottish SPCA, has exhorted the general public to "start to prioritise the health of their animals over the way they look and stop purchasing these extreme breeds" [129]; a view echoed by veterinarians in New Zealand who described three highly brachycephalic breeds, the pug, bulldog, and French bulldog, as having "health and welfare too compromised to continue breeding" [38]. Unfortunately, in some cases it would not even be possible to correct these defects through outbreeding as there are no remaining individuals with healthy characteristics. The breeding of pugs exemplifies one of several situations where our preference for cute, infantile-looking pets is not harmless and is, in fact, having a detrimental effect on the well-being of the animals themselves.

5 CUTENESS IN ROBOTICS

A look at the appearance and branding of social robots suggests that cuteness is a desirable feature in robotics as well—consider, for example, the robot called "cutie robot" (QTrobot [81]). Furthermore, when users are involved in the design of robots, they exhibit a marked preference for—and sometimes fixation on—cute designs (e.g., [11, 119] and the authors' own research). Rose and Björling [119], when conducting participatory design with teenagers for a social robot to measure stress, also came across this theme of cuteness. The teenagers frequently used the word *cute* to describe robots they liked from popular culture and as feedback about the robots and prototype they saw, which Rose and Björling [119] interpreted as a call to design for cuteness for this application.

Cuteness is regularly leveraged in social robotics to create pleasing designs. The baby schema has been directly referenced as inspiration by several robot designers, including the designers of Paro and Kismet, among others [12, 13, 123, 146], but many of its features can be seen in a wide range of robots—consider the large head and big eyes of Pepper and Nao or the stubby limbs and rounded body of QTrobot. Turkle [147] says that companion robots "push our Darwinian buttons" and result in "people feel[ing] a desire to nurture them", which other authors link to the designs incorporating the baby schema [96, 123]. Breazeal and Foerst [13] further argue that it is reasonable to explicitly target the baby schema in robotic designs to get people to treat them with protection and care and to scaffold robot learning [12, 13]. Beyond facial features, there are other attributes associated with cuteness that we see in social robots. When Rose and Björling [119] discuss the theme of cuteness for robots after analysing their participants' conversations, they not only reference the baby schema facial features, but attributes like being small, non-threatening, and inspiring the feeling of wanting to take care of or befriend the robot.

Humanoid robots rely particularly heavily on the baby schema. Incorporating more facial features makes a robot perceived as more human-like [31], which in turn can predict likability [120], but more human-like robots run the risk of being perceived as uncanny or threatening [120]. However, robots with exaggerated child-like features seem to counteract this perception. For example, a cluster of humanoid robots that Rosenthal-Von Der Pütten and Krämer [120] identified as following the baby schema was perceived as the least threatening of the groups, as well as perceived as likable and submissive. Cuteness, often expressed through baby schema features, can also improve the trustworthiness of social robots [21].

5.1 Zoomorphic Robots

Designers have also tried to avoid negative perceptions of their robots by moving away from humanoids. Zoomorphic robots, like humanoid robots, draw on established social scripts and leverage prior experience, but Shibata [134] suggests through his taxonomy of robot types (human, familiar animal, unfamiliar animal, and imaginary animal/new character) that humans will be less biased and severe in their judgments towards robots that are based on less familiar inspirations. Positive associations with the inspiration itself may also be leveraged. Designers frequently turn to pets—especially dogs—as a model for zoomorphic social robots, due to their social competence and the deep, long-lasting bonds people form with them [91], while avoiding animals that many people have negative feelings about, like spiders and snakes.

Zoomorphic robots parallel many aspects of animals, not only in the way they look, but in how they encourage people to think about them and treat them. Several authors liken even non-zoomorphic robots to pets; Gn [49] writes that "machines solicit affection by simulating pets and partners" and the thesis from Darling [29] is that people should view and interact with robots like domesticated animals. Other authors, like Miklósi and Gácsi [91], suggest we should look more at ethology (the science of animal behaviour) to design social robots, suggesting dogs as the prototypical companion that could be used when designing companion robots. One of the most studied zoomorphic robots is AIBO, which is modelled on a small dog. Both adults and children have been shown to attribute some level of mental, social, moral, and biological characteristics to AIBO [43, 61, 89, 102], even though other studies show they behave differently towards AIBO and real dogs [64, 112, 115]. Krueger et al. [68] summarise these studies as "users characteris[ing] their relation to AIBO to some degree in an analogous way as to a living dog".

Like humanoid robots, zoomorphic robots often draw on cuteness to make them appealing. For example, Paro was explicitly designed to be cute [123] and Sony released a rounder, cuter version of AIBO, AIBO 311/312, to appeal to female customers [45]. Other zoomorphic robots, especially those designed as toys, use baby schema features, like big eyes and round, flat faces to promote positive associations. The additional attributes of cuteness mentioned by Rose and Björling [119] of being small, non-threatening, and needing care frequently apply to zoomorphic robots. Many of them are the size of a cat or small dog and move slowly, which makes them physically non-threatening. The pet inspiration also contributes to the feeling of the robot needing care as pets are highly reliant on their owners for many of their needs. Zoomorphic robots are often, subtly or otherwise, using cuteness to facilitate acceptance.

