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Towards a Framework for Designing Connected Toys

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Smart and Internet-connected toys (IoToys) offer new and exciting possibilities to enhance play experiences analogous to Mark Weiser's visions of ubiquitous and calm technology. Within this work, we sought to create a set of principles for evaluating and designing calm internet-connected toys and trial them through the evaluation of a set of popular ('off the shelf') IoToys. This work is the first of its kind to apply calm principles to IoToys and use them to evaluate current off-the-shelf connected toys. This work highlights the challenges inherent in adults evaluating toys designed for children. We contribute an approach to understanding calm in the context of IoToys through our principles and a method for evaluating calm within IoToys. We found while that our IoT calm principles have some limitations our work provides key insights into how we might understand calm in IoToys. We hope this work will help inform practitioners and academics interested in designing future IoToys.

Calm Principles, Connected toys, IoToys, Calm Technology, Ubiquitous computing, Expert evaluation

1. INTRODUCTION

Over two decades ago Chris Bryne, a commercial toy analyst and researcher, predicted that internet-connected toys would extend play possibilities, evolve, and renew with the user[1]. However, due to limited and constrained play possibilities, which dominate rather than enhance play, this vision has yet to be realised Ihamäki and Heljakka (2018). Many researchers have argued that connected toys bring new challenges and concerns from privacy issues de Paula Albuquerque et al. (2020) Pekka (2020) Weiser and Brown (1996) to interrupting the play experience Holloway and Green (2016a) Radesky and Christakis (2016). In this paper we focus on the play experience and possibilities in the context of Internet-connected toys, privacy and security concerns are not examined.

The overall goal of our work is to understand how the notion of Weiser's calm technology that "engages both the center and the periphery of our attention, and in fact moves back and forth between the two" Weiser and Brown (1996) can be applied in design of Internet of Toys (IoToys). In this paper we explore how an existing set of calm principles can be adapted to the context of IoToys. Much prior work has focused on calm technology and the application of Weiser's theories to versions of existing objects, such as ambient lights that alter mood Jafarinaimi et al. (2005) interactive tangible displays Edge and Blackwell (2009) and breathing equipment for people undergoing respiratory failure Jafarinaimi et al. (2005). However, the exploration of calm in the context of IoToys has not yet been explored despite rising concerns over 'unhealthy' relationships with technology Stankov et al. (2019) that may be addressed through 'calmness': , tensions around the parent-child dyad Radesky and Christakis (2016), and attention fatigue Fuller et al. (2017).

In this paper we present a study using an inspection method to determine if an existing set of calm principles (from Case (2015)) can be adapted and used to measuring calm in IoToys. The motivating research question was:

- **RQ1** How can we measure calm in current off-the-shelf IoToys?

[1] https://eu.heraldtribune.com/story/news/2007/02/15/toy-makers-can-see-their-futures-linked-to-the-web/28528785007/

The key contributions of this work are a revised set of calm principles for IoToys, and a method for the evaluation of IoToys. The novelty of this work can be understood as the first attempt at applying the works of Weiser and Case to evaluate connected toys against the principles of calm technology.

2. BACKGROUND

2.1. The Internet of Toys

In the last decade toys have become enriched with technology creating a network of connected digital devices that aim to facilitate play Verenikina et al. (2003); Mertala (2020), entertainment, and learning (education, cognition and emotion), typically coined 'Connected–Toys' de Paula Albuquerque et al. (2020). To find a solution that differentiates the categorisation of connected toys, researchers Giovanna Mascheroni and Donell Holloway contextualise connected toys as Toys, Media, Social Robots, and vessels for Datafication Mascheroni and Holloway (2019). In their work they argue that these "sensor-based toy things" are a) media by way of communication which mediates between family life and the online world, b) Social Robots in that they are often anthropomorphised and socially responsive to children's conversation; bonding with children by learning their preferences and play patterns. And finally, c), they become datafication vessels composed of complex algorithms that measure human behaviours Mascheroni and Holloway (2019).

