Magic and Reality: what children's drawings tell us about their perception of technology

Sveva Valguarnera
Università della Svizzera Italiana
Lugano, Switzerland
sveva.valguarnera@usi.ch

Cristina Sylla
Research centre on Child Studies,
ITI/LARSyS, University of Minho
Braga, Portugal
cristina.sylla@ie.uminho.pt

Monica Landoni
Università della Svizzera Italiana
Lugano, Switzerland
monica.landoni@usi.ch

ABSTRACT

In this paper we explore children's perception of technology by looking at the drawings and descriptive texts submitted to the Design and Research Challenge run for the International Conference on Interaction Design and Children 2022 by 166 children from US, Japan, Portugal and Switzerland aged 7 to 11 years old. We cluster and analyse drawings as a means to elicit the perception, understanding and expectations children have of the role technology can play in supporting connectedness, the theme of the conference. We report differences and similarities across countries, age and gender, as well as discuss the dichotomy between magic and realistic proposals, as it provides an important dimension of the CCI design space. Therefore, we start by looking at the use of drawings for better understanding children's needs and wishes and move on to explore the children's sense of technology, to finally reflect on its implications on design.

CCS CONCEPTS

• **Human-centered computing → HCI theory, concepts and models**.

KEYWORDS

drawings; descriptive text; age; gender; expectations; competences; magic

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1 INTRODUCTION

In this paper we explore the potential of drawings to assess children's perceptions, understanding and expectations concerning technology. In our study, we analysed the drawings and descriptive texts submitted to the Research and Design Challenge (RDC) for the International Conference on Interaction Design and Children 2022, looking at age and gender as main lenses. Inspired by considerations in [20] on how extra annotations provided by children helped in the interpretation of portrayed elements, we also turned to text submitted together with each idea as well as that included in the drawing, to better understand the ideas conveyed in the drawings. The RDC theme for IDC2022 is "Connectedness". Children all over the world were invited to imagine and submit "their ideas of how technology can foster connectedness among people who live near and/or far from each other, who are of the same age or from different life spans, who have similar and/or different social and cultural background, etc. In short, how can technology creatively connect people, people and pets, or even people and objects if they have a special role in somebody's life?". In the first phase of the challenge children sent a record of 166 ideas, each composed by a title, an explicative drawing and a brief textual description as requested in the call. Therefore, prompted by the availability of such a rich collection of representations of what technology can do for children, we set out to run our study. This takes the format of an exploration into expectations, understanding and preferences children have towards the technology to come, while also allowing us to test how effective such a drawing based method is in revealing this type of information.

2 RELATED WORK

2.1 Children's drawings

Drawings have an historical tradition as a method to evaluate cognitive development. A particularly influential approach is the visual-haptic theory [5], which is still applied in a number of research areas such as: art education, child studies and psychology. Lowenfeld and Brittain [5] see drawing as a process that children use to signify and reconstruct the world around them. This exploitation of the environment has a strong sensory component, involving all their senses, and the way children represent things shows how they understand them, which evolves with time as children become more aware of the world around them.

Children's drawings have been used in Child-Computer-Interaction as a method to involve young children as design partners of technology [3], and to gather information related to user experience [15] [14] [19] [20] [21]. For example, [21] used children's drawings to assess fit and fun of technology, [14] investigated the use of drawings to understand if it is possible to evaluate usability aspects of an interface by looking at children's drawings, and uncover indicators that would reveal children's satisfaction with the interaction. Drawings have also been used to compare the learning benefits of tangible versus graphical interfaces for preschoolers, particularly to assess children's degree of involvement with the interfaces [15]. Nicol and Hornecker [7] studied children's drawings to investigate

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Figure 1: Collage of different elements, 8-years-old girl from CH

its effectiveness to elicit children's feedback on interactive museum prototypes. Barendregt and Becker [1] investigated the use of children's drawings to evaluate a game with younger children and its potential as a method to invite children to generate design ideas, and if drawings can be used as a collaborative design method. Vishkaie [17] analysed children's drawings with early elementary school children, K1, to learn about their perceptions with animated and inanimate objects, to inform the design of interactive toys. Overall, children's drawings seem to provide useful information about children's perceptions, however it is not always an easy task to fully interpret the meanings conveyed in children's drawings. Research has also pointed out that the use of drawings may be advantageous for the evaluation of technologies with children over other methods, since at young age children may not yet be able to write proficiently or may have difficulties expressing themselves, or they may feel unsure expressing themselves verbally to a researcher [19].

In this paper we look at children's drawings and descriptive texts to elicit the perception, understanding and expectations children have of the role of technology. In our thematic analysis, two main categories emerged, i.e., ideas based on magic and those grounded in reality. Magic is a topic which has also been explored in the HCI community, particularly focusing on how principles of magic can inspire the design of technology [9] [16] [2].

