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Children's Digital and Non-Digital Play Practices with Cozmo, the Toy Robot

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Feature

Introduction

This article reports on the emerging findings from a study undertaken as part of an international research collaboration (Australia, Belgium, Italy, UK; DP180103922) exploring the benefits and risks of the Internet of Toys (IoToys). IoToys builds upon technological innovations such as smartphone apps that remotely control home-based objects, and wearable technologies that measure sleep patterns and exercise regimes (Holloway and Green). Mascheroni and Holloway summarise the features of IoToys as entities that users can program, with human-toy interactivity, and which have network connectivity.

In this discussion we focus on children's play with a small programmable robot named Cozmo (fig. 1). The robot also has an 'explorer mode' in which children can view the world through the eyes of Cozmo, and a camera which can film the robot's view, accessed through the mobile app. Children are encouraged to personify Cozmo, including feeding the robot and keeping it tuned up. Cozmo also has numerous functions including tricks, a coding lab, and games that utilise three provided 'Power Cubes' that encourage child-robot interaction:

- *Keep Away* – the player slides the cube closer to Cozmo then pulls away quickly when Cozmo 'pounces' – the aim of the game is to ensure Cozmo misses the cube.
- *Quick Tap* – a colour matching game which involves hitting the cubes (before Cozmo) when the colours match.
- *Memory Match* – Cozmo shows a pattern of colours, and the player then taps the cubes in the right colour order – each round the pattern gets longer.

Fig. 1: Cozmo

Whilst the toy uses Wi-Fi rather than connecting directly to the Internet, Cozmo was chosen as a focus for the study because many of its characteristics are typical of IoToys, including connectivity, programmability, and the human-toy connection (Mascheroni and Holloway).

Children's play lives have been changed through the development of digital technologies including smartphones, tablets, laptops, and games consoles (Marsh et al.) and inevitably, children's play experiences now cross a range of boundaries including the "virtual/physical world, online/offline and digital/nondigital" (Marsh 5). As IoToys become more prevalent in the toy market, there is an increasing need to understand how these connected toys transcend digital-material boundaries between toy and media technology. Whilst toys such as Cozmo share similar traits with traditional toys, they also increasingly share characteristics with computing devices (i.e., video games, mobile apps) and domestic media (i.e., Amazon Alexa; Berriman and Mascheroni). The combination of the traditional and digital adds a layer of complexity to children's play experiences as the interaction between the child and the robot is 'reconfigured as a bidirectional, multidimensional, multisensory experience' (Mascheroni and Holloway 5).

By asking 'what types of play does an Internet-enabled toy engender?', this article examines the capabilities and limitations of Cozmo for children's play experiences. Currently, there is little reliable information about children's IoToy use despite the media attention the subject attracts. Many assumptions are made regarding how technological devices offer restricted opportunities for play (see Healey et al.), and therefore it is vital to investigate the benefits and limitations of these new-generation technologies for parents and children. This article contributes to ongoing debates focussing on children's playful engagement with digital technology and the importance of engaging parents in discussions on different types of play and children's development.

Methodology

This international study involved thirteen families across four countries (Australia, Belgium, Italy, UK; Appendix 1). Ethical clearance was obtained prior to the commencement of the study. Consent was gained from both the children and the parents, and the children were specifically asked if they could be audio-recorded and photographed by the researchers. Pseudonyms have been used in this article.

Families were visited twice by a researcher, with each visit lasting around an hour. Firstly, the children were interviewed about their favourite toys, and the parent was interviewed about their thoughts on their children's (digital) play practices. This provided background information about the child's play ecologies, such as the extent to which they were familiar with IoToys. Cozmo was also introduced to the children during the first visit and researchers ensured they were confident using the toy before leaving. Cozmo was left with the children to use for a period of between one and three months before the researcher returned for the second visit. Families were reinterviewed, with a focus on what they thought about Cozmo, and how the children had engaged with the toy in their play.