Further attempts by Ihamäki to categorise IoToys and associated play found definitions for various forms of play with connected toys; exploratory, constructive, creative, pretend, fantasy and sociodramatic, physical locomotor and language or wordplay which authors believe constitute the realms for toy-based learning Ihamäki and Heljakka (2021). The researchers believed that these modes of play help children to understand and translate the world they live in. Earlier research Heljakka and Ihamäki (2018) found, play to be facilitated in the following ways- 'Edutainment' is the term used for educational-based entertainment, language and world play, embedded play, and companion-based role play – commonly seen in anthropomorphised toys– and in some cases play is facilitated in virtual and digital worlds Heljakka and Ihamäki (2019) – all of which extend the existing capabilities of toys. However, how children have learned to play with connected toys has yet to be fully realised and questions surrounding children's current play patterns and imagination have yet to be addressed Holloway and Green (2016b). A toy can be briefly described as a physical object that is used for playing; in the realms of IoToys, these objects have become far more curious resulting in comparisons to media devices and claims of demanding as opposed to encouraging play practices Berriman and Mascheroni (2019). For example, HelloBarbie is one of the most scrutinized toys for privacy and security failures, which have been the catalyst for 'anti-tech for kids' groups like Campaign for a Commercial-Free Childhood (CCFC) and the campaign 'Hell No Barbie' Weisbaum (2015). Their concerns are not without merit, many toys have been recalled for the very reasons CCFC publish Golin and Campbell (2017). Hackett and groups have begun to demonstrate the power parents have over their children's play environments and exposure to technology Hackett (2016). Further criticisms of connected toys have been documented by the Alliance for Childhood organisation and academics Mascheroni and Holloway (2019); highlighting concerns about restricted socialisation with other children and diminished curiosity, imagination, and creativity in children Holloway and Green (2016b). Radesky found that high demand for attention–especially from children– can have a negative impact on a range of human aspects from cognitive function to negative influence on the family unit Radesky and Christakis (2016). Despite this, current Internet and connected toys demand significant attention from children. Does attention demand from popular toys such as Ozmo, CogniToys Dino, Cue Robot, Smart Toy Monkey and Hello, Barbie? include physical interactions, flashing lights, voice-activated conversations, autonomous movements, and mobile phone applications.

2.2. Ubiquitous computing and the birth of calm technology

In the early 1990s, Mark Weiser coined the now-popular term calm technology. In early work, Weiser theorized a future like the one we see today– where technology is both ubiquitous and immersive Weiser and Brown (1996). Likewise, his concerns over obtrusive and demanding technologies have become a topic of today's research, most specifically in the domain of Child-Computer Interaction with attention fatiguing affecting children the most Radesky and Christakis (2016). Weiser predicted the world we live in and offered the notion of calm technology as a solution. This notion anticipates that profound technologies will be those that disappear into the background of everyday life i.e., so embedded into the natural environment that they become indistinguishable from it. He gives the example of written language, theorising it as an invisible linguistic technology that is symbolic of spoken word whilst freeing people from the limitations of individual memory. As written language does not require our active attention when we are proficient readers, we can interact with it almost unconsciously, for example when navigating using street signs. He later contends that computers are far from our natural environment, proposing a new way of thinking about computers where they could become so embedded that they vanish into the natural environment much as street signs do. This idea that when a person learns something sufficiently enough, they cease to be aware of it has many terms such as, "compiling", "tactic dimension", and "periphery".

While much prior work on ubiquitous technology exists, the most relevant work focusing on the design of calm technology to-date is Amber Case's set of calm principles for next-generation technologies. Case cements the importance of the Periphery in the third principle "Technology should make use of the Periphery" i.e., use a sensory indicator that fits into the natural environment. Prior work focusing on IoToys Ihamäki and Heljakka (2018); Mascheroni and Holloway (2019) has proposed design values which include, conveying information 'in a sensory manner', 'effectively mimic social norms', and that their connectivity is so well integrated with the plaything that it becomes a 'technology that disappears'. McReynolds et al. (2017) looked at connected toys from a privacy perspective to develop a set of recommendations, one being 'toys better communicate through visual indicators'. Earlier literature Lauwaert (2009) developed 10 visual and interaction design principles for a connected toy align with Weiser's vision of Calm and can be mapped to Case's principle of non-intrusive design (Table 1).

3. THE RESEARCH STUDY

The following section outlines how our inspection method was used to measure calm in IoToys. The study was approved by the ethics committee at the University of Central Lancashire for the intended purpose of understanding whether calm principles can be applied to IoToys.

