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Kaleidoscope on the Internet of Toys

Safety, security, privacy and societal insights

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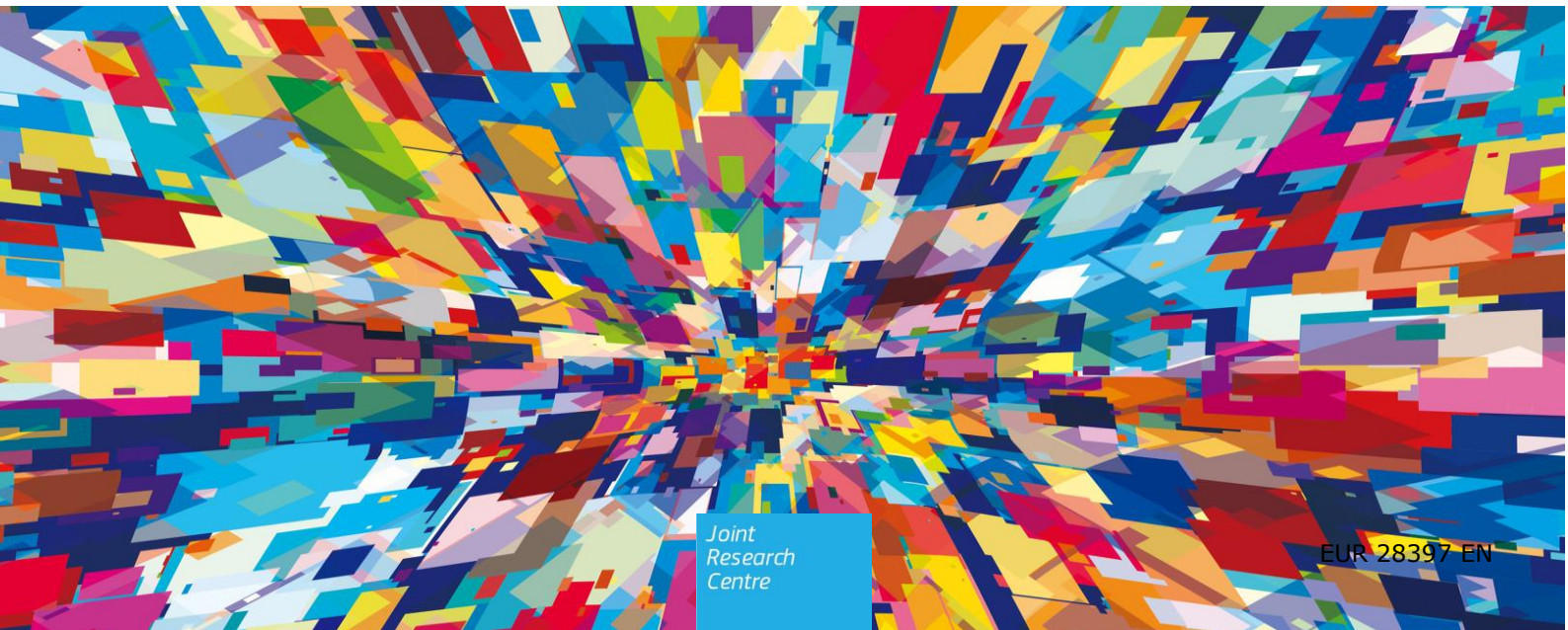

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We deeply thank all co-authors of this paper - Donell Holloway, Jackie Marsh, Giovanna Mascheroni, Jocher Peter, Dylan Yamada-Rice - who accepted enthusiastically our proposition to present the outcome of our panel's discussion in this document, and dedicated time and energy on the task.

More particularly, our thanks go to Prof. Giovanna Mascheroni for her work as Chairwoman of the session and to Prof. Jackie Marsh, who supported in the first place the idea of organising a panel of experts on the Internet of Toys and did all the necessary effort with her team to make it to be possible. We thank also our host for that day, University of Brno and the team of Prof. David Smahel, who took care wonderfully of all the logistics.

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The COST Action IS1410, DigiLitEY, is European network of 33 countries focusing on research in this area (2015-2019) led by Prof. Jackie Marsh of University of Sheffield who has published widely herself on aspects of digital literacy, childhoods and play.

http://digilitey.eu/

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Dylan Yamada-Rice is a Research Manager for Dubit, a company that specialises in strategy, research, and digital for kids entertainment brands. She also works as a Visiting Lecturer for the Royal College of Art's Information Experience Design programme. Her research interests include digital play and multimodal communication practices. She works at the intersection of academic and industry knowhow and is Director of Industry Partner Links for the COST (European Cooperation in Science and Technology) network DigiLitEY. She is currently a lead researcher on a commercially-funded study looking at children's engagement with Virtual Reality content. Part of this project also involves collaborating with specialists from the University of Leeds to consider potential health and safety implications of the technology. Previously, she contributed to an ESRC-funded project exploring play and creativity in pre-schoolers' use of tablet apps and an AHRC-funded project on developing videogames and play for hospitalised children. She has edited and contributed to the book 'Visual Methods with Children and Young People: Academics and Visual Industries in Dialogue' published by Palgrave (2015).

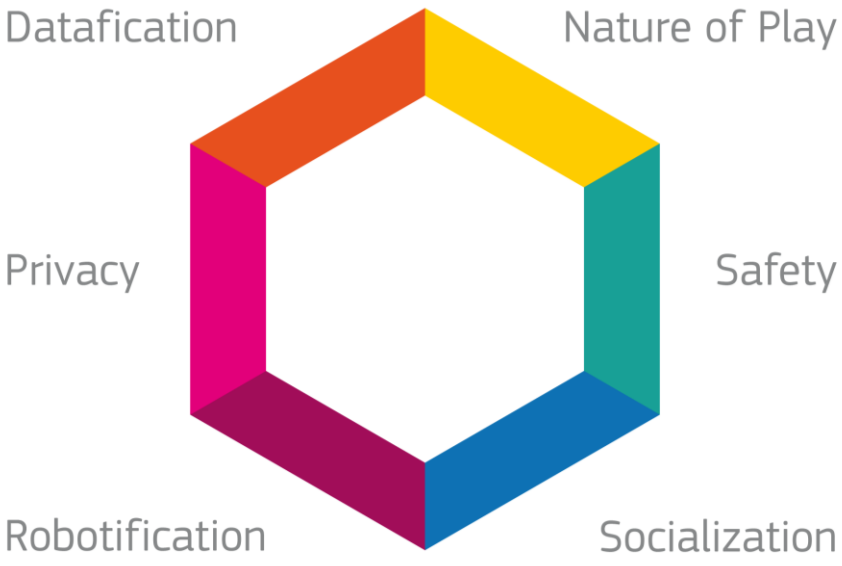
Abstract

This paper gives an insight into safety, security, privacy and societal questions emerging from the rise of the **Internet of Toys.** These are Internet Connected Toys that constitute, along with the wave of other domestic connected objects, the **Internet of Things,** which has increased the ubiquity of the ICT within our everyday lives, bringing technology more than ever closer to ourselves and our children. What changes and challenges will 24/7 Internet connected devices, and Connected Toys in particular, bring to our society? What precautionary measures do parents, teachers, health care professionals, and also industry partners and policymakers, need to take in order to protect our children's play, safety, security, privacy and social life? Based on which considerations? In which timeframe? The paper offers a kaleidoscope of six experts' views on the Internet of Toys, each exploring the topic and raising questions from a specific angle, as follows: Public and industrial discourse; Safety, security and privacy concerns; Social robot-children interactions; Quantified-self of the Childhood; Nature of Play and, finally, Possible benefits of higher collaboration between research and the Internet Connected Toy Industry.