Data were deductively analysed using a revised version of Hughes's taxonomy of play that takes account of the digital aspect of children's play contexts. Hughes's original framework, identifying the types of play children engage in, was developed before the rise of digital media. The revised taxonomy was developed by Marsh et al. (see Appendix 2) in a study that examined how apps can promote children's play and creativity. Data emerging from this study illuminated how Hughes's taxonomy can be applied in digital contexts, demonstrating that "what changes in digital contexts is not so much the types of play possible, but the nature of that play" (Marsh et al. 250). The adapted framework was applied to the data as a way of analysing play with Cozmo across digital and non-digital spaces, and selections from the transcripts were chosen to illustrate the categories, discussed in the next section.

Framing Children's Digital and Non-Digital Play Practices

The findings from the data highlight numerous digital play types (Marsh et al.) that occurred during the children's interactions with the robot, primarily:

- Imaginative play in a digital context in which children pretend that things are otherwise.
- Exploratory play in a digital context in which children explore objects and spaces through the senses to find out information or explore possibilities.
- Mastery play in digital contexts in which children attempt to gain control of environments.
- Communication play using words, songs, rhymes, poetry in a digital context.

Other types of play that were observed include:

- Virtual Locomotor play involving movement in a digital context e.g., child may play hide and seek with others in a virtual world.
- Object play in which children explore virtual objects through vision and touch.
- Social play in a digital context during which rules for social interaction are constructed and employed.

Imaginative Play

"Imaginative play" was prevalent in all the case study families, in particular anthropomorphic/zoomorphic play. Anthropomorphic/zoomorphic play can be categorised as imaginative play when children are aware that the object is not real; they display a willing suspension of disbelief. The morphology of social robots is often classified into anthropomorphic (i.e., human-like) and zoomorphic (i.e., animal-like) and different morphologies can elicit differences in how users perceive and interact with robots (Barco et al.). This was the case for the children in this research, who all referred to the fact that the toy was a robot but often described Cozmo as having human/animal attributes. Across the sample, the children talked about Cozmo as if it was a fellow human being or pet. Eleanor (aged 8) stated that "I feel like he's one of my family", while Emma (aged 8) said "we sometimes call him 'brother' because he is a little bit like family". Martina (aged 8) observed that Cozmo sometimes has "hiccups'' that prevent him from responding to her queries, reasoning that "it happens by itself because it eats too much". Louis (aged 9) did not refer to Cozmo as being human, although he did attribute emotions to the toy, mentioning that Cozmo runs in circles whenever he is happy. Sofia's mother stated that "one thing that made me laugh is that for Sofia it is a puppy. So, she would pet it, give it kisses". The mother of Aryana (aged 9) commented that "they tried to like treat it like a living thing, not like toy, like a pet . ... They treat it not like something dead or something frozen, something live".

Epley et al. suggest that anthropomorphisation occurs because knowledge that individuals have about humans is developed earlier than knowledge about non-human entities. Therefore, the knowledge children have of being human is drawn upon when encountering objects such as robots. It may be of little surprise that children react like this because, as Marsh (Uncanny Valley 58) argues, "younger children are likely to possess less knowledge about both human and non-human entities than older children and adults, and, therefore, are more likely to anthropomorphise". Severson and Woodard (2) argue that even in cases where children know the object is not real, the children ascribe feelings, thoughts, and desires to objects in such a

serious manner that anthropomorphism is a "pervasive phenomenon that goes beyond mere pretense".

Robot toys such as Cozmo are specifically designed to stimulate anthropomorphism/zoomorphism. Beck et al. have shown that head movements help children identify emotions in robots. Cozmo is programmed to recognise faces and learn names, which inevitably contributes to children feeling an emotional connection. For example, Eleanor (aged 8) remarked that "he was always looking at me and it looked like he was listening to me when I was talking". The desire for a connection with the robot was so strong for Oscar (aged 7) that he deliberately programmed the robot to respond to him, saying "I can make him do happy stuff which makes me feel like he likes me". Emma's mother stated that whenever Emma (aged 8) did something that seemed to make Cozmo happy, she would do those things repeatedly. Emma also referred to Cozmo as having agency, for example, when Cozmo built towers or turned himself into a bulldozer. Even though she made those commands herself via the app, Emma attributed the idea and action to Cozmo.