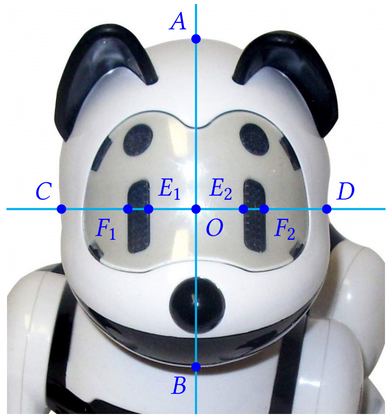


Fig. 3. Points used for measurements based on the procedure by Borgi et al. [9].

5.1.1 Baby schema in canine zoomorphic robots. Given the lack of literature analysing cuteness in zoomorphic robots, we wanted to get an indication of how baby schema features are used in zoomorphic robots and how this compares to live animals. To do this, we compared eye size, forehead size, and cephalic index (a measure of head shape) in live dogs and robotic dogs. We selected robots with canine inspiration from the dataset gathered by Löffler et al. [77], which comprised 18 robots. We also selected nine popular breeds of dog across the three categories of head shape: brachycephalic (short-headed), mesaticephalic (medium-headed), and dolichocephalic (long-headed). The brachycephalic breeds were pug, French bulldog, English bulldog, the mesaticephalic breeds were Labrador retriever, poodle, beagle, and the dolichocephalic breeds were dachshund, German Shepherd, and greyhound. All of these dogs are highly popular breeds, with all bar pugs and greyhounds being among the top ten most common dog breeds according to the American Kennel Club's registration statistics [1]. Pug and greyhound are included as examples of the most extreme head shapes currently seen in dogs.

Procedure. For eye size and forehead size, we followed the procedure outlined by Borgi et al. [9]. We searched the internet to find front-facing photos of each robot in the dataset from Löffler et al. [77], where possible with the mouth closed, and measured the dimensions indicated in Figure 3 using Adobe Photoshop. We omitted two robots that do not have eyes and a further seven robots (mostly animatronics) where appropriate photos could not be found, leaving us with nine robots[1], largely entertainment robots or children's toys. For eye size, we measured the average eye width (*EF*) and measured the face width (*CD*). We then divided eye width by face width to give us a ratio, where a larger value indicates the eyes take up a larger proportion of the face. For forehead size, we had to omit a further two robots that have a permanent open-mouthed expression, leaving us with seven robots[2]. We measured the forehead length (*AO*) from the top of the head to between the corners of the eyes (or centre of the eyes if the eyes had no discernible corner) and measured the face length (*AB*) from the top to bottom of the head. We then divided forehead length by face length to give us a ratio, where a larger value indicates the forehead takes up a larger proportion of the face. We also included data for nine breeds of dog, named above. Figures 4 and 5 show the difference between the robotic dogs and real dogs. For both of these measures, a larger value is associated with a more infantile appearance.

[1] Aibo ERS-7 (3rd gen.), Aibo ERS-1000 (4th gen.), Bandai Smartpet, FurReal Biscuit My Lovin' Pup, FurReal Gogo My Walkin' Pup, Teksta Robotic Puppy, Tomy Dog.com, WowWee CHiP, Youdi Puppy Dog Robot
[2] Aibo ERS-7 (3rd gen.), Bandai Smartpet, Genibo, Teksta Robotic Puppy, Tomy Dog.com, WowWee CHiP, Youdi Puppy Dog Robot

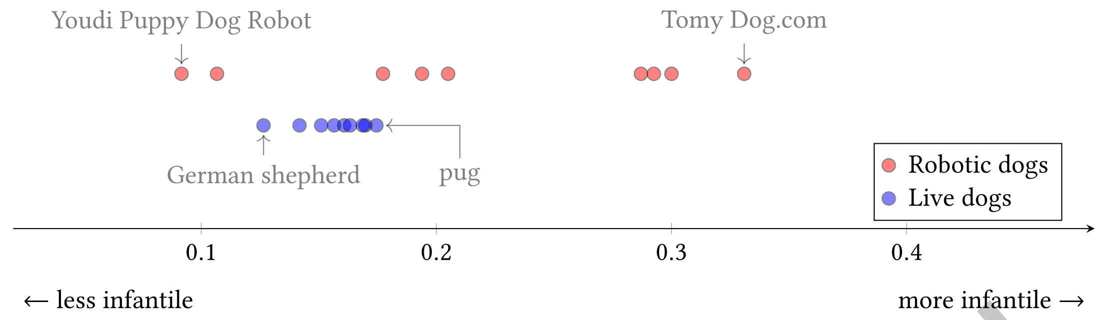


Fig. 4. Stacked strip plots showing the eye width to face width ratio in dogs and robotic dogs. The most extreme examples in each group are labelled.