Introduction

Modern ICT offers formidable opportunities and possible new benefits to citizens and society. The rise of domestic Internet connected devices increases the ubiquity of ICT, embedding it further within our everyday lives, and bringing it closer to ourselves more than ever, 24/7. Internet connected objects (known as the 'Internet of Things') are increasingly coming into our homes, with objects such as watches, fridges, toothbrushes, or coffee machines, turning our houses into Smart Houses. Among the newly connected familiar objects are also Internet connected toys that parents today are starting to choose for their children. Internet connected toys can offer new, important opportunities for play, learning, health and educational support, thanks to their interactive and personalised features, but they also raise questions about safety, security, privacy, trust and other fundamental rights of children. Indeed, Internet connected toys, as is the case with any other connected device, may record personal information regarding our children's lives, and then use and share the data. In a time of concerns about internet safety, security and privacy and social change, it seems crucial to take a step back, pose questions and look at these **connected toys**, characterised as the '**Internet of Toys'**, from various angles.

On November 7, 2016, the COST Action IS1410, Digital Literacy and Multimodal Practices of Young Children (DigiLitEY), hosted a panel discussion on the Internet of Toys in Prague, Czech Republic. This event was chaired by Giovanna Mascheroni (Università Cattolica del Sacro Cuore) and featured discussion by a diverse group of academics - Donell Holloway (Edith Cowan University, Australia), an expert in young children's digital literacy and media practices in homes and schools; Jochen Peter (University of Amsterdam) whose research focuses on the consequences of adolescents' media use for their socialization and psycho-social development; Stephane Chaudron (JRC, European Commission) as Policy-oriented researcher and expert in Digital Childhood. These academics engaged in discussion with representatives of the new European connected Toy Industry, Justyna Zubrycka, chief designer and co-founder of Vai Kai, and Dylan Yamada-Rice, research manager for Dubit, a company that specialises in strategy, research, and digital for kids' entertainment brands. In addition, Jackie Marsh (University of Sheffield), Chair of DigiLitEY, was invited to contribute to the discussion in this paper.



This paper presents a **kaleidoscope** of six experts' views on **Internet connected toys** and Internet connected children's devices.

1. The Internet of Toys: media, commercial and public discourses

In this first section of the paper, Donell Holloway identifies the potential risks and benefits of internet connected toys, as shaped by news, commercial and other public discourses.

2. The Internet of Toys – Safety and Security considerations

Stephane Chaudron, Rosanna Di Gioia and Monica Gemo consider issues relating to safety, security, privacy, trust and other fundamental rights of the child that are posed at stake by the use of Internet connected toys.

3. Social robots and the robotification of childhood

Social robots may be defined as entities that "can autonomously interact with humans in a socially meaningful way". Developing a sociological analysis on social robots and their links with children, Jochen Peter invites the reader to reflect on the role of internet connected devices 'robot' and children interactions we want for our society.

4. The Internet of Things and the Quantified Child

'What are the consequences of children being socialised to 'quantified self' practices from birth, increasingly allowed by the tracking features of Internet connected care devices?' This is the main question regarding the 'datafication' of childhood that Giovanna Mascheroni poses, and reflects on, in her section.

5. The Internet of Toys and the Changing Nature of Play

Play in the digital world is becoming increasingly complex due to children's use of technologies, in particular Internet connected toys. 'What are the implications of these developments for thinking about the nature of play today?' is the question Jackie Marsh addresses, based on her recent qualitative research on children's digital play.

6. Designing connected play: Perspectives from combining industry and academic knowhow

Finally, Dylan Yamada-Rice provide us with an informative reflection based on her work and experience at the intersection of academic and industry know-how, building bridges between the two worlds.

1. The Internet of Toys: media, commercial and public discourses

Donell Holloway, School of Communications and Arts, Edith Cowan University, Australia

The Internet of Toys marks a major change in how we think about children's media consumption, purchase and ownership. This is because most smart toys are 'hybrid' products – where the physical object (the toy) is owned by the customer, yet the presence of embedded and connected software means that the customer is subject to long term contractual obligations. These terms and conditions enable data exchange between the child and the platform; the child and parent; and the child and other data sharing recipients.

While existing toy companies and start-ups are eagerly innovating and promoting their connected products, problems involving data hacking and other privacy issues have already surfaced. The Hello Barbie and VTech hacks are recent examples. This section identifies the potential risks and benefits of internet connected toys, as shaped by news, commercial and other public discourses. Notwithstanding the possibility of the social amplification of risk via news media and specialist commentary [1], media plays a prominent part in disclosing consumer risks and concerns and thus, plays a "significant role in forming and shaping risk scenarios" [2] to inform design, policy and the public. The section demonstrates how two dominant commercial groups (toy manufacturers and security entrepreneurs) have shaped the discursive context in which the benefits and risks of internet connected toys have so far been portrayed.

The discourses briefly examined in this section are obtained from English language newspapers, magazines, blogs, online videos and so on available over the last year. They are almost exclusively aimed at adult audiences and discuss issues relating to child consumers who are usually too young to fully understand and consent to data collection or to understand other security issues or, even, to voice their opinion regarding their views on evidence based data issues.

The most prominent publically available stories and conversations about internet connected toys tend to focus on the data security problems children and their families face, as well as the possibility of individual children's Internet connected toys being hacked or compromised. These news reports and stories most often originate from independent white hat hackers, who have unofficially tested the toy company's toys and systems. White hat hackers are known to penetrate the data systems and networks of an organisation with a view to exposing a company's weakness—so that the organisation can remediate any breaches before they "can be taken advantage by others" [3]. News reports that have originated from white hat hackers include security breaches to Mattel's Hello Barbie, Geneses' Cayla Doll, VTEch Toys and Fisher-Price's Smart Bear. Headlines similar to the examples below have been circulated over a number of news outlets and tech magazines, and reiterated in a variety of blogs and parenting focussed magazines and sites.