Overall, the children implemented imaginative play practices through the pretence of Cozmo's 'human-like' attributes such as knowing their name, "looking at" and "listening to" them, and displaying different emotions such as love, anger, and happiness.

Exploratory Play

"Exploratory play" usually occurred when the children first received the toy and most of the children immediately wanted to get to know Cozmo's features and possibilities. Arthur's father stated that the first thing Arthur (aged 8) did was grab the remote and start clicking buttons to find out what would happen. Oscar's mother was amazed that her child had played initially for five hours using Cozmo when he did not spend this long with other toys. She explained that he had been exploring what the toy could do: "he was getting it to choose blocks, pick up blocks, do tricks, make faces, and do dances … . He really enjoyed that".

Controlling Cozmo to travel between rooms was an example of "Virtual Locomotor play", although the robot could also lead to locomotor play in the physical world as children chased after Cozmo or danced with it. Further examples of virtual locomotor play occurred when the robot followed and chased children if they moved from the play area. Oscar (aged 7) enjoyed using this mode to set the robot on a course which led to it 'spying' on his younger sister. His mother noted that:

> because their bedrooms are opposite sides of the hallway, he kept sending Cozmo to go and watch what she was doing and waiting and seeing how long it took her to realise he was there.

Jacob (aged 10) also swiftly realised Cozmo's surveillance potential as he referred to the robot as a "spying machine". Louis (aged 9) stated that after he had explored all the options Cozmo offers, playing with it became dull. To him, all the fun was in the exploratory play. Other children across the sample also reported that they stopped playing with Cozmo after a while when they felt like there was nothing new to explore.

Mastery Play

"Exploratory play" was also connected to "Mastery play" through programmatic sequencing which enabled the robot to move and follow different directions as requested by the children. For example, Eleanor (aged 8) commented, "I liked to play games with him ... . I liked doing the acting thing". This involved programming the toy to undertake a series of actions that were sequenced in a performance. For Ebrahim (aged 7), the explorer mode also led to mastery play, as he set up an obstacle course for Cozmo using his toy soldiers, explaining that "I took a couple of my soldiers in here and made them out in a specific order and then I tried to get past them in explorer mode". Arthur (aged 8) would continuously try to find ways to make Cozmo go through obstacle courses faster. He especially liked the coding and programming aspect of the toy, and his father would challenge him to think his decisions through to get better results. Children also utilised other objects in their exploratory and mastery play. Louis (aged 9) would put up barricades so that Cozmo could not escape, and Matteo (aged 9) constructed "high towers" and operated "stability tests" by using Cozmo's explorer mode and constructing pathways through furniture and other objects. The blurring of physical/virtual and material/digital play, which is prevalent in contemporary play landscapes (Marsh et al., *Children, Technology and Play*), is highlighted during these episodes in which the children incorporated their own interests linked to their personal environments into their play with Cozmo.

Mastery play inevitably involved "Object play", as children played around with icons on the app to investigate their properties. Cozmo offers a variety of games which stimulate various abilities and can be played via the app or remote. Available games allow both child-robot interaction by means of the 'Power Cubes' provided with the robot, and programming games with different difficulty levels. Physical contact between the child and Cozmo, and the robot's responses, encouraged anthropomorphism, as Jacob (aged 10) switched from referencing Cozmo as 'it' to 'him' as the discussion progressed:

> Interviewer: (to Jacob) We got a robot interfacing this time. (To Cozmo) Hello, are you still looking at me? That's great. (To Jacob) So, do you want to show us your fist bumps that you coded?
>
> Jacob: Oh, I didn't code it. Well, I did code it. Go to tricks. Do you want to fist bump him?
>
> Interviewer: Yeah, can I fist bump him?
>
> Jacob: Just put your fist near him like close, close, like that.