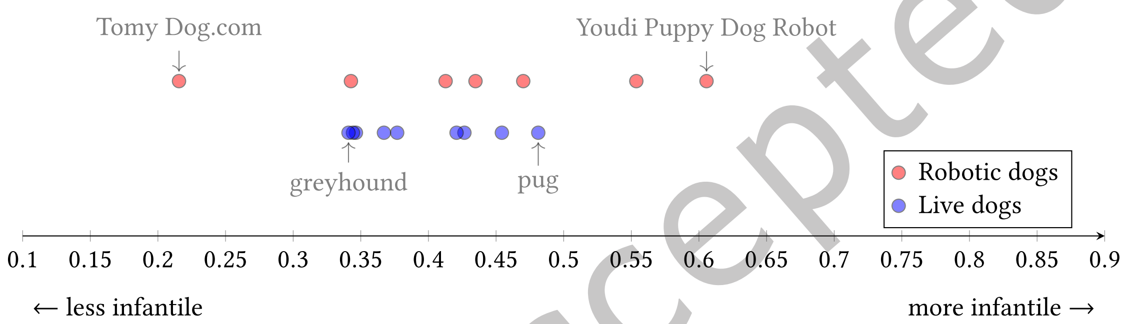


Fig. 5. Stacked strip plots showing the forehead length to face length ratio in dogs and robotic dogs. The most extreme examples in each group are labelled.

For the cephalic index, we measured the width and length of the skull from a top-down view. We omitted thirteen robots where appropriate photos could not be found, leaving us with five robots[3]. We divided skull width by skull length and multiplied by 100, as is standard practice in zoology. Here, larger values indicate a shorter snout or a brachycephalic breed, which is associated with a more infantile appearance. We also include the cephalic index for the nine different breeds of dog listed above, taken from measurements by McGreevy et al. [86]. Figure 6 shows the difference between robotic dogs and real dogs.

The images analysed and a spreadsheet of the resulting measurements are available online[4].

Discussion. Although eye size, forehead size, and cephalic index are not the only measures of cuteness, the distribution of points in Figures 4 to 6 indicates that many canine zoomorphic robots diverge from realistic dog-like appearances in the direction of infantile, cute appearances.

Figure 4 shows a particularly marked trend towards enlarged eyes in robotic dogs. Seven out of the nine robotic dogs have larger eyes (relative to their face width) than all of the live dogs. The exceptions are the Youdi Puppy Dog Robot, pictured in Figure 3, and one lightly-actuated fluffy toy.

Figure 5 shows a mixture of forehead sizes in robotic dogs, representing a much greater range than seen in live dogs. These exaggerated appearances are not always in the direction of baby schema cuteness—the Tomy

[3]Aibo ERS-7 (3rd gen.), Aibo ERS-1000 (4th gen.), Genibo, WowWee CHiP, Youdi Puppy Dog Robot
[4]https://osf.io/5hc8v/?view_only=4db75db4edcc43e99a1c0944e7a367ab

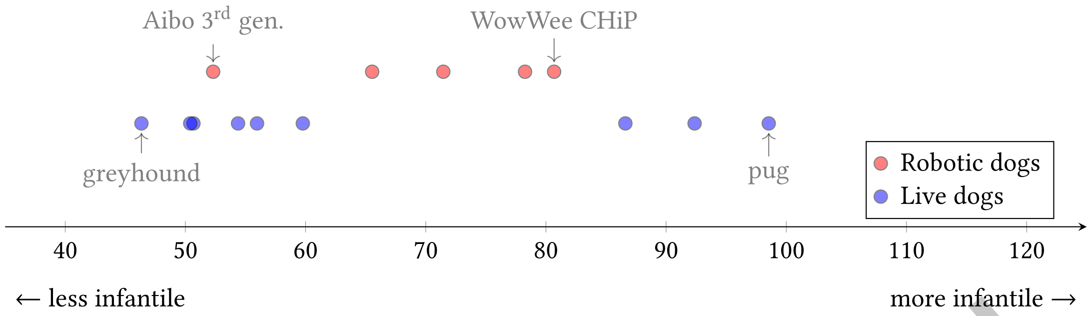


Fig. 6. Stacked strip plots showing the cephalic index in dogs and robotic dogs. The most extreme examples in each group are labelled.

Dog.com robot has a very small forehead, partially due to its face being dominated by its large eyes. Other robotic dogs, like the Youdi Puppy Dog Robot, have much larger foreheads than the most extreme live dogs.

Although the cephalic index of robotic dogs does not reach the extremes of some live dogs (e.g., pugs, French bulldogs, English bulldogs), Figure 6 shows a trend towards brachycephaly (flat faces) in robotic dogs. Miller's *Anatomy of the Dog* gives the average cephalic index of brachycephalic dogs as 81, while mesaticephalic dogs (those with a head of medium proportions) have an average cephalic index of 52 [36, p. 87]. In four of the five cases in which the cephalic index could be calculated for a robotic dog, the cephalic index exceeded 65 (Figure 6), which would put all four in the top quartile for brachycephaly of the 48 common breeds McGreevy et al. [86] measured. The exception was the third generation of Aibo, the ERS-7, which had measurements placing it in the mesaticephalic range.

While many of the designs are extreme in the more infantile direction, some are extreme in the less infantile direction and some present a mixture of extremes. For example, the Youdi Puppy Dog Robot has comparatively small eyes but a very large forehead, whereas the Tomy Dog.com has large eyes but a very short forehead. This mix of extremes is not entirely unnatural; it is also seen in live dogs, such as the greyhound, which has the third largest eye width to face width ratio but smallest cephalic index of the dogs analysed.