- Hackers can hijack Wi-Fi Hello Barbie to spy on your children [4]
- Talking Doll Cayla Hacked To Spew Filthy Things [5]
- When children are breached—inside the massive VTech hack [6]
- Fisher-Price smart bear allowed hacking of children's biographical data [7]

Alongside these security scares, commercially based discourses promoting Internet connected toys are seen to promote the potential benefits of these toys. These advertisements and infomercials advertise to parents by emphasising their educational value or other moral attributes (such as keeping children fit or active or as fostering

creativity or social play). By emphasising the moral attributes of Internet connected toys these advertisements and infomercials also seem to redress well known, older 'moral panics' regarding children and the Internet: computer games socially isolate children, have no educational value, and keep them unfit or unhealthy by keeping them glued to a computer screen.

Although hard to find, there are other marginal or less dominant discourses about the risks and benefits of the Internet of Toys running in conjunction with the security and commercial discussions about internet connected toys. These more marginal discourses cover a wider range of topics and have included a variety of discussions around educational value, play affordances, physical health implications, social and recreational values associated with the emergence of the Internet of toys.

Table 1 summarises the publically available discourses around the risks and benefits of Internet connected toys—from most prominent ideas and opinions to less published or discussed viewpoints.

IoToys Risks	**IoToys Benefits**
Data security (biographical data)	Educational (engaging and individualised to child)
Device security (toy can be hacked and used as a surveillance device)	Encourages play and toy interaction over passive screen time?
Device security (toy can be hijacked to behave badly or erratically)	Fun, exciting
Device security (geolocational tracking of children)	Can teach coding
Children's privacy (secrets recorded, incremental effect of data collection and sharing over a lifetime)	Supports more physically active play
Overuse and balance in life (sleep, physical activity, socialising)	Encourages more social play (with toy and with other children)
Lack of real authentic play (developmentally important)	Fosters collaborative play with other children
Lack of parent child interaction (developmentally important)	Diagnostic possibilities (identify learning difficulties or medical problems)
Play too controlled or contrived—driven by scripts and algorithms (e.g. Hello Barbie).	Safe and secure (Internet privacy and security)
Health implications from electromagnetic radiation (EMR)	Can be continually updated with new content

Table 1. Publically available discourses about the risks and benefits of Internet connected toys (Nov 2015-Dec 2016)

To date, little governmental or regulatory discussion regarding the Internet of Toys has occurred within the public realm. In this sense, dominant public discourses around the Internet of Toys tend to conform to a straightforward neoliberal ideology (that values an unfettered free market economy with minimal government or collective oversight) and where the commercial interests of toy manufacturers and security entrepreneurs hold forth. Very recently, however, consumer groups such as the Norwegian Consumer Council, the Electronic Privacy Information Centre, and the Campaign for a Commercial Free Childhood and Consumers Union have made public statements about data privacy and security of Internet connected toys and have petitioned the US Federal Trade Commission to step in to take action against toy companies that are violating the Child Online Protection Act [8]. The steps taken by these consumer watchdogs will hopefully bring about a more nuanced discussion, as well as policy and regulatory attention as to what needs to be done in terms of policy, industry practice and parenting advice in order to mitigate risks and maximise benefits arising from the emerging Internet of Toys industry.

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2. Internet of Toys – Safety and Security considerations

Stephane Chaudron, Rosanna Di Gioia, Monica Gemo, European Commission, JRC

You might not have paid much attention, but in the last months, toys of a new kind are appearing on the shelves of toys shops. They can be very different kinds of toys, such as watches, robots or teddy bears, for instance, but all have in common the facility to be connected to the internet and some are able to adapt to the actions of the user, to be 'smart', in other words. No screen is necessarily needed in order for an object to be considered a 'Smart Toy' or 'Connected Toy'. A recent publication of the Future of Privacy Forum & Family Online Institute (FOSI) [1] made the distinction between 'Smart Toy' and 'Connected Toy'. 'Smart Toys' contain embedded electronic features (microphone, camera, sensors, accelerometer, gyroscope, compass …) that enable them to interact with their users and adapt to their actions. Those toys are not necessarily connected to the Internet. 'Connected Toys' on the other hand are 'designed to connect to the Internet and therefore remote servers that collect data and power the toy's intelligence' [1, p.2]. Those connected toys are not necessarily 'Smart'. We will here mainly consider Connected Toys that, amongst other features, record all sorts of data while children are playing and interacting with them: sounds, images, movements, locality, or even heartbeat. Furthermore, Connected Toys have the facility to share those recorded data, the 'play data'. Play data are any data that can be recorded by the toy or device while the user is playing [2]. By recording play data, the toy retains the memory of the play, and potentially of its evolution.

Recording sounds, images, movements or locality can add to the dimension of play by offering new interactive opportunities that nourish imagination and the creativity of the player. The toy can provide feedback on performance that the player can use to improve her or his playing skills or abilities. No Internet connection is actually needed for such features in a toy, as we saw above, and this facility has been used for decades already. So, why have toys become connected to the Internet? The Internet connection is needed to share the play data remotely with others, children or parents in the first instance, then schools and health services potentially, and, inevitably, with the product and service providers, the industry itself (see Figure 1).

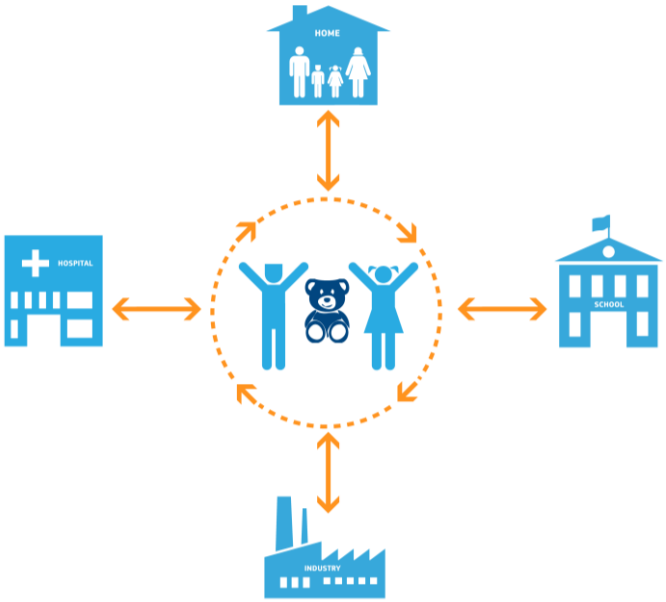

Figure 1: Possible use of recording and sharing of 'Play data'

- PLAYING - LEARNING: As indicated previously, recording 'Play Data' helps the toy to be more interactive and closer to the player. It allows a relevant type of Connected Toy to engage more emotionally with the child in some cases. The analysis of the Play Data enables the toy to provide feedback to the user and may help him/her to improve skills and abilities.
- CARING (PARENTING, SCHOOLING; HEALTH CARE): In some cases, the Play Data analysis allows feedback to be provided to carers also. Parents, teachers and health carers have possibilities via dedicated and synchronized apps to check and keep track on the child usage (Play data) but also they can access Personal Data that might not be of primary interest to the child in the play (i.e. heart beat), but provides data that are linked with the psycho-physical state of the child.
- PROFILING by the INDUSTRY: The Connected Toy service provider may record, analyse, use and even sometimes share Play Data and possibly other Personal data such as:
    - Personal information (name, age, localisation, email address, postal address can be collected if the user – aged above 13 or the carer on behalf of under 12s- agrees)
    - Automatic collection of data such as IP address, behaviour when using the website or app, including visits to other 'friends' apps and websites, and consumer behaviour. [2,3,4]

    Those data allow the industry to monitor and analyse the user's online behaviour with the aim of improving the service or the products and personalising them, but also the data may be used to improve communication and advertisement strategies.