In addition to the fist bump game, Dylan (aged 9) unlocked the Fist Bump app icon on his tablet enabling him to receive rewards by alternating physical fist bumps with himself and virtual fist bumps between Cozmo and the iPad. These object and exploratory play types were positioned as stimulating the robot's feelings and emotions through musical sounds (like a robot "purring") that seem to be designed to foster a stronger connection between the child and Cozmo.

All the children in the research played Cozmo's games; the tapping game and the building games with blocks were popular. A clear connection between mastery and object play is shown in those situations where children explore objects to gain control of their environment. While children pointed out that winning the games against Cozmo was almost impossible, some tried to change the game in their favour. Arthur (aged 8), for example, would move the blocks during games to slow down Cozmo. Whenever Emma (aged 8) became impatient with the games, she would move the blocks closer to Cozmo to finish certain games faster.

Mastery play was valued by parents because of its interactivity and educational potential. Arthur's father praised Cozmo's programming and coding possibilities and valued the technical insight and problem-solving skills it teaches children. Oscar's mother also valued the educational potential of the toy, but did not appear to recognise that the exploratory play he engaged in involved learning:

> I liked the fact that it had all these sorts of educational aspects to it. It would have been nice if we'd have got to use them. I like the idea that it could code, and it would teach coding ... but it wasn't to be.

There was some disappointment with the lack of engagement with the coding capabilities of Cozmo. Parents lamented that their children did not engage with coding activities but accepted that this was due to the level of difficulty or technical issues (i.e., Cozmo shutting down frequently), as well as their children's inability to navigate coding activities (i.e., due to their age).

Communication Play

"Communication play" was observed as the English-speaking children learnt how to write things into Cozmo that the robot would then say. Ebrahim (aged 7) explained "you can type whatever you want him to say, like, I typed this, 'I play with Monica'". Emma (aged 8) made up entire stories for Cozmo to tell, and Arthur (aged 8) made up plays for Cozmo to perform. Oscar (aged 7) felt that the app had helped him learn to read: when asked how it helped him to read, he said "by me typing it in and him saying the words back to me so then I can hear what it says". This highlights how IoToys can facilitate a playful approach to literacy and supports the work of Heljakka and Ihamäki (96), who assert a need to "widen understandings of toy literacy into multiple directions". As such, the potential to support aspects of children's literacy and digital learning in a way that is engaging and playful illuminates the benefits that these types of toys can provide. In contrast, Italian and Belgian children faced more difficulties in communicating with Cozmo as they did not speak English. However, this did not limit the possibility to interact and communicate with Cozmo, for example, through parental mediation or by referring to recognisable symbols (sounds, icons, and images in the app).

Other Types of Play

The data indicated that four play types (imaginative, exploratory, mastery, and communication play) were the most prevalent among the participating families, although there was also evidence of "Locomotor play" (during exploratory play), and "Object play" (during mastery play). "Social play" was also reported, for instance, when children played with the robot with siblings or friends. All the children wanted to show Cozmo to friends and family. Arthur (aged 8) even arranged with his teacher that he could bring Cozmo to school and show his classmates what Cozmo could do during a class presentation.

"Creative play" (play that enables children to explore, develop ideas, and make things in a digital context) was limited in the data. Whilst there was some evidence of this type of play – for example, Oscar (aged 7) and Matteo (aged 9) built ramps and obstacle courses for Cozmo –, in general, there was limited evidence of children playing in creative ways to produce new artefacts with the robot. This is despite the toy having a creative mode, in which children can use the app

to code games and actions for Cozmo. For Eleanor, it seemed that the toy did not foster open-ended play. Her mother noted that Eleanor normally enjoyed creative play, but she appeared to lose interest in the toy after displaying initial enthusiasm: "I don't think it was creative enough, I think it's not open-ended enough and that's why she didn't play with it, would be my guess".

Oscar (aged 7) also lost interest in the toy after the first few weeks of use, which his mother put down to technical issues:

> I think if it worked flawlessly every time he'd gone to pick it up then he would have been quite happy ... but after a couple of negative experiences where it wouldn't load up and it's very frustrating, maybe it just put him off.