3.1. Methodology

The purpose of the study was to evaluate whether a set of existing calm principles (from case2015calm-7) can be adapted and used to evaluate IoToys. The first stage in this work was to adapt the (general) principles to the more specific context of IoToys and so that an agreement (Likert) scale could be used to record the extent to which the principle applied to an IoToy. In adapting the principles we focused on explanations of calm technologies Verenikina et al. (2003); Bakker et al. (2012); Peet (2017) and the following IoToy specific factors we considered important. Table 1 shows the original calm principles from Case, Interpretation of the principle in the context of IoToys, and the adapted IoToy Principles used in the study. In the following sections we explain how these factors influenced the principles shown in Table 1.

3.1.1. Information required by the user

Understanding how much 'player' knowledge (game mechanics, interactions, rules, modes of play) is needed upfront for a child to play successfully with a toy. This helps to determine if the right amount of technology has been used to enhance the playfulness of a toy; Technology that needs upfront knowledge or laborious learning before play can be deemed too complex for the child end user.

Principle 4: Technology should amplify the best of technology and the best of humanity.

Principle 7: The right amount of technology is the minimum needed to solve the problem.

Principle 8: Technology should respect social norms.

3.1.2. Context, ease of setup, and play

Like the first consideration, we consider how easy it is to start interacting/playing with a toy. However, in this case we also consider the social constraints of society i.e. technical literacy, portability, and attention. We deem it important that children can start playing with their toys quickly without relying on numerous dependencies such as adults or other connected technologies. Additionally, this factor looks at how 'out of the box' the toy is by reviewing the complexity of the toy against the ease of set-up.

Principle 4: Technology should amplify the best of technology and the best of humanity.

Principle 8: Technology should respect social norms.

3.1.3. Modes of communication with the player and how communication is achieved to inform players

We factor in how children might recognise communication types and differentiate between them. This is important to determine if the toy is effectively communicating errors such as system malfunctions, and battery/ Wi-Fi loss in a way the child can confidently recover/identify if something is not working. Furthermore, we factor in the way in which this information is communicated, through lighting, sound or haptics. And finally, how this might differ from the expected communication types, such as talking, lighting up, movement etc during play.

Principle 1: Technology should require the smallest possible amount of attention.

Principle 2: Technology should inform and create calm.

Principle 3: Technology should make use of the periphery.

Principle 5: Technology can communicate but doesn't need to speak.

3.1.4. Player/toy relationship

This relates to understanding the kind of toy and its purpose to determine the child's relationship to it. For example, companion toys for communication, game-based toys for competition, and remote-controlled toys for learning. This is important when reviewing the toy in conjunction with the other factors to determine if the technology, play and communication style match enhances toy's purpose (communication, competition, learning etc).

Principle 4: Technology should amplify the best of technology and the best of humanity.

Principle 7: The right amount of technology is the minimum needed to solve the problem.

Principle 8: Technology should respect social norms.

3.1.5. Works with and without the technology

We deemed it important to factor in one of Case's core principles, 'Technology should work even when it fails' to test whether a toy can still be played with if the technology stops working (malfunction, battery/Wi-Fi loss etc). The reason for this is to establish what is the priority, play or the technology; if a toy cannot be played with without its technology counterpart it could be deemed to be a less successful toy for playing than a toy that can still be played with without the technology within it working.

Principle 6: Technology should work even when it fails.

Our study adopts a similar approach to evaluating toys as heljakka2019persuasive who used media advertisements, toy introductions and group playtests to give their child participants additional information about the toys that were being evaluated. Their study recruited a group of 20 5–6 year-old Finnish preschool children to playtest a collection of 4 smart toys (CogniToys Dino, Fisher-Price Smart Toy Bear, Wonder Workshop's Dash and Hatchimals). Researchers ran 2 group interviews where they demonstrated toy features, facilitated 1 on 1 playtest, and presented non-commercial videos of each toy found on YouTube. After the playtesting sessions researchers asked the children what they thought the toy could teach them and how they might they play with it alone and with other children. Study outcomes were analysed against a set of design values which were sought during inductive analysis of the results from the interview questions. Although we have used a similar process, we adopt an alternative approach to questioning. Use on the advantage that our participants are adult experts in HCI, we conduct a inspection-based evaluation of the toys after a short playtest. Our data is collected via a paper-based questionnaire featuring a Likert-scale and open-ended questions.