Sharing play data can, thus, help in improving learning, parenting, schooling, health care or costumer profiling, but it also poses also safety and security concerns.

Play data are actually personal data and as such they need to be carefully managed, especially in the case of children's data. Parents aim to provide children with safe and secure toys. In this sense, a first question could be raised - 'What data relating to my child are recorded, and for what purposes are they stored, analysed and shared?' The answer usually lies in the Privacy Statement or Privacy Policy of the Toy Company [2,3,4], and herein lies some of the difficulties. How many parents actually take the time to read those documents before choosing a new toy, or as the child starts to use it? Usually, very few, if any. The document is, most of the time, not accessible to everyone and can consist of several pages of text, although some Toy companies, such as Mattel [3], have attempted to improve these documents by providing summaries. 'How are play data protected once recorded, sent, stored?' could be a second question posed, as indeed any points of the shared data system, from the Wi-Fi connection to the cloud storage, constitutes a weak point susceptible to leakage or hacking. What can be the measures taken to prevent this? Gaining the consumer's trust is key in the process, and the Industry knows it. Another challenge that Industry faces is the need at a European level to comply by May 2018 with new General Data Protection Regulation (GDPR) [5], which addresses several fundamental issues and will enforce new Data subject's rights. Those are mainly:

- the need for the individual's clear consent to the processing of personal data;
- easier access by the subject to his or her personal data;
- the rights to rectification, to erasure and 'to be forgotten';
- the right to object, including to the use of personal data for the purposes of 'profiling';
- the right to data portability from one service provider to another.

Although the relevant decisions concerning data use and protection will be made by the parents of children under the age of 16, the toy industry needs to address these new rights in a child- and family-friendly way.

Apart from issues relating to personal data protection, a further dimension of childhood is at risk with certain kinds of connected toys, which is a child's right to privacy. Children are people, with emotions, feelings and rights. From this perspective, one has to think carefully about the purpose of recording and sharing the sounds, images and movements of children's play. Play has consistently been the way for children to embrace and make the world more understandable to them, sometimes even helping to make life more bearable. Free play has also the necessary function of releasing tensions through helping the child to keep secrets, elements of play that adults and parents do not always welcome. Teddy bears have always been the best at keeping secrets. What if from now on, Teddy can share those secrets with others? The question is open and left to the parents, teachers and other carers to consider. The Internet of Toys is about to bring significant changes in children's relationships with others and their surrounding environments. It is time to think about the possible consequences, to optimise the possible benefits and to mitigate the risks.

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3. Social robots and the robotification of childhood

Jochen Peter, Amsterdam School of Communication Research, University of Amsterdam

The times that robots were only used in industry, for labour, and for repetitive and potentially dangerous activities are over [e.g., 1]. In the past years, robots have increasingly entered our everyday life [2]. Most important, robots have been designed for relationships, interaction, as well as play and have progressively become social [1], [3]. Social robots may be defined as entities that "can autonomously interact with humans in a socially meaningful way" [2, p. 755]. While social robots have attracted attention in the care for the elderly [e.g., 4], they are also more and more used in the treatment of autistic children [5] and present in toys for developmentally typical children. The robot dinosaur Pleo, for example, has been around for nearly ten years, and social-robot toys, such as the robot dog ChiP, have recently been launched. Several advanced new toys are also connected to the Internet, thus creating the Internet of Toys and contributing to an increasing robotification of childhood.

The robotification of childhood can be seen in the context of the emergence of sophisticated, 'smart' machines. At least six forces have driven this development [3], [6]. First, computing power has exponentially increased. Second, sensors, microphones, and cameras have become miniaturized and affordable. Third, dramatically growing amounts of information are available in digital and networked form, notably through the Internet. Fourth, mobile connectivity has become powerful and widespread, at least in rich countries. Fifth, computing progressively takes place in the cloud. Once connected to the (robot) cloud, robots can flexibly be developed further and learn from other robots. Sixth and finally, artificial intelligence and machine learning have progressed considerably, which facilitates robots' autonomous interactions in changing environments and with different age groups, for example with children. Given the pervasiveness and momentum of these driving forces of robotification, several observers [7], [8] expect fundamental changes in human life that not only apply to adults, but in the form of robotic, internet-based toys also to children.

As children are thus likely to encounter more and more social robot toys, notably in the Internet of Toys, at least five characteristics of child-robot interaction become important [for a detailed treatment of the issue, see e.g., 9]. First, robots can be embodied (i.e., physically instantiated [10]) or disembodied, for example in the form of intelligent digital agents [11]. Second, child-robot interaction does not depend on classic interfaces, such as keyboard or screen, but is increasingly 'natural:' it operates through speech, gestures, and vision, rather than through text or symbols [12]. Third, child-robot interaction is interactive in that child and robot deal reciprocally with each other [12]. Fourth, partly through connection to the Internet and cloud computing, robots are in principle able to adjust the interaction to the particular child [6]. Specifically, child-robot interaction can be personalized to the wishes and needs of the particular child, for example through 'memory' for previous interactions or information about other robots' interactions with similar children [3]. Although many more features of child-robot interaction are conceivable [12], it is crucial to note that the rather natural, interactive, adjustable character of child-robot interaction goes considerably beyond traditional toys and requires careful research, notably about its consequences.

While we still know relatively little about the consequences of children's interaction with robots, both opportunities and risks for children's cognitive, socio-emotional, and moral-behavioural development are conceivable. In terms of children's cognitive developments, scholars have focused, for example, on the acquisition of foreign language skills [e.g., 11]. Social robots may not only compensate for unavailable native speakers as language tutors, but they may also reduce the embarrassment that children may encounter when having to

talk to human teachers, thus facilitating foreign-language learning [e.g., 11] – not least when social robots may draw on Internet resources and can personalize tutoring to children's needs. At the same time, Internet-based personalization in children's education may increase the risk of educational bubbles or, more generally 'filter bubbles' [14], that is, the notion that, through filtering algorithms, children may only receive information that fits their pre-existing knowledge and interests, while contradictory information is withheld from them. Moreover, social robots may turn into surveillance machines, potentially endangering children's privacy [e.g., 13].