2.2 Magic and Magical Thinking

Our understanding of magic builds on the concept of magical thinkers and believers in magic [11]. As magical thinkers we can move objects with our thoughts, let inanimate objects become alive, and we can even do much more, with the full knowledge that all this happens in the realms of our imagination and our dreams [11]. People that instead believe that this could happen, are believers in magic. Whereas in ancient times our forefathers were believers in magic, explaining the phenomena they could not understand as magic, the evolution of science has shown us that magic contradicts the fundamental laws of nature. Nonetheless, research suggests that the belief in magic is a fundamental property of the human mind [12], and this is particularly true for children. A comparative study [13] investigating the capacity of discriminating between ordinary and fantastic realities represented in pictures with three age groups, 6-years-old, 9-years-old and adults, confirmed previous research that 6-years-old children performed significantly worse than 9-years-old, and both age groups performed significantly worse than adults on the test. Thus supporting "the hypothesis that there is a developmental progression on the capacity to discriminate between ordinary and fantastic visual realities" [13].

According to [11] children's magical thinking is an important and necessary complement to cognitive development, enhancing creativity and helping to develop coping mechanisms. Magical thinking takes place in emotional domains, and underpins our construction and understanding of meaning [11] . As we grow in age, we gradually change from believers in magic to magical thinkers, and while most four- to six-years-old children still believe in magic [8] [4] [10], by the age of nine most children are aware of the difference between magic and reality [11]. Whether magic thinkers or believers, magic seems to play an important role in human cognition; in children, magic is part of their role-play as it can be seen in their storytelling, and besides helping them to explain the world, it gives them a feeling of power and independence [11].

3 RESEARCH QUESTIONS

Informed by these concepts, and building on previous work on children's drawings we sought to answer the following research question: How much are drawings telling us about children's perception, understanding and expectations concerning technology? How is the sense of children for technology grounded in magic?

4 SUBMISSIONS

4.1 Collection

A total of 166 ideas were submitted, mostly coming from two schools, one in Portugal (PT) and one in Switzerland (CH), with a very few from other sites (USA and Japan). As in the past editions, the majority of submissions were sent from schools already collaborating with researchers in the Child-Computer Interaction community.

For each of the submissions, children wrote a title and the description of their idea, this way they could create and share meaning using two modes: non-verbal, graphic depiction and written, telling the drawing [18]. As suggested by Wright, this "crossover of modes increases children's capacity to use many forms of representational thinking and to mentally manipulate and organise images, ideas and feelings" [18]. Moreover, the combination of graphic depiction and written explanation provided us with additional information to better understand children's drawings. However, as the children wrote in their local language, the descriptions had to be translated by the adults responsible for the submission to be included in the RD challenge booklet. Because of this, we have to point out that the resulting descriptions, while useful to understand the children's drawings, may be contaminated by the adult mediators. While this is certainly a limitation, it can also help researchers focus more on the drawings than on the descriptions, in order to capture the

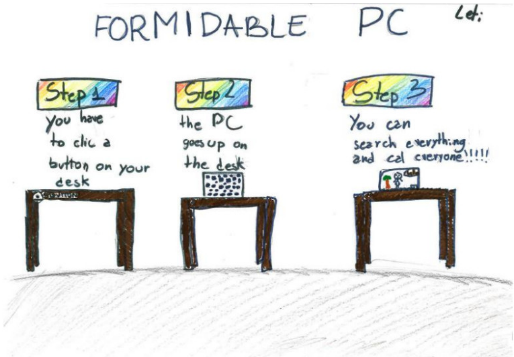

Figure 2: Storyboard representing an idea, 10-years-old girl from CH

Figure 3: Drawing with embedded text, 11-years-old boy from CH

children's authentic voices. And even if it might be difficult to understand children's drawings, in fact, studies have also confirmed that despite such limitations drawings seem to have advantages over other methods to access children's perceptions and opinions [19] [1].

To reflect the rich creativity expressed by children, the submissions were divided into those connecting: people; humans, animals and aliens; humans, objects and wishes; connecting places and reducing distances; and connecting times. While most drawings depicted one single piece of technology to support connectedness, few of them were a collage of different elements (Figure 1) and others told us a story and represented it in a story board (Figure 2) with or without text to help comprehension. Often text was embedded in the drawing too as an essential part of it (Figure 3). In the spirit of the challenge, children had total freedom to express themselves and this resulted in a variety of drawings and 3D artefacts (Figure 4).

4.2 Coding

We started our thematic analysis by defining two major categories to enable us to distinguish between ideas based on magic and those

Figure 4: 3d artifact, 7-years-old girl from PT

grounded in reality. This distinction was based on Subbotsky's [11] four dimensions of magic, "thought over matter", "coming to life magic", "transformation magic" and "violating fundamental properties of space and time". According to this, the drawing of an app that translated all languages in real time was coded as grounded in reality, while drawings that depicted various forms of teleportation were coded as magic. Figure 6 shows shows two examples of drawings that were coded as magic.