The robotic dogs analysed here are largely children's toys, so it makes sense that designers prioritise an appealing appearance. However, we note that the use of exaggerated baby schema features is more prevalent in robotic toys with plastic surfaces than those with fur, which had appearances comparable to traditional stuffed toys and facial proportions similar to those of live dogs.

There are limitations to this analysis, including difficulty finding appropriate images to measure the cephalic index from and taking accurate measurements from photos. This analysis is also limited to robots inspired by dogs, so a deeper investigation needs to be conducted into zoomorphic robots inspired by other familiar animals, like cats and rabbits, and imaginary animals, such as the Furby. Future work could also investigate what seems to be a trend to cuter robots over time; successive generations of AIBO have incorporated a larger forehead and a shorter, flatter face, with the cephalic index increasing from 52 to 66 from the third to fourth generation. Similarly, Furby, the iconic children's toy, has recently undergone a redesign. Although the eyes now occupy less of the face width, their size has grown relative to the beak, which is no longer actuated and has a permanent open-mouthed expression. The eyes are also cartoon-like with exaggerated highlights. The colour scheme has shifted from mostly natural browns, blacks, and whites to vibrant pinks, purples, and oranges. These design changes also suggest that works investigating changes in cuteness over time may need to consider a wider range of cuteness measures, moving beyond facial proportions.

In summary, many canine zoomorphic robots are leaning on exaggerated baby schema features, which go beyond those seen in live dogs, suggesting our love of cuteness is being reflected in the choices made in the design of zoomorphic robots, as well as in the design of humanoid robots and preferences for animals.

6 WILL CUTE ZOOMORPHIC ROBOTS BE GOOD FOR PEOPLE AND ANIMALS?

We are seeing cuter and cuter zoomorphic robots. But is this a good thing? In this section we speculate on some positive and negative aspects of how cuteness might influence people in their interactions with individual animals and attitudes to animals more broadly, and how this might impact the animals.

We frame our discussion with particular reference to children's interactions with animals and the use of robotic animals as educational tools. Zoomorphic robots are commonly targeted at children for their entertainment, which is true for most of the robots analysed in Section 5.1.1. However, materials surrounding zoomorphic robots often position the child as the robot's carer (Furbies designate the child as a "Mommy" or "Daddy" [53]), and some feel that owning might help teach children responsibility and care for future pet ownership [122]. We also focus on supporting educational goals because animal welfare education was the use case that prompted this work. Animal welfare education aims to safeguard the welfare of both people and animals by educating people (often children in schools) about animals' needs, emotions, and behaviour [95]. Therefore, any zoomorphic robot used in animal welfare education should be designed so that it ultimately facilitates the well-being of animals, and cuteness may support or hinder that goal.

6.1 Potential Benefits

Cuteness could hold some benefits for people and animals based on the way it may positively influence engagement and nurturing behaviour, leverage 'moral power', and help in the recognition of facial expressions.

6.1.1 Engagement. As the psychological research establishes, cuteness focuses and sustains attention [51, 56, 110]. Attention and engagement are particularly important for effective comprehension and retention during education [75, 138]. Thus, the use of a cute robot in animal welfare education may result in greater attention paid to the lesson and therefore greater retention of the key learning objectives. Cheok [22] mentions that Japan has long used cute mascots to deliver boring information in an acceptable and appealing way. However, the cuteness of an object might become the focus and then be distracting from lesson content. Additionally, as mentioned in Section 1, in the workshop we conducted, children described both the robots and pets as cute. Something that evokes the same cuteness response as pets may be a useful tool that helps children connect it to a pet and apply similar thought patterns and behaviours.

6.1.2 Nurturing. Cuteness positively influences intentions to care for the cute object [50], as well as inhibits aggressive behaviour [44]. This is behaviour that animal welfare education wants to encourage, so cuteness could be help reinforce these intentions. It would also likely prolong the life of a zoomorphic robot used for animal welfare education if children are predisposed to treating the robot in a gentle manner. Anecdotally, when we introduced children to Qoobo (the robot they thought was particularly cute, see Figure 1) in the workshops, they handled Qoobo gently, stroking and patting it.

Cuteness can also influence caring behaviour via attachment. Thorn et al. [144] found closeness with pets is positively associated with owner-perceived cuteness and Archer and Monton [5] found that the preference for infantile features was stronger in owners who were strongly attached to their pet. In turn, Hawkins et al. [54] found that attachment to pets significantly predicted positive attitudes toward animals. Therefore, fostering attachment to zoomorphic robots via cuteness may help to encourage careful and caring behaviour.

6.1.3 Moral power. Sherman and Haidt [132] reframe the cuteness response as an emotion that acts to expand the moral circle by "releasing" sociality. The moral circle refers to those entities to which harm is morally forbidden [137] and often includes non-human entities, particularly family pets. Sherman and Haidt [132] further argue that the innate response to cuteness is more sustainable than compassion, which can be subject to fatigue. Zhang and Zhou [158] also argue that the use of cute tools in moral education "can activate children's emotional responses to cuteness, arouse the emotions corresponding to moral care, and enable them to better absorb and internalise moral content". Therefore, there can be a power in perceived cuteness that can be used to induce people to treat something kindly.