3.2. Apparatus

The connected toys (Cue Robot[2], Yoto[3], Sphero[4], Osmo[5] and LEGO Boost[6]) were selected as they were commercially available from popular toy retailers at the time of writing. The toys were produced by a range of manufacturers and targeted children from 0 - 18 and included one or more of the following types of connectivity:

1. Connect to a companion application – typically these toys connect to a mobile application to set up and is essential to the play
2. Connect directly to the Internet – these toys are standalone devices that connect to the Internet and don't require the use of any other peripherals

3.3. Participants

The evaluation session was conducted with Human-Computer Interaction (HCI) experts from the University of Central Lancashire, inclusion criteria included knowledge of HCI evaluation methods and required them to either have children or grandchildren or be actively researching in the field of Child-Computer Interaction. The purpose of this was to ensure participants were familiar with the methods to evaluate and have some knowledge of playing/designing with children. There were six participants (5 males, and 1 female). There was no payment for participation but refreshments were provided.

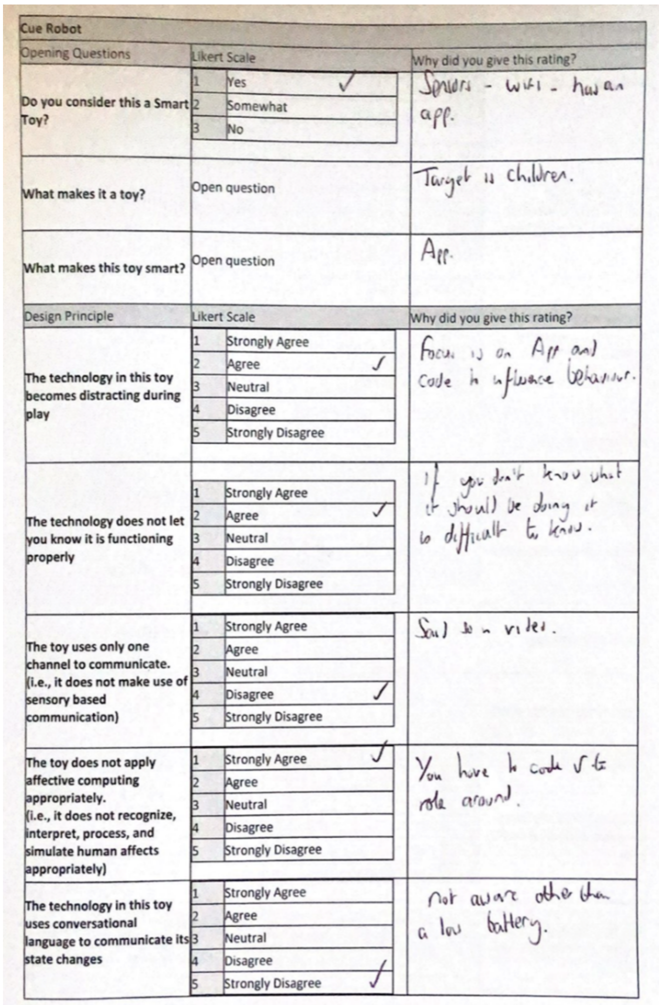
3.4. Procedure

The study took place in the University of Central Lancashire's Imaginarium research lab, involved all six participants and lasted approximately 2 hours. The session began with participants conducting an unstructured playtest of all five toys. During the playtest the facilitators ensured all participants felt they had familiarised themselves with the toys and understood their main features. They were also

[2]https://uk.makewonder.com/cue/
[3]https://eu.yotoplay.com/?gclid=EAIaIQobChMIh7G_m6nY-gIVlKztCh27iAXcEAAYASAAEgJyy_D_BwE
[4]https://sphero.com/products/sphero-bolt
[5]https://www.playosmo.com/en/shopping/kits/genius-family-starter-kit/
[6]https://www.lego.com/en-gb/product/adventures-with-mario-starter-course-71360