In terms of the socio-emotional consequences, one opportunity of child-robot interaction may lie in the possibility that children use interaction with robots to compensate for issues or deficits they may encounter in interaction with humans, as evidenced by research on social robots and autistic children [5]. Conversely, however, children may find interaction with a robot so attractive that it gradually displaces interaction with humans, notably when social robots are humanoid. A similar hypothesis has been put forward when Internet-based communication became available [16] and deserves attention given the aforementioned characteristics of child-robot interaction, which can be assumed to attract children.

In terms of consequences for the moral-behavioural development of children, one opportunity of child-robot interaction may be that children "will (…) see, conceptualize, and interact with [social robots] as a unified entity, and not merely a combinatorial set of its constituent properties" [17, p. 35]. This "new ontological category hypothesis" [17, p. 35] implies that, in conceptualizing social robots as entities located somewhere between the animate and the inanimate, children may intuitively develop novel ways of dealing successfully with social robots. On the downside, children's interaction with social robots may often resemble master-servant relationships in which the child dominates and objectifies the robot. This tendency towards domination and objectification of other entities may carry over to children's relationships with other humans [17].

In conclusion, given current technological developments, today's generation of children is probably the first generation whose entire life will be shaped by social robots. It is, therefore, paramount that we understand, based on the characteristics of child-robot interaction, how children interact with social robots and which opportunities and risks child-robot interaction entails for children's development and later life.

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4. The Internet of Things and the Quantified Child

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Internet of Toys (IoToys) is expanding the range and quantity of children's everyday life practices that can be tracked, recorded and analysed. Together with wearable devices and apps, IoToys is indeed contributing to an unprecedented quantification of childhood that begins in utero. Pregnancy apps encourage expectant mothers to monitor and scrutinise their and their foetus' bodies [1], [2]. Later on, wearable sensors such as smart socks and anklets, smart teddy bears, and parenting apps assist parents in the task of collecting and recording various aspects of babies' early life, in order to compare their babies' feeding, sleep, and growth patterns with what is culturally constructed as 'normal' [3]. As children grow up, educational apps [4] or platforms [5], [6] enable teachers, parents and children themselves to track and measure the experience, process and outcomes of learning, in order to maximise students' engagement and offer personalised learning. In this sense, IoToys is just the ultimate technology that can be used to track and monitor children's behaviour and, more specifically, children's play practices.

Whereas journaling children's health and habits has long been established, tracking it by means of apps, wearables and smart devices deeply transforms this practice, turning it into a form of 'datafication' [7][8]. In other words, children's practices and lives are transformed into digital data that are stored in online corporate platforms [7], not dissimilarly to what happens with the information collected by adults when recording their fitness practices, intake of calories, sleep patterns, work productivity and so on.

When children are concerned, though, a key difference is worth mentioning, one that relates to children's agency and rights. While adults often voluntary engage in self-tracking, children are monitored by parents or caregivers (when they are too young) or 'pushed'[6] to self-track in exchange of rewards of various kinds (such as earning points for good behaviour in school, or achieving bonus points in a game). What are, then, the consequences of children being socialised to 'quantified self' practices since they are born? As sociologist Deborah Lupton notes, smart objects, wearable devices and tracking apps are socio-cultural artefacts that embody and reproduce shared norms and beliefs. These technologies construct self- tracking as "a practice of selfhood that conforms to cultural expectations concerning self-awareness, reflection and taking responsibility from managing, governing oneself and improving one's life chances" [6, p.68]. In accordance with the neoliberal ideology, self-tracking valorises self-improvement and positions the individuals - be it by parents or children themselves – as the sole responsible for their health, achievements and development [3], [6]. Indeed, self-tracking can be turned into a form of empowerment when aimed at resisting dominant neoliberal discourses and categories or satisfying personal curiosities, such as in the Quantified Self movement [3]. When children are the target of tracking practices, however, this liberating potential is more rhetorical than actual, precisely because children's self-tracking practices are unlikely to be voluntary and children have little or no agency to resist being monitored by parents, teachers and friends.

Moreover, self-tracking normalises surveillance as a cultural and social practice. Different forms of surveillance are in play here. First, pregnancy and parenting apps and/or devices "normalise the process of everyday intimate surveillance" [9]. Monitoring and surveying children is well intentioned and purposeful, and is currently being constructed as a virtuous, normative parenting practice. Second, consciously or not, children are interiorizing forms of 'participatory veillance' [10] when they engage, or are encouraged to engage, in self-monitoring practices.

Most important, by means of tracking apps and devices children's lives are datafied and stored in corporate platforms. Therefore, children's behaviour is the object of algorithmic surveillance [10], aimed at calculating and predicting future (consumption) behaviour. How children's data are analysed, manipulated and stored is not transparent. Examples of data breaches in children's online communities have already highlighted the potential risks to children's privacy and safety.

In conclusion, the datafication of childhood raises a number of concerns. Risks for children's rights to privacy are the most visible and immediate consequences, and have already been addressed in the academic and public agenda. Growing up in a culture where (self-) surveillance is normalised is also likely to shape children's future lives. Therefore, the social and cultural consequences that self-monitoring practices entail for children on the long term cannot be underestimated and should be explored in future research.

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5. The Internet of Toys and the Changing Nature of Play

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Play in the digital world is becoming increasingly complex due to children's use of technologies. Contemporary play practices take place across a range of digital and non-digital domains and cross virtual and physical-world boundaries in a fluid manner [1] [2]. The Internet of Toys involves playthings that promote these kinds of connected play. What are the implications of these developments for thinking about the nature of play today?

In research conducted on under 5's use of tablets and apps in the UK [3], the project team observed children using toys that were connected to the Internet. For example, 2 year-old Amy was filmed playing with a Furby, which she fed using an app. As Amy offered the physical toy virtual items of food from within the app, the Furby flashed its eyes and talked excitedly in 'Furbish' to Amy. Amy then took Furby to a virtual toilet, chattering happily to the toy as she did so, moving on to pretend that her hands were dirty from this process. Amy engaged in extended imaginative play with the cuddly toy, and whilst children have always brought non-human playthings to life by pretending that they are alive, the fact that the Furby talks, sings and flashes its eyes made that leap into anthropomorphism a small step for her [see 4 for a fuller discussion of this play episode].

These versions of Furby are connected to the Internet in various ways – children can collect and swop virtual Furby eggs with their friends, for example. The toy is also connected to the networked world of popular culture, and top-rated songs and viral videos are pushed through to the app (after being filtered by the toy producer, Hasbro) so that Furby and owners can keep up with the latest trends [5].

Some worry that play involving technology is limited in some way, as they fear that it constrains children's imagination [6], but we found no evidence of this in our project, which involved extensive study of children's play. Indeed, the majority of types of traditional play, such as imaginative and fantasy play, were evident in the observations of children's play with technology [7]. In the short episode of Amy's play with her Furby, for example, we noted the following types of play: symbolic, socio-dramatic, communicative, imaginative, object play.