However, cuteness may not be the only way to achieve this moral power. Perceived animacy seems to have an association with moral standing [89]. In Voysey et al. [149], children gave reasons why it was or was not acceptable to kick a zoomorphic robot. The reasons were split into two themes, where the robot was either viewed as an item of property or viewed as a being with moral standing. The latter group perceived the robot as more animate and more likely to have things it liked and disliked than the former group. Similarly, participants in a workshop conducted by Darling [29, p. 211] were highly reluctant to destroy the Pleo robot with which they had been interacting. Darling [29] suggests an innate moral standing attributed to robots. It may be better to strengthen this by building an emotional relationship with the robot, as the appeal of cuteness can fade quickly [19].

6.1.4 Understanding expressions. As shown in Section 5.1.1, cute robots often exaggerate the size of facial features, particularly the eyes. Facial expressions are a major component of how humans interpret animals' internal states; a form of communication that has enabled humans and dogs to co-exist safely and work together, developed between them over thousands of years of domestication. For example, a muscle to raise the inner eyebrow is present in dogs, but not wolves, which Kaminski et al. [63] suggest is due to human preference and selection for expressive faces in canines. In turn, dogs make more facial expressions when human attention is on them, suggesting they use facial expressions as a way to communicate, rather than these expressions being purely involuntary motions [62]. Given that children frequently misinterpret dog facial expressions [71, 88], which may lead to bites [103], facial expressions, including the shaping of the ears, eyes, and mouth, are an important topic for education. Furthermore, expressive faces may produce emotive, nurturing responses. The movement produced by the muscle mentioned in Kaminski et al. [63] appears to enlarge the eyes and resembles human sadness. Waller et al. [151] further find that dogs that produce this expression more are rehomed quicker, suggesting a nurturing response to this expression.

6.2 Potential Risks

Cuteness could hold some risks for people and animals based on the way it may minimise safety concerns in human-animal interaction, exacerbate breeding pressures, cause us to neglect 'ugly' animals, commodify cuteness, and make us susceptible to sharing private data.

6.2.1 Minimisation of safety concerns. As cuteness is associated with infantile creatures, it is often implicitly unthreatening. While this may be true in many situations, it may fail to highlight the risks that can be present in human-animal interactions; dogs, cats, and other animals have teeth and claws that they will use to defend themselves if necessary. When children view animals as cute and harmless they may interact with them in an inappropriate way and fail to take warning signals seriously. Furthermore, common behaviour in response to a cute animal (high-pitched voices, attempts to pet or cuddle) may be even more likely to startle an animal and provoke a bite [7, 59]. Children may have a false sense of security around dogs due to depictions in films and TV shows [7, 116]. This false sense of security will likely be reinforced by existing zoomorphic robot toys, since the vast majority do not have negative reactions.

6.2.2 Exacerbation of breeding pressure. Many factors may play a role when it comes to acquiring a pet. Holland [57] groups these factors into four categories: animal-related factors, like appearance, behaviour, and health;

social influences; socioeconomic and demographic factors; and previous ownership experience. Preferences for different breeds are influenced by the world around us, particularly media. For example, films featuring dogs have been associated with increased popularity of the featured breed for up to ten years following its release [46, 55]. While not yet investigated in the context of pet ownership, authors suggest that social media and celebrity influencers may also have an impact on breed choice, particularly among younger owners [106].

Fads for a particular breed may mean owners obtain a pet without full understanding of the breed temperament and needs—causing a mismatch between owner lifestyle and animal needs that may result in increased surrenders to animal shelters and potential subsequent euthanasia [55, 124]. For example, the eight years following the 1985 re-release of the film *101 Dalmatians* saw a seven-fold increase in the number of puppies registered [55]. However, Dalmatians were bred to run alongside horse-drawn carriages and are advised to get at least two hours of exercise per day [143], which is not necessarily achievable for every owner. Unfortunately, when dogs do not get enough exercise they can become restless and destructive [26, 27], which can trigger relinquishment to animal shelters or rehoming [92, 124].

Furthermore, as demand for a given breed increases, the pressure on breeders to produce more individuals of that breed increases and unscrupulous breeders may chose to sacrifice animal welfare in order to satisfy this demand, by breeding closely related animals or getting animals pregnant repeatedly without suitable respite [6], increasing incidences of poor health seen by veterinarians. Any zoomorphic robots that enter into the public sphere, in schools or in homes, will contribute to this influence, particularly if they are especially appealing, cute, or analogous to certain breeds. The primary recommendation to improve pedigree dog welfare from Rooney and Sargan [118] is that we should be "creating and fostering the image of a happy and desirable dog being one that experiences high welfare"—a recommendation that we find ourselves in contravention of if cuteness is our primary focus in the development of zoomorphic robots.