Other families also talked about how the battery was quick to drain and slow to charge, which impacted on the nature of the play. Emma's mother stated that the WiFi settings needed to be changed to play with Cozmo which Emma (aged 8) could not do by herself. Therefore, she was only able to play with Cozmo when her mother was around to help her. According to the parents of Arthur and Emma (both aged 8), Cozmo often showed technical errors and did not perform certain games, which caused some frustration with the children.

The mother of Aryana (aged 9) also reported a loss of interest in Cozmo, but not particularly related to technical reasons: "she lost interest all the time, so she didn't follow the steps to the end, she just play a little bit and she'd say, 'Oh I'm bored, I want to do something' … mostly YouTube". Such hesitant engagement may be due to technical issues but might also be due to the limitations regarding creative play identified in this study.

Conclusion

This study indicates that the Cozmo robot led to a variety of types of play, and that the adaptation of Hughes's framework by Marsh et al. offered a useful index for identifying changing practices in children's play. As highlighted, children's play with Cozmo often transcended the virtual and physical, online and offline, and digital and material, as well as providing a vehicle for learning. This analysis thus challenges the proposition that electronic objects limit children's imagination and play.

Prevalent in the findings was the willingness of children to suspend disbelief and engage in anthropomorphic/zoomorphic play with Cozmo by applying human-like attributes to the toy. Children related to the emotional connection with the robot much more than the technical aspects (i.e., coding), and whilst the children understood the limitations of the robot's agency, there are studies to suggest that caution should be applied by robot developers to ensure that, as technology advances, children are able to maintain the understanding that robots are different from human beings (van den Berghe et al.). This is of particular importance when existing literature highlights that younger children have a less nuanced understanding of the 'alive' status of a robot than older children (Nijssen et al.).

Children often incorporated more traditional toys and resources into their play with Cozmo: for instance, the use of toy soldiers and building blocks to create obstacle courses demonstrates the digital-material affordances of children's play. All the children enjoyed the pre-programmed games that utilised the 'Power Cubes', and there was an element of competitiveness for the children who demonstrated an eagerness to 'beat' the toy. Importantly, parents reported that

the app supported children's literacy development in a playful way, although this was more beneficial for the children whose first language was English. The potential for children's literacy development through playful child-robot interaction presents opportunities for further study.

One significant limitation of the toy that emerged from the findings was the capacity to encourage children's creative play. Kahn Jr. et al.'s earlier research showed that children endowed less animation to robot toys than to stuffed animals, as if children believe that toy robots have some agency and do not need assistance. Therefore, it is possible that children are less inclined to play in creative ways because they expect Cozmo to control his own behaviour.

The research has implications for work with parents. The parents in this study emphasised the value of mastery play for education, but at times overlooked the worth of other types of play for learning. Engaging parents in discussion of the significance that different types of play have for children's development could be beneficial not just for their own understanding, but also for the types of play they may then encourage and support. The study also has implications for the future development of IoToys. The producers of Cozmo promote types of play through the activities they support in the app, but a broader range of activities could lead to a wider variety of types of play to include, for example, fantasy or dramatic play. There are also opportunities to promote more creative play by, for example, enabling children to construct new artefacts for the robot toy itself, or providing drawing/painting tools that Cozmo could be programmed to use via the app. Broadening play types by design could be encouraged across the toy industry as a whole but, in relation to the IoToys, the opportunities for these kinds of approaches are exciting, reflecting rapid advances in technology that open up possible new worlds of play. This is the challenge for the next few years of toy development, when the first possibilities of the IoToys have been explored.