It is however worth noting that even "magic" drawings usually presented elements that can be described as technological, such as buttons, keyboards, holograms and so on (Figure 5). Often children would explicitly use the term "magic" either in the title or in the description of their idea.

We also added categories for describing the main theme of the challenge: connectedness, these were communication, translation, time travel, mind reading and transportation, as the main ways children envisaged technology could support different types of connections between humans and animals. As children were invited to think of technology we also added a few categories to let us pick on trends and preferences in terms of the envisaged tools: digital devices to depict everyday items such as smartphones, laptops, and tablets, holograms, wearables and robots as these are becoming more familiar at least in movies and television. As for the context where children envisioned using the technology they were describing, we had school and videogames, covering both education and their spare time. Food, money and space emerged naturally as categories linked to natural needs and curiosity.

The drawings were coded by three researchers separately; when two or more researchers were in agreement, the agreed-upon code was entered for the final analysis. However, the inter-rater agreement was over 90%.

Figure 5: Flying phone, 8-years-old girl from CH

	7yo	8yo	9yo	10yo	11yo	Total
Male	5	28	11	10	15	69
Female	6	31	23	27	25	76
Total	11	59	23	27	25	145

Table 1: Distribution of the drawings according to authors' age and gender

Starting with the original dataset of 166 drawings, we excluded from our analysis anonymous drawings and drawings that could not be associated with a specific age or gender (such as group drawings). This led to the exclusion of 5 drawings. Then, we coded whether each drawing and its textual description was related or not to the proposed theme of connectedness. This led to the exclusion of 16 drawings, which were not included in the subsequent analysis.

The resulting data set was composed of 145 drawings, 69 by male children and 76 by female children. Table 1 shows the distribution of age and gender among the children.

Then, we coded the remaining drawings according to the following categories: magic, grounded in reality (mutually exclusive), holograms, humans, animals, cartoon/movie related, digital devices, teleportation, robots, wearables, portal, translation and other. Each researcher furtherly divided the "other" entries according to the content of the drawings; similar categories were then merged, while categories that had three or less entries were removed. We removed the categories human and cartoon/movie related, and added translation, communication, schools, money, video games, food, transportation, space, communication via thoughts. One drawing could belong to more than one category, for example boots that allowed the wearer to travel fast were coded both as "wearable" and "transportation".

We furtherly refined our "wearables" category by coding the drawings according to the type of wearable depicted: the categories were: jewellery, glasses, footwear, headwear, clothing, watches and other. Some drawings were coded as belonging to more than one subcategory, as for example they depicted both shoes (footwear) and a helmet (headwear).

5 RESULTS

5.1 Analysis

For each category, we created separate contingency tables; one of them is shown in Table 2. As the sample size is small, we opted to perform Fisher's exact test with a p-value threshold of 0.05 to examine the significance of the association between the different categories and either gender or age of the children; in accordance with Subbotsky's research [11], who reports that by the age of nine most children are aware of the difference between magic and reality, we divided the children in two groups according to age, "younger" children who are younger than 9 (7-8 years old), and "older" children who are 9 or older (9-11 years old).

	Magic	Grounded in reality
Younger children	47	7
Older children	37	29

Table 2: example of the age-magic versus grounded in reality contingency table

We found a significant association (p=0.0003) between age and the depiction of technology as magical, with younger children significantly more likely to depict "magical" technology such as teleportation or mind-reading. As explained by previous research, by the age of nine children are more likely to be magic thinkers whereas younger children tend to be believers in magic [11].

We did not find any other significant association between the age of the child and the content of the drawing; however, we detected some trends whose significance could be potentially ascertained with a larger sample: specifically, we found that older children's drawings featured wearable technology and holograms more often than younger children's (however, the p-values that we found were respectively 0.0917 and 0.0572, both above the threshold for significance), and that older children also tended towards representing technology for communication (p= 0.1025). While we cannot say that there is a statistical significance, the small size of the sample, coupled with the fact that in all these cases the p-value was near the threshold for significance, suggests that these tendencies could be explored more deeply.

While we expected gender to play a more significant role in the depiction of technology, the only significant association we found was between gender and the depiction of animals (p=0.0381), with girls representing this kind of technology significantly more often.

We also looked for significant associations between the different kinds of wearables depicted and the age and gender of children; however, we did not find any significant associations. While age seems to be a discriminant, gender proved to be not significant, at least when looking at the magic vs realistic dichotomy.