Table 1: *Development of the IoToy Calm Principles*

Existing Calm Principle	**Interpretation**	**New IoToy Calm Principle**
1. Technology should require the smallest possible amount of attention.	The technology in a toy should not seek so much attention from the player that it becomes distracting to their play	1. The technology in this toy becomes distracting during play.
2. Technology should inform and create calm.	A toy should afford players the peace of mind that they will be notified of any failures	2. The technology does not let you know it is functioning properly.
3. Technology should make use of the periphery.	A toy should consider human peripheral vision as a way to engage users without distracting them from a primary task.	3. The toy uses only one channel to communicate.
4. Technology should amplify the best of technology and the best of humanity.	The technology in the toy should harness the power of human cognition but not in a way that assumes they are equal.	4. The toy does not apply effective computing appropriately.
5. Technology can communicate but doesn't need to speak.	The technology in the toy includes affective computing so it can predict human behaviour without the needing to interrupt human play with machine queries.	5.The technology in this toy uses conversational language to communicate its state changes.
6. Technology should work even when it fails.	Toys that are connected must still be playable when a power source or internet connection is no longer available (when it fails).	6. Play quality is reduced when the technology is depleted. (Battery loss, Wi-Fi loss, mechanical fault).
7. The right amount of technology is the minimum needed to solve the problem.	A toy should only have enough technology to enhance play, if not, it is likely that the additional technology will become intrusive and disruptive to play.	7. The toy uses more technology than what is needed for enhanced play.
8. Technology should respect social norms.	A connected toy should only use socially acceptable technology– it must align with individual mental models	8.The technology in this toy does not respect social norms.



Cue Robot		
Opening Questions	Likert Scale	Why did you give this rating?
Do you consider this a Smart Toy?	1 Yes ✓ / 2 Somewhat / 3 No	Sensors - wifi - has an app.
What makes it a toy?	Open question	Target is children.
What makes this toy smart?	Open question	App.
Design Principle	Likert Scale	Why did you give this rating?
The technology in this toy becomes distracting during play	1 Strongly Agree / 2 Agree ✓ / 3 Neutral / 4 Disagree / 5 Strongly Disagree	Focus is on App and code to influence behaviour.
The technology does not let you know it is functioning properly	1 Strongly Agree / 2 Agree ✓ / 3 Neutral / 4 Disagree / 5 Strongly Disagree	If you don't know what it should be doing it is difficult to know.
The toy uses only one channel to communicate. (i.e., it does not make use of sensory based communication)	1 Strongly Agree / 2 Agree / 3 Neutral / 4 Disagree ✓ / 5 Strongly Disagree	Saw) to a video.
The toy does not apply affective computing appropriately. (i.e., it does not recognize, interpret, process, and simulate human affects appropriately)	1 Strongly Agree ✓ / 2 Agree / 3 Neutral / 4 Disagree / 5 Strongly Disagree	You have to code it to ride around.
The technology in this toy uses conversational language to communicate its state changes	1 Strongly Agree / 2 Agree / 3 Neutral / 4 Disagree / 5 Strongly Disagree ✓	Not aware other than a low battery.

Figure 1: *Example of a completed page from an evaluation form*

available to answer any questions. This unstructured playtest of the toys lasted 30 minutes in total.

In the second part of the session all participants together watched a short promotional videos from each toy (adverts produced by the toy manufacturers). These ranged from 3-5 minutes in length and helped ensure that all participants had a consistent understanding of the features of each toy. After watching each clip participants individually completed an evaluation form for the associated toy (see Figure 1 for an example excerpt from an evaluation form).

The evaluation form included 3 opening questions:

1. Do you consider this a Smart Toy?
2. What makes this toy smart?
3. What makes it a toy?;

A standard a 5-point Likert scale of agreement (strongly disagree=1, strongly agree=5) asking participants weather they believe the IoToy meets the requirements of each of the calm design principle from Table 1. Finally, we asked for a textual explanation of why each answer was given ('Why did you give this rating?').

3.5. Analysis and Results

Figure 2 shows the mean scores from the Likert scale responses (strongly disagree=1, strongly agree=5) which asked evaluators to what extent the calm principles can be applied to the IoToys. As the IoToy calm principles were newly developed we were keen to understand whether the expert evaluators were able to apply them successfully. Therefore, our focus was on the qualitative responses (open-ended question) where participants were asked to give a rationale for their Likert rating. The authors followed the Braun and Clarke's Thematic Analysis procedure Braun and Clarke (2006) with an open-coding inductive approach. This began with three coders (authors of this paper) familiarising themselves with the data before collaboratively coding; it quickly became apparent that four main codes were emerging from the data:

- **Understanding and Application** All three coders agreed that the participant had been able to understand and apply (give an agreement rating) the principle.
- **Understanding** All three coders agreed that the participant showed evidence they understood the principle, even if they had not been able to apply it effectively.
- **Misunderstanding** All three coders agreed that the participant had not been able to understand the principle.
- **Insufficient Information** All three coders agreed that the participant did not have enough information about the toy and its features to apply the principle.