6.2.3 Neglect of 'ugly' animals. Not all animals are cute. Some children may have pets like spiders and snakes that the majority of people do not find cute. However, these pets still deserve to be treated kindly and have good welfare. Education that relies purely on the power of cuteness to inspire kind, moral behaviour will likely fail when encountering these animals, particularly given Sherman and Haidt [132] argue disgust shrinks the moral circle. Cuteness may appeal to the affective component of an individual's attitude to animals, but attitudes also have cognitive and behavioural components [34], so Kingston [65] suggests that interventions for wildlife conservation may be more effective if they target multiple components of attitude. Therefore, it is important to provide other motivations, such as discussing the minds of the creatures and trying to appreciate the animals for what they are.

6.2.4 Commodification of cuteness. Surrendering pets to animal shelters often involves family dynamics and can be precipitated by children losing interest in the pet and abdicating responsibility for it [30]. Ulfsdotter et al. [148] found that the reasoning given by owners in 12.6% of cases of rehoming rabbits was losing interest. A similar figure (11%) was found by Jensen et al. [60] as the reason given for relinquishing dogs and cats to animal shelters. Anecdotally, this can coincide with the end of puppyhood, when the behaviour and appearance of the dog become less cute; in a study by Salman et al. [124], the majority (44.4%) of dogs and cats surrendered to shelters were between 5 months and 3 years of age, compared to 20.5% surrendered between the ages of 3 and 8 years.

Commodifying cuteness in robotic pets may encourage this habit of getting bored and leaving on the shelf. Fernaeus et al. [40] conducted a long-term study of interactions with Pleo (a dinosaur robot) in the home. Families compared Pleo to pets in interviews and initially behaved towards it like it was a pet. However, this behaviour was not sustained long-term and after an initial period of interest the robot was only brought out for special occasions. Caudwell et al. [19] highlight that cuteness may be effective at establishing short-term connection, but may hinder longer-term relationship formation. A zoomorphic robot that relies on cuteness to draw in the user rather than considering how to develop a more meaningful relationship will struggle to convey the challenges and joys of long-term pet ownership.

6.2.5 Cuteness as a dark pattern. Some researchers have challenged the use of cute features in social robots, describing their design as a 'dark pattern' [70]. The term dark pattern was coined by Harry Brignull [14] and refers to design choices employed in interaction design to deceive the user into doing things they did not intend, such as signing up for unwanted subscriptions or agreeing to share personal data. Dark patterns often rely on psychological tricks based on how users process information and influence user decisions by modifying the user's decision space and manipulating the information flow [85].

While the concept has normally been applied to screen-based interfaces, Lacey and Caudwell [70] expanded this to home robots, arguing that the use of cuteness in these devices constitutes a dark pattern by giving the robot the illusion of powerlessness. Home robots are often proposed as members of the family and use cuteness in an attempt to promote intimacy and trust with humans [18]. The language of cuteness is seen in much of the promotional material for domestic robots [70]. Such companies make reference to the user "nurturing" the robot or describe it as "endearing" [8, 23, 24]. Lacey and Caudwell [70] highlight three reasons they believe the cute, powerless aesthetic of domestic robots constitutes a dark pattern: the emphasis of short-term gains over long-term decision-making, the false illusion of user sovereignty, and the likelihood of generating 'data myopia' (shortsightedness) [139] in the user.

We argue that the last aspect, where users agree to share lots of data in contexts they might not normally, such as within the home and in affective scenarios [108], will become exacerbated in zoomorphic robots, since they are likely to be coming into the house as a pet analogy. Children often disclose secrets to pets [17, 87], so much so that it is used in measures for attachment to pets [54, 69, 87]. Some researchers argue that this disclosure could be because the pet is viewed as a nonjudgmental source of support and children know the pet cannot share their secret with others [39, 73, 74, 117]. However, the latter assumption is violated in the case of domestic robots that may be recording and storing data from interactions. There is debate over the extent to which parents should be able to monitor their children's activities online and children's right to privacy in situations where they may be at risk [135], but by and large it would be highly unethical to share children's private interactions with pets with other parties.

7 A NEW DESIGN APPROACH

When designing a zoomorphic robot, a key question to ask is: what is the point of cuteness? While cuteness can provide a quick "affective hit" [28], it is not a panacea, and focusing on cuteness may distract from other, more helpful design opportunities. That is not to say we are advocating for avoidance of cuteness; instead we want designers of zoomorphic robots to be conscious of cuteness, its purpose within their designs, and its potential impact. We want to avoid dead-end cuteness that captures attention but has no greater purpose and want to encourage a view of cuteness as a way to pull attention initially but as an entry point to the exploration of other dimensions (interactivity, intelligence, etc.).

A way we suggest this could be achieved is through a zoocentric design approach that focuses on how design choices will impact animals and their well-being. In contrast to an anthropocentric approach, which looks to cuteness as a way to hook the user and satisfy their needs, a zoocentric approach would seek to employ cuteness insofar as it benefits the zoomorphic robot itself and animals more broadly. Furthermore, the zoocentric approach may use other means to promote respect and establish boundaries that end up disrupting the facade of cuteness, potentially by including realistic behaviours such as withdrawal and fear-driven aggression. However, in many circumstances, an anthropocentric and a zoocentric approach may use cuteness for similar purposes or produce the same outcomes. For example, engagement may be an appealing thing for an anthropocentric designer but also for a zoocentric designer seeking to use zoomorphic robots to educate about animals.