While not relevant drawings were not included in the previous analysis, we also analysed whether the prevalence of off-topic drawings could be correlated either with age; the p-value proved to be above the threshold for significance at 0.1118, however as mentioned above the small size of the sample suggest that further analysis could lead to a different result.

Looking across all drawings we could also see how certain ideas were more popular than others and could be found in contributions

Figure 6: On the left, microphone that allows you to speak with fishes; on the right, remote control that turns you into a plush toy

coming from different countries. This was the case of boots that made you travel fast where you wanted to be. We found drawings depicting shoes, trainers and fancy boots, made by girls and boys both in Switzerland and Portugal, as in Figure 6. We also encountered other such instances as the headbands for transmitting thoughts to people (PT) or to control an iPad (CH) or even to make the animal you are thinking about appear for real in front of you (CH), or the glasses and contact lenses to control other devices or VR.

5.2 Discussion

After coding two main categories emerged: that of magic versus more realistic proposals with age being as discriminant as to be expected. Magic was either mentioned explicitly in the title and/or descriptive text or inferred from these and mostly resulted in technology behaving in totally unexpected and not realistic ways. Children's magical thinking as explained by [11] is an important and necessary complement to cognitive development, enhancing creativity, and giving children a feeling of empowerment. Children's creativity was visible in their drawings. The significant association between age and the depiction of technology as magical, with younger children significantly more likely to draw "magical" technology, confirms that younger children tend to be believers in magic, whereas older children tend to be magical thinkers. According to [5], the way children represent things shows how they understand them, which evolves with time as children become more aware of the world around them. Gender did not seem to play a role even if we noticed a higher level of anthropomorphism and overall cuteness, difficult to quantify, in submissions made by girls even when portraying similar ideas (such as a collar for speaking with animals). The definition and more importantly the role cuteness could play in design with and for children needs further investigation while literature reporting on studies with adults [6] suggests how anthropomorphic representations of technology results in higher expectations from users, who would express human-like kind of intelligent response. We could also observe how children more exposed to video games, mentioned explicitly in their ideas, produced more realistic proposals, a hint that early playful exposure to technology can equip children with a basic understanding of its functioning and thus with a more down to earth expectation for it.

6 CONCLUSIONS

We run an analysis of children's submissions made to the IDC22 RDC. It is remarkable to notice how children managed to find effective and creative ways to express their expectations and wishes for future technology to support connectedness. In interpreting the drawings made by children we found that the included descriptive text had an important role, especially when deciding if to assign them to the magic vs realistic category. As mentioned also by [20], additional annotations helped clarify the story told by the child. Many children portrayed technological objects but at the same time we read magic, either explicitly or implicitly in their titles and short descriptions. Does looking at technology as it can do magic have an impact on design with and for children? We need to further explore whether children behave like adults, and according to [6] if when their expectations - for magic - are not fulfilled, lose their trust in technology and refrain from using it for complex tasks or if on the contrary, their trustworthy approach to life keeps them trying harder to make sense of the tools they have at hand. Or, on the other hand, can principles of magic be used to inspire the design of technology, as defended by [9], and can we get inspiration from children's drawings to design better interfaces? Either way, we feel designers should be careful when using drawings to elicit user requirements and capture this magic versus realistic dimension as a meaningful clue to drive them in the right direction.

The ideas submitted by children as an answer to the Research and Design challenge proved very rich and creative, a worthy data set to share with other researchers. In future work we plan to analyse the drawings submitted to the prior editions of the IDC RD challenge, and make a comparison across time, this may give us interesting insights into how children's perception of technology is changing and how it reflects new technological developments. As a community we should discuss whether and how to keep it and have it grow over the years. Issues of data protection and confidentiality will need to be addressed, going beyond the current explicit request made at submission time to choose whether and how authors want to be acknowledged by full name, initials or just be anonymous. Age,

Figure 7: On the right, very fast boots from PT; on the left, flying shoes from CH

gender, school and country are additional information we used in our analysis and their availability should be discussed and possibly kept too. However, due to the nature of the data set we did not have access to further details about the children who participated, such as their familiarity with technology and with science fiction books, movies and cartoon. We feel that this information might allow for a deeper level of analysis, that we intend to further develop in the future. We feel that maintaining over time and making such a curated data set more widely available could not only enable researchers to keep the pulse of how children perceive technology but also enable children to explore each other's likes and dislikes and perhaps even help them form a richer sense of what future technology could do for them. This is why, on top of recognising children as the owners of the submitted ideas, we can truly put them at the centre of the technological innovation process in the true RDC spirit. We need to point out that in order for this initiative to continue and grow, the whole CCI community needs to engage with it, reach out to children and help them get their voices heard. A coral effort is needed if we want to build a long standing and meaningful initiative.

7 SELECTION AND PARTICIPATION OF CHILDREN

No children participated directly in this work; we used the R&D challenge booklet publicly available in the IDC2022 website.

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