The coders then proceeded to collaboratively code all of the data, assigning one code to each piece of data, where there was disagreement the coders discussed the data until agreement was reached. As the data was minimal (typically only a single short sentence) no further combination of codes or development of themes was possible. Table 2 shows the results of this coding with the frequency of each code identified across all explanations as to which a Likert response was given for all five toys. Where evaluators did not provide an exploratory response this was not assigned a code and these number of non-response are shown in the far right column in Table 2.

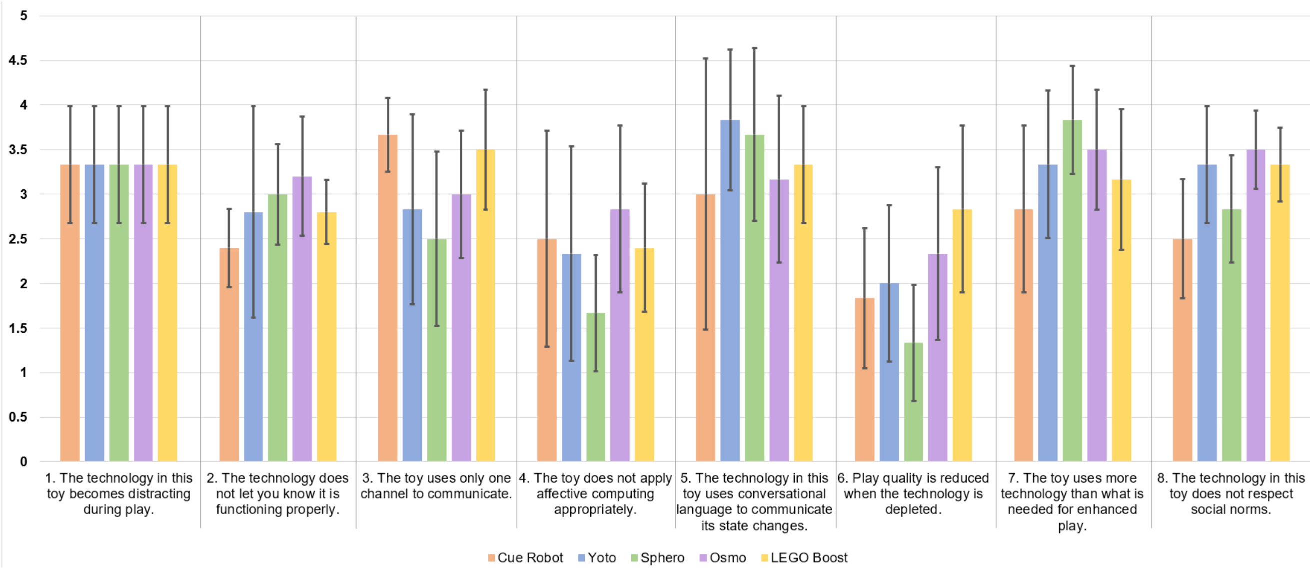


Figure 2: *Mean scores from the Likert scale responses (strongly disagree=1, strongly agree=5) from the evaluators on the extent to which the IoToy calm principles applied to each of the five toys across each of the eight IoToy calm principles.*

Table 2: *A table presenting the frequency of coded qualitative responses as to why ratings were given.*

IoToy Principle	**Code**				No Response
	Understanding and Application	*Understanding*	*Misunderstanding*	*Insufficient Information*	
1	9	1	18	0	2
2	15	2	3	7	3
3	19	4	1	4	2
4	7	6	5	7	5
5	14	8	1	6	1
6	19	10	1	2	0
7	21	6	1	2	0
8	15	13	0	2	0

4. DISCUSSION

From Table 2 it is evident that from the 240 responses given for all toys and from all evaluators, 119 (50%) of the explanations given by the evaluators showed understanding and application of the appropriate IoT calm principle. A further 50 (21%) showed understanding of the appropriate IoT calm principle even through the evaluator struggled to apply it. These results showed that, while there potentially is scope for improvement, the methods and principles have promise in understanding the 'calmness' of IoToys. In 30 (13%) cases the evaluator did not have sufficient information about the toy to apply the principle, this highlights potential areas for improvement in providing information about the toys to participants. As this code was not highly prevalent it implies that in the majority of cases evaluators felt they had enough information, while in a much smaller number of cases some did not. This may be due to evaluators forgetting or misinterpreting what they saw in the promotional videos, or not experiencing (or remembering) all features of the toy in the playtest. In the following section we examine the findings in response to each calm IoToy principle.