There are several reasons a zoocentric designer might want to incorporate cuteness in a zoomorphic robot, particularly when it comes to promoting good treatment of something that draws a parallel to live animals (e.g., encouraging nurturing, lending moral power). However, the approach they take to achieve the required cuteness might be different to an anthropocentric designer, and one way they might particularly diverge is the use of baby schema cuteness. The seeming innateness of our attraction to the baby schema makes this challenging. Therefore, designers must be careful of the inspirations used in their designs and frequently reevaluate them during the design process to see if these cute features are emerging and risking detrimental consequences (e.g., minimising safety concerns, commodifying cuteness, encouraging users to share private data).

7.1 Recommendations

We aim to provide some more concrete recommendations for how a zoocentric designer might approach cuteness. In particular, we identify the extreme and unhealthy features associated with baby schema cuteness to avoid and suggest alternatives to the baby schema if cuteness is still a goal.

7.1.1 Avoid extreme conformity associated with baby schema cuteness. We suggest that, where at all possible, designs for zoomorphic robots should avoid analogies to animals that are known to have health problems, particularly brachycephalic breeds like pugs and bulldogs, and the baby schema features that are associated with them.

The International Collaborative on Extreme Conformations in Dogs has created a list of physical characteristics to be avoided in dogs so that they can experience good welfare [58]. While some of the recommendations are unlikely to be applicable to zoomorphic robots (e.g., avoid turned-in eyelids), relevant recommendations include avoiding:

- Flat faces
- Clearly overshot or undershot jaws
- Large and protruding eyes
- Bulging or domed skull
- Disproportionately broad head and shoulders

We suggest avoiding these features to limit associations with animals that experience poor welfare. These recommendations are most applicable to canine zoomorphic robots, but would also apply to other zoomorphic robots based on domestic mammals, like cats and rabbits.

7.1.2 Use alternatives to baby schema cuteness. If designers are avoiding baby schema cuteness, but still want to benefit from the impact of cuteness, what should they do instead? Most of the existing research on the characteristics that affect the perception of cuteness focuses on the size and arrangement of facial features, but the robot that the children thought was really cute had no face (see Figure 1), suggesting that there are other characteristics that contribute to the perception of cuteness in zoomorphic robots. Here we consider how the design of the robot's appearance and behaviour may influence perceived cuteness and invite researchers to investigate these and other dimensions further.

Appearance. Cheok [22] and Ohkura et al. [101] found that soft fur is one of the cutest textures. The association between cuteness and soft fur was also something we observed in our workshop with children. Children were given prompts to brainstorm about pets, including how they look, sound, and feel. The most commonly used words were soft (used by 14 participants), fluffy, and cute (both used by 13 participants). These words co-occurred frequently. Of the children who described pets as cute, 92% described them as soft and/or fluffy. Cheok [22] suggests that the animal-likeness of long, soft fur reminds people of animals they find cute, like puppies and kittens, leading to the perception of the texture as cute. This mediation of cuteness by animal-likeness is also suggested by Ohkura et al. [101], as participants described the cutest textures as "like animal hair". The findings of Cheok [22] and Ohkura et al. [101] also align with the attributes found by Siettou et al. [136] that make shelter dogs more adoptable, i.e., medium to long fur. Long, soft fur seems to invite tactile interactions and may further be associated with cuddliness [11].

The choice of surface colour may be pulled in different directions. Cheok [22] and Ohkura et al. [101] found a gentle pink was perceived as cutest, which they linked to associations with flushed infant cheeks and flowers, but this would not be an animal-like choice. Therefore, it might be wiser to choose from natural animal coat colours for a zoomorphic robot. Some studies have found preferences for medium-light dog and rabbit coat colours [52, 72, 113], but results are mixed and other factors, like breed, may have an impact.

Behaviour. Another under-explored area is behaviours that contribute to cuteness. Even basic postures and movements can influence cuteness; Mara and Appel [83] found a simple head tilt by a robot is cute, just as it is in dogs [2]. Well-designed behaviours can also transform non-cute robots into cute ones. Participants in the study by Sugano et al. [141] did not view the vacuum cleaner robot, Roomba, as innately cute, but rated slow turning movements performed by the robot and it bouncing off obstacles as cute. Similarly, Nakayama and Yamanaka [97] conducted an experiment about the perceived animacy of a set of five robotic cubes that moved in coupled oscillation when triggered by the participant's proximity. Out of 240 participants, 41 described these moving cubes as cute[5]; a comment twenty times more common than the second most frequent. Both Nakayama and Yamanaka [97] and Sugano et al. [141] point to their use of robots that are not intrinsically cute or animal-like to suggest that the perception of cuteness may be tied to the perception of animacy provoked by movement. Building on this, Gn [49] suggests that cute movements seem to be those that imply vulnerability, like clumsiness, uncertainty, or confusion.