In what ways, therefore, is the Internet of Toys changing play, if we can identify many of the same characteristics that occur in play with traditional toys? Such play, in many cases, involves a range of media and, thus, can be characterised as transmedia play [8], but then this is also the case for play with toys that are not connected to the Internet. The key transformation, therefore, is arguably the extent to which, when playing with objects connected to the Internet, local play can be shaped by global factors (such as the link to viral videos hosted by companies such as YouTube), children may connect with others, and the merging of dichotomies such as online and offline domains, and public and private spaces and practices, may occur. This is also the case with regard to a number of other kinds of communicative practices in which children engage, in which these kinds of links to the external world are significant factors in their activities, such as watching unboxing videos [9]. Children's play and social worlds are no longer confined to the physical spaces in which they are located, and their imaginations, always virtual, may now encompass a different kind of virtuality [1] [2] [4]. The Internet of Toys, therefore, offers further opportunities to engage in the kinds of transmedia, trans-domain practices that are becoming part of the everyday fabric of many children's lives, with the toy operating as a kind of 'boundary object' [10], enabling the child to transverse these domains and practices with ease.

These developments do raise the need to consider a range of factors given the concerns that are associated with such activities, as outlined in this publication, but they do not

require a fundamental re-thinking of what play is and can be, nor do they suggest that children are any less creative in their play today than they have been in the past. Play with toys connected to the Internet can be every bit as creative as play with traditional playthings. As Vygostsky noted:

> *We can identify creative processes in children at the very earliest ages, especially in their play. A child who sits astride a stick and pretends to be riding a horse; a little girl who plays with a doll and imagines she is its mother; a boy who in his games becomes a pirate, a soldier, or a sailor, all these children at play represent examples of the most authentic, truest creativity. [11, p11]*

Amy's play with her Furby, in which she looked after it, talked to it and pretended it had made her hands dirty, can also be seen as an example of play that exhibits 'the most authentic, truest creativity' (ibid).

Rather than being anxious about the potential loss of play and creativity in relation to the Internet of Toys, therefore, we should focus instead on considering the quality of play that takes place when these objects are used, as should also be the case with regard to whatever kind of toy a child is playing with. Fostering quality play involves a range of activities including observing children, talking to them, modelling play, playing alongside and with them, giving them time and space to play alone, and ensuring that they have a variety of experiences that spark their imagination [12] – these practices should not change just because a toy is connected to the Internet.

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6. Designing connected play: Perspectives from combining industry and academic know-how

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Academics, designers and producers tend to consider the evolving Internet of Toys (IoToys) from within their individual disciplines. On the one hand, academics bring a long history of researching and theorizing play and communication practices to the task of considering young children's use of connected toys. On the other hand, designers and producers of connected toys have detailed understanding of the possibilities and affordances of technology, as well as the technical mechanics involved in toy production. In other words, they know what it is possible to make, and what it is not possible to make. Industry also has an eye on trends in digital toy production and content, and how these are likely to evolve. This is because the digital play industry track data on technology usage and media consumption, and so on. These are things that academics are often a step behind in understanding because of a tendency to consider children's use of an end product. However, my work across academia and the commercial toy and digital content industry has taught me that the amount of expertise companies have of child development and theories around play and communication practices is extremely varied and start-up companies in particular have little resource to conduct in-house research. This means that some connected toys are not as well made for young users as they could be. However, these crossovers have also taught me that sometimes academics call for changes to designs that are not easily possible or commercially viable. Therefore, regular collaboration between academia and industry would aid production of the best possible connected toys and content for young children.

The aim behind a (COST DigiLitEY network-funded) Short Term Scientific Mission (STSM) I conducted with Vaikai in Berlin was to consider the design of their connected doll known as Avakai in relation to young children's use. Avaikai are sets of two digitally connected wooden dolls that produce emotional communication through a correlation of set movements that induce emotional responses. In doing so, I compared primary data on the designers' backgrounds and their intentions for the doll with observations of young children's use of the toy. This made it possible to understand where the two linked or did not. Such a focus was built on the supposition that the toy's design carried as much significance to the findings of the project as the young children's use of it. Such emphasis builds on work that has used object-orientedness [1] object-ethnographies [2], artefactual literacies [3] and material stuff [4,5,6], to highlight the role and agency of materials, and emphasises that this is no less important than considering the human practices that derive from them [7]. Further, this position recognises that how these materials are combined in the construction of connected toys is also the product of designers' individual or combined backgrounds. As a result, smart toys cannot adequately be understood without considering both the design elements, as well as social science approaches to understanding children's use of the toys. Thus, there is a need for academics, designers and the broader digital toy and content industry to work more closely together to produce the best products possible for young children. This is becoming ever more important, given the evolving speed of new materials and technologies for play and communication.

In relation to how designers, producers and academics working in the field of the IoToys can work together, I would like to propose using a Design Thinking Model [8] (Figure 2). Although created as a design tool, the processes naturally align themselves to approaches used in both design and social science research, and thus can be a good starting point for establishing a collaboration across the two areas..

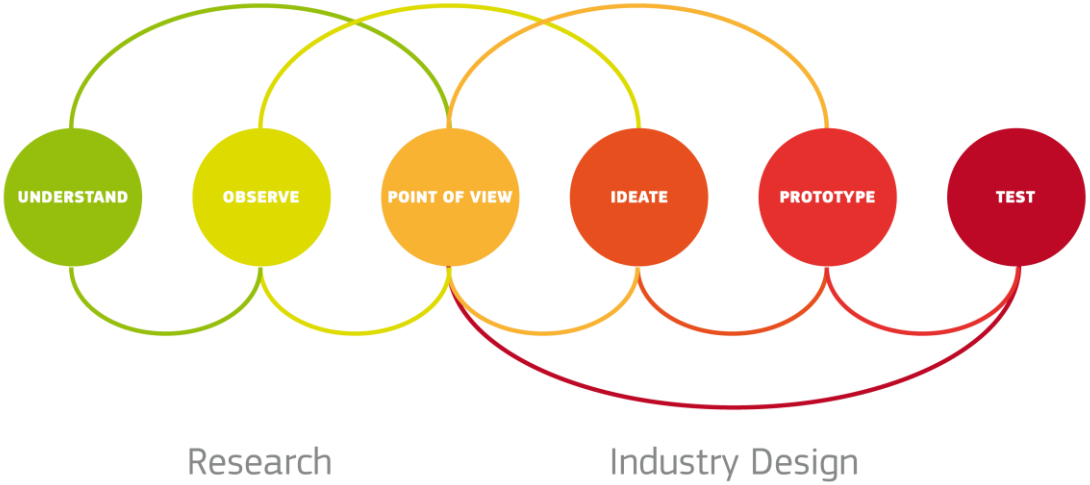

Figure 2: Six-stage Design Thinking Model (HPI, undated)

The six staged process outlined in Figure 1 could be split to best use expertise in both social science research, and industry design methods. For example, the first three stages in the model: 'understand', 'observe' and create a 'point of view' on a topic (such as young children's use of digital toys) are often used in social science research, and the interdisciplinary area has a long history of theorising and creating means to gather knowledge in ways that tie with these three stages. The latter three stages, 'ideate', 'prototype' and 'test' are common practices in design, and of course collaboration can be applied across the six stages. To apply these ideas further, if the Design Thinking Model was used in a collaborative project by academics and industry on the production of new connected toys, it might work like this:

Stage 1: 'Understand'

This stage would use social science methods to understand children's needs with regards to the development of a new connected toy. This could be done through a literature review or primary research. Such information, for example, might be used to identify a theme of play for a new toy.