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Appendix 1: Participants

Country	Name (Pseudonym)	Sex	Age	Siblings
1 UK	Eleanor	F	8	2 younger brothers
2 UK	Ebrahim	M	7	2 older sisters
3 UK	Oscar	M	7	1 younger sister
4 UK	Aryana	F	9	2 younger brothers
5 AU	Jacob	M	10	1 younger brother
6 AU	Dylan	M	9	2 older brothers
7 Italy	Martina	F	8	2 younger sisters
8 Italy	Anna	F	8	1 younger sister
9 Italy	Luca	M	8	1 older brother
10 Italy	Matteo	M	9	1 younger sister
11 Belgium	Louis	M	9	2 younger sisters
12 Belgium	Emma	F	8	1 younger sister
13 Belgium	Arthur	M	8	1 younger sister

Appendix 2: Play Types

Play Type	Play Types (Hughes)	Digital Play Types (adapted by Marsh et al., "Digital Play")
Symbolic play	Occurs when an object stands for another object, e.g. a stick becomes a horse	Occurs when a virtual object stands for another object, e.g. an avatar's shoe becomes a wand
Rough and tumble play	Children are in physical contact during play, but there is no violence	Occurs when avatars that represent users in a digital environment touch each other playfully, e.g. bumping each other
Socio-dramatic play	Enactment of real-life scenarios that are based on personal experiences, e.g. playing house	Enactment of real-life scenarios in a digital environment that are based on personal experiences

Social play	Play during which rules for social interaction are constructed and employed	Play in a digital context during which rules for social interaction are constructed and employed
Creative play	Play that enables children to explore, develop ideas, and make things	Play that enables children to explore, develop ideas, and make things in a digital context
Communication play	Play using words, songs, rhymes, poetry, etc.	Play using words, songs, rhymes, poetry, etc., in a digital context, e.g. text messages, multimodal communication
Dramatic play	Play that dramatises events in which children have not directly participated, e.g. TV shows	Play in a digital context that dramatises events in which children have not directly participated, e.g. TV shows.
Locomotor play	Play which involves movement, e.g. chase, hide and seek	Virtual locomotor play involves movement in a digital context, e.g. child may play hide and seek with others in a virtual world
Deep play	Play in which children encounter risky experiences, or feel as though they have to fight for survival	Play in digital contexts in which children encounter risky experiences, or feel as though they have to fight for survival
Exploratory play	Play in which children explore objects, spaces, etc. through the senses in order to find out information, or explore possibilities	Play in a digital context in which children explore objects, spaces, etc., through the senses in order to find out information, or explore possibilities
Fantasy play	Play in which children can take on roles that would not occur in real life, e.g. be a superhero	Play in a digital context in which children can take on roles that would not occur in real life, e.g. be a superhero
Imaginative play	Play in which children pretend that things are otherwise	Play in a digital context in which children pretend that things are otherwise
Mastery play	Play in which children attempt to gain control of environments, e.g. building dens	Play in digital contexts in which children attempt to gain control of environments, e.g. creating a virtual world

Object play	Play in which children explore objects through touch and vision	Play in which children explore virtual objects through vision and touch through the screen or mouse
Role play	Play in which children might take on a role beyond the personal or domestic roles associated with socio-dramatic play	Play in a digital context in which children might take on a role beyond the personal or domestic roles associated with socio-dramatic play
Recapitulative play	Play in which children might explore history, rituals, and myths, and play in ways that resonate with the activities of our human ancestors (lighting fires, building shelters, and so on)	Play in a digital context in which children might explore history, rituals, and myths, and play in ways that resonate with the activities of our human ancestors (lighting fires, building shelters, and so on)
Transgressive play		Play in which children contest, resist, and/or transgress expected norms, rules, and perceived restrictions in both digital and non-digital contexts.

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Dr Louise Kay is a Lecturer in the School of Education at the University of Sheffield. Her research focuses on curricular and assessment policy frameworks in Early Childhood Education, and the impact that these have on teachers, children and parents. Further interests include STEAM education in Eary Childhood Education, play, pedagogy, workforce professionalism, and policy analysis.

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Silke Brandsen is a PhD student at the Institute for Media Studies at KU Leuven. Her research focuses mainly on the emotional responses of children to (online) news. Previously, Silke worked as a junior researcher at the Meaningful Interactions Lab (Mintlab) at KU Leuven, where she did research on children's digital skills and on the domestication of IoToys and the types of play they engender

Carmen Jacques, Edith Cowan University

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