Perceived cuteness might also be influenced by the noises made by the robot. Existing work on making human voices cute finds that young, high-pitched, female voices are perceived to be the cutest [22, 82, 130]. Zhang et al. [157] also found that quiet, high-pitched noises were preferred for robots' consequential sound, which they suggested was due to its perceived cuteness. While gender and age may be less obvious and relevant in animal noises compared to human voices, age and size will still frequently be inferred through pitch and volume [41]. Caudwell et al. [19] further highlight the importance of 'phrase' length in establishing a sense of childlike cuteness, noting that Anki's Vector beeps in one- or two-word 'phrases', which would suggest it is in the same phase of language development as a 2- to 3-year-old. We might take inspiration from the vocalisations of domesticated animals that are perceived as cute. Cats rarely meow among other cats, but do so to get human attention [10]. Cats seem to vary their vocalisations to convey different emotions, and these are largely correctly perceived by humans [128]. Robot vocalisations modelled on this, such as Moore and Mitchinson [93], may be effective in communicating emotions non-verbally [66], and they could further foster the connection to animal cuteness.

8 LIMITATIONS & FUTURE WORK

Firstly, we recognise that this work is very much coloured by the context of a country with high levels of pet ownership and high expressed regard for animal welfare. Wolfensohn [155] stresses that the application of cuteness to animals is a socio-cultural and economic creation; different cultures have different attitudes to animals as friends versus food or labour. With cultural context in mind, there is still more work to do in the cultural perceptions of robotic and animal cuteness. Some design choices may be cute to some populations, but not to others.

The work focuses on cuteness as presented to children, based on the workshops that prompted the investigation. This seems to be a group particularly fixated on cuteness—the adult educators with whom we worked were more focused on the functionality of the robot rather than the aesthetics, and when they did mention the appearance

[5]This work took place in Japan and materials used in the study were in Japanese, so the term used by participants may be *kawaii*, which we note has a slightly different connotation.

of the robot, they predominantly did so with reference to its animal-likeness (or lack thereof) [150]. However, children are not the only group targeted with cute designs. Older adults are also a common target for robotic pets, with research on their preferences for robotic companions suggesting they should combine cuteness and zoomorphic inspiration [32]. Other authors suggest the inclusion of baby schema features is what elicited positive responses about a robotic bear from older adults, with eye tracking revealing they had focused primarily on the face [100, 127]. Future work may want to consider how the cuteness of robotic pets could influence the lives of older adults and to reflect on other ethical dimensions, e.g., issues of deception and infantilisation.

This paper presents a highly speculative view of the impact of cuteness in zoomorphic robots that has not yet been investigated with experimental studies. Future work could involve a systematic literature review on cuteness in human-robot interaction and experimental studies to better understand preferences for cuteness in zoomorphic robots, perhaps taking a similar approach to Borgi et al. [9] and Chen and Jia [21] and digitally manipulating the faces of zoomorphic robots. Additionally, work could analyse if being primed with images of cute zoomorphic robots has an impact on preferences for real animals.

An alternative option for future work is to engage more deeply in the speculative nature of this topic through speculative design. The practice of speculative design aims to identify and debate critical issues, asking the 'what-if' questions rather than affirming commercially-driven design directions [33]. It has also recently been pushed for in the context of human-robot interaction based on how distant the future of pervasive human-robot interactions realistically is [154]. A speculative design approach could take us from presumed answers (i.e., cuteness) to big questions and beyond. Such practice could involve roboticists, designers, artists, ethologists, and animal welfare experts, among others, to consider the implications of mindless use of cuteness and look beyond baby schema cuteness and cuteness full stop. We note a recent step in a related direction by an animal welfare charity. The Royal Society for the Prevention of Cruelty to Animals has launched a report entitled *Animal Futures*, which presents five different future worlds based on how choices today might impact animals' lives [121]. One speculative scenario looks at how technology may influence pet ownership, considering the potential rise and impact of genetically modified designer pets and robotic pets, showing the timeliness of a discussion like this.

9 CONCLUSION

Cuteness has pervaded our relationships with animals and shaped our design of robots. Broadly speaking, cuteness is beneficial, as it encourages kind, careful behaviour. However, in domesticated animals, cuteness and, in particular, baby schema features are associated with poor health. Therefore, we suggest that designers and roboticists need to be more critical about the use of cuteness and baby schema features in zoomorphic robots. Cuteness could encourage people to treat zoomorphic robots in the careful, caring way that we would want to encourage to be used toward live animals. However, we speculate that, by designing for cuteness in zoomorphic robots, we may end up exacerbating the pressures on the breeding of live animals, minimising the risks involved in interactions with animals, and turning cuteness into a key commodity for animals. We may do better to look to concepts other than baby schema cuteness for the same benefits, and we should be particularly critical of cuteness where it is traded for functionality. Thus, we suggest a zoocentric design approach for zoomorphic robots; an approach that bears in mind the impact zoomorphic robot design might have on animals and uses cuteness insofar as it would benefit animals. Zoomorphic robots are placed to become more and more common, particularly in the lives of children. As this happens, it becomes more important to consider the place for cuteness in zoomorphic robots and more detailed quantitative and qualitative studies are needed to investigate this, but at this point in time we call designers of zoomorphic robots to be conscious of the concept of cute in their designs and think critically about its potential ramifications.

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