Stage 2: 'Observe'

Again a stage based on observation is well suited to the skills of social scientists. Continuing with the example above, this stage would be undertaken by an academic to observe how children use the proposed theme in their physical play, alongside naturally occuring language and movements, and so on. In the case of the project with the Avakai connected dolls, this would include watching children play with unconnected dolls, observing the gestures and narratives they use when doing so. For example, do children move dolls in certain ways when enacting emotional narratives? Then, observations of children using toys with similar technology (if such toys exist) could be used to understand if the proposed mechanics of the Avakai might work with young users. This might include the development of an understanding of how children use other connected toys. This information would all feed into the next stage, developing a point of view.

Stage 3: 'Point of View'

Following the first two stages, academics and industry partners would come together to discuss the findings and establish a point of view. This leads directly into stage 4.

Stage 4: 'Ideate'

This stage is primarily within the expertise of designers and industry, where ideas for the new toy are brainstormed and explored. However, social scientists can contribute to this stage by bringing in examples of language, play and movement collected in the first two stages.

Stage 5: "Prototype'

Stage Five also fits easily into the established history of designers and industry, where paper or more sophisticated prototypes are produced to test the toy concepts with the intended users.

Stage 6: 'Test'

In this stage children would be observed using the toy and interviewed about the related ideas. In my experience, this works well with both academics and industry members present. In the testing sessions I have undertaken for industry, children are often interested in who has made the toy and therefore having the chance to share ideas directly with the creator engages them in the activity.

I hope these ideas can be used as an initial spring board for finding ways in which social scientists and industry members can work collaboratively to combine different but related expertise in order to produce better products for the evolving Internet of Toys market.

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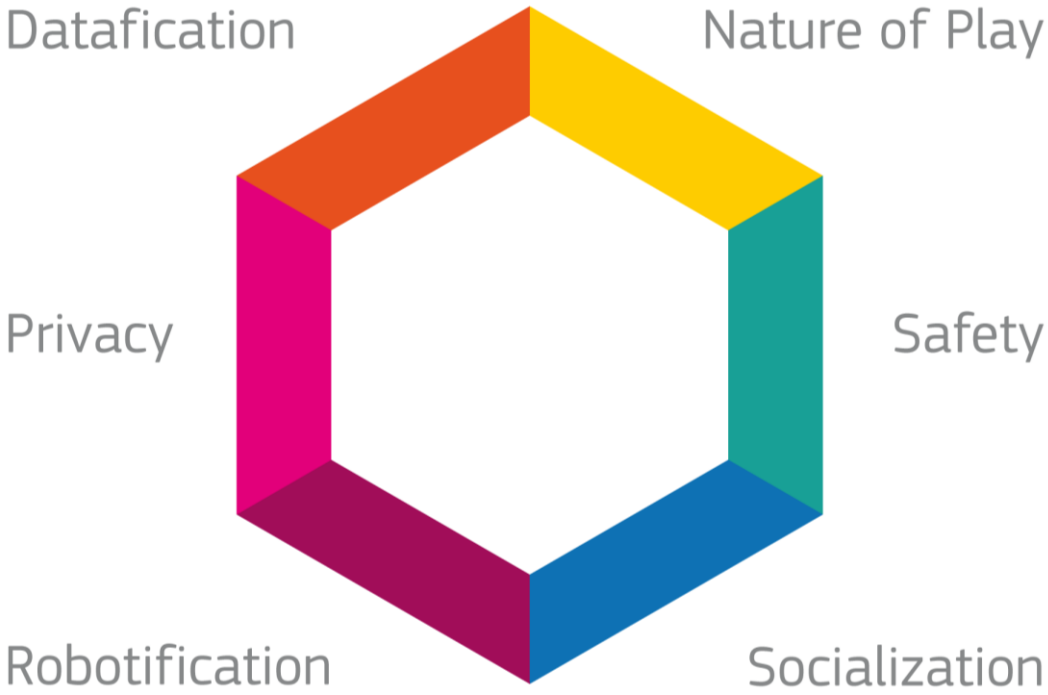
Conclusions

Our kaleidoscope, consisting of six different and complementary experts' views on Internet Connected Toys, or the **Internet of Toys (IoToys),** has explored the topic from various angles. These have included public and industrial discourses; safety, security and privacy concerns; social robot-children interactions; quantified-self of Childhood; the nature of play; and the benefits of Research and Toy Industry collaborations.

What can we learn on the IoToys from the composition of the six images of our kaleidoscope?



Let us shuffle the order of the images offered so far and start from Peter's considerations on child-robot interactions. Peter notes the 'rather natural, interactive, adjustable character' of child–robot' interactions, among which we can include interactions between children and Internet-connected toys, which 'go beyond traditional play'. Marsh also particularly outlines this point in her section. She points out the key transformation of the spatiality of the play. This is no longer limited and confined to the physical space but made of local-physical and global-virtual elements. Here, Marsh sees three main impacts of this new structuring of the space in which children play. 1. Local play can be shaped by global factors, e.g., thanks to their interactive and adjustable character, Internet-connected toys can actively suggest the latest song or video buzzing on the web. 2. Children may connect with others that are not physically in the same space. 3. The distinctions between offline/online and private/public spheres become blurred. As a consequence, following Marsh, children's imagination evolves and finds its raw material in a transformed space made of blurred local-physical and global-virtual elements. Children playing with IoToys may therefore 'encompass a new kind of virtuality' and 'engage in the kind of transmedia, trans-domain practices that are becoming part of the everyday fabric of many children's lives, with the toy operating as a kind of '*boundary object'* enabling the child to transverse these domains and practices with ease'.

Following these considerations, the IoToys seems to offer children the opportunity to learn to evolve with ease in their world, an increasingly connected world. Again regarding opportunities, Peter classifies the opportunities that IoToys (as part of the robot world) offer to children's development in three categories: cognitive, socio-emotional, moral-behavioural. IoToys, like robots, can compensate for practical issues (e.g., lack of native speakers to teach a foreign language). They can increase the socio-emotional attractiveness of learning or patch up for 'deficits or issues that [children] can encounter in human interaction, as evidenced by research on social robots and autistic children. They can interestingly lead children to create new sorts of human-robot relations as the distinction between animated (human) and unanimated (objects) is becoming blurred, too. Mirroring those opportunities, Peter inevitably sees the risks under the same three categories. At the cognitive level, 'Internet-based personalisation in children education may increase the risks of 'educational bubbles' or (…) 'filter bubbles' [algorithm-filtered virtual space in which] children may only receive information that fits their pre-existing knowledge and interests, while contradictory information is withheld from them.' On the socio-emotional side, the children-IoToys interaction could be so attractive to children that it could tend to replace human interactions. On the moral-behavioural side, Peter flags the possible integration of Master-Servant domination schemes and objectification of human relationships.

'Play data', defined in Chaudron, Di Gioia and Gemo's section as 'any data that can be recorded by the toy or device while the user is playing', allow to get one step away from the child-toy interactions. Play Data permit to analyse, characterise, and profile the children-IoToys interactions from the distance. Chaudron, Di Gioia and Gemo schematise the usefulness of Play data analysis in three categories: 1. Learning and playing 2. Caring, while providing information to parents, schools and health services (Caring, Learning and Playing can be linked entirely or partially to Peter's categories mentioned above) and 3. Profiling for industry usage as Connected Toy service provider may record, analyse, use and even sometimes share Play Data and possibly other Personal data (such as name, age, localisation, …) or automatic collection of data such as IP address or consumer behaviour. 'Those data allow the industry to monitor and analyse user online behaviour with the aim of improving the service or the products and personalising them, [...] to improve communication and advertisement strategies. [...] [However,] it also poses safety and security concerns' at each point of the sharing data system starting from the Wi-Fi connection to the cloud storage. Mascheroni and Holloway, together with Chaudron, Di Gioia, Gemo question the privacy settings of IoToys and underline the lack of clarity in many occasions on how are data used, shared, manipulated, stored. They also flag out the need for the Industry to face the challenge to comply by May 2018 with the new European General Data Protection Regulation (GDPR) [5], and to do so in a family friendly way. The new GDPR Regulation addresses several fundamental issues and will enforce new data subject's rights (rights to consent or object to the processing of personal data, to data access, as well as rights to provide rectification, erase, export personal data, etc).

Mascheroni also warns on the possible normalisation of children surveillance as cultural and social practice when considering children (self-)tracking practices. She also reports the idea, close to neoliberalism technology, that 'self-tracking valorises self-improvement and positions the individuals - be them parents or children themselves – as the sole responsible for their health, achievements and development' but underlines the difference between the rhetoric and actual facts, 'precisely because children's self-tracking practices are unlikely to be voluntary and children have little or no agency to resist being monitored by parents, teachers and friends'. If we compare this idea with the Play Data usage for Learning, Caring, Profiling presented by Chaudron, Di Gioia, Gemo, it seems on the contrary that health, achievements and development of a child becomes the responsibility of whole community, Parents, Schools, Health Carers but also of the Industry that uses Play Data for sustaining and developing products.

Potential benefits to children's development are in fact used by the Industry in its commercial discourse, as reported by Holloway: 'These advertisements and infomercials advertise to parents by emphasising their educational value or other moral attributes (such

as keeping children fit or active or as fostering creativity or social play).' This strategy seems to be needed to balance the common discourse that sees computer and digital technology use as unhealthy and anti-social by keeping children glued to screen, educational by entertaining them with (violent) games. Holloway reports that 'Although hard to find, there are other marginal or less dominant discourses about the risks and benefits of the Internet of Toys running in conjunction with the security and commercial discussions about Internet-connected toys. These more marginal discourses cover a wider range of topics and have included a variety of discussions around educational value, play, physical health implications, social and recreational values associated with the emergence of the Internet of toys'. Consumers' rights watchdog groups seem to play a crucial role in initiating more nuanced discussion that needs to be followed and supported by policy and regulatory bodies.

This brings us back to the importance of studying the Quality of Play in the case of Child-IoToys interactions as underlined by Marsh but also by Dylan. Dylan proposes to look closely at the quality of Play of children with IoToys in a collaborative way that involves both researchers and industry. Dylan indeed proposes a pragmatic path to answer to the need of balanced discussion on risks and opportunities claimed by Holloway in the first section of this paper. Developing research-industry win-win collaborations is probably of key importance to enhance efficiently beneficial opportunities and reducing risks. Policy-makers and regulatory bodies have equally a key role to play to provide an adequate framework for the development of IoToys, beneficial to both Industry and families.

To conclude, this work underlines the urgent need to provide a framework for the use of Connected Toys, by children especially, as they present important implications for trust, privacy and security, and also have implications for social evolution. The Connected Toys market is only emerging, as it was worth $2.8 billion in 2015, while in comparison the total toy industry sales in 2015 amounted to $22 billion. However, the Internet of Toys market is set to grow to $11.3 billion by 2020[1]. At the same time, the new data subjects' rights need to be enforced by May 2018 to comply with the new European General Data Protection Regulation. It is therefore crucial for the market and wider society to be provided with a Connected Toys Usage Framework as soon as possible in order to inform these developments. The elaboration of such a tool, developed hand-in-hand by both academic experts and Industry partners, is of the greatest importance in providing our children with opportunities to grow happily in a protected, safe and secure digital world.

[1] Juniper Research, *Smart Toys : Do Toys Dream of Digital Lives ?* (Nov.2015), available at https://www.juniperresearch.com/press/press-releases/smart-toy-revenues-to-hit-$2-8bn-this-year. Accessed on 22/12/2016.

List of abbreviations and definitions

E-CIT	Empowering Citizens' Right in emerging Information and Communication Technology
FOSI	Family Online Safety Institute
GDPR	General Data Protection Regulation established in the European Union
HPI	Hasso Plattner Institute
IoT	Internet of Things
IoToys	Internet of Toys
ICT	Information Communication Technology
JRC	Joint Research Centre

Smart Toy	Toy that contains embedded electronic features such that it can adapt to the action of the user.
Connected Toy	Toy connected to the Internet, including toys that connect to a remote server that collects data and empowers the toys' intelligence.
Datafication	Transformation of social action into online quantified data, thus allowing for real-time tracking and predictive analysis.
Infomercial	Form of commercial that provides general interest information to the consumer mixed with commercial discourse or the other way around.
Play data	Any data that can be recorded by the toy or device while the user is playing
Privacy statement	Terms of use that explain what personal data are collected from consumer devices and how they are used.
Robotification	Increasing tendency to replace tasks that are executed, or are executable, by humans with robots.
White Hat Hackers	Digital security specialist who attempts to break into protected systems and networks to test and assess their security. It's all about intention: black-hat hackers have a similar skill set, but break into systems to steal data or do damage.

List of figures

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