Principles 7 and 8 received unanimous agreement from experts suggesting that calm can be measured–to some –degree using the adapted principles in this study. For example,

- Principle 7: Showed the highest number of responses coded as showing understanding and application of the principle, making it the easiest to understand and apply overall. Many of these responses include qualifying phrases such as "coding might be overkill", and "Seems to be about right– nice and simple" which may portray some uncertainty. Yet still reference understanding of the principle. Whereas one response "is essentially audio story book" showed a misunderstanding of the principle, and a further five examples were coded as having insufficient information.
- Principle 8: Half of the responses showed understanding and application of the principle. There were some responses which indicated confusion but evaluators were still able to provide an example of understanding, for example "Not sure what social norms are for what is essentially a robot it started burping and being annoying".

Our method for measuring calm is based on a set of principles which reflect core calm technology values. To be calm, products must aim to align themselves with relevant principles. Not all the principles will be relevant so it may be worth investigating how people decide what is relevant. Such as,

- Principle 2: Half of the responses were coded as understanding and application and from Figure 2 it can be seen that the mean scores for all toys were close to 3 (neutral). "Would likely be obvious if the tech was not working" exemplifies this neutral stance. It references there are some signifiers to working order.
- Principle 3: The principle encourage evaluators to think of ways the toy can communicate, if there is only one mode, it is likely that the toy is not making use of the human periphery. We looked for multiple I/O responses to demonstrate understanding. Almost two-thirds of responses showed understanding and application of the principle, responses were unambiguous evidencing understanding by stating various modes of communication. There was one instance of misunderstanding, "seems to recognise things in the distance", and, as is evident with all of the data coded as misunderstanding, further exploration is needed to understand why this occurred.
- Principle 4: We looked for evidence of understanding of affective computing with examples. Almost a third of the responses showed understanding and application of the principle by successfully highlighting ways the technology does not utilise or adhere to human behaviour. Likewise, another third of the responses indicated that there was insufficient time or material to effectively respond to this principle. A small number of responses were coded as misunderstanding the principle such as "From what I've seen there don't seem to be a lot of sensors" and "you have to code for it to roll around" which highlight features controlled by human input opposed to functions that respond indirectly to known human behaviour.
- Principle 5: "Robot uses conversational language to communicate state changes" and "I don't think it does it just witters on about the place experience" are two examples of responses that showed understanding and application of the principle as they provide examples. Almost half of the responses to this principle are made up of similar responses leaving examples of how state changes are or are not communicated. Comparatively, responses like "Could still draw or play with letters", "unsure", and "no evidence of this" showed misunderstanding of the principle in this case.

Considering the number of responses coded as misunderstanding we found that evaluators, including experts, need varying degrees of reference material to get enough information to qualify their understanding and build a clearer view of the toy's functionality.

- Principle 1: We found that almost two-thirds of responses were coded as misunderstanding, for example, one response was "Focus is on the app and code is to influence behaviour" indicating the expert understood the use of the technology but did not respond to whether the technology distracts from play. The other data coded as misunderstanding also mentioned technology, but not the effects of the technology on attention.The nine responses that showed understanding and application of the principle were easily identified due to the use of keywords like distracting, interfering, overwhelming and calm. Dispute this lack of understanding identified through the coding, this principle saw the most consistently high level of agreement in terms of evaluators feeling that it applied to the toys (see Figure 2).
- Principle 6: For this principle almost two-thirds of responses showed understanding and application of the principle, and a further third showed evidence of understanding. We found clear examples examples related to failure and understanding of the principle such as "Would not work without power/connectivity" and "Could still be played with but would be less fun"

5. LIMITATIONS

Overall the findings showed that Principle 1 was the most challenging for the evaluators to understand and apply, on reflection we speculate that this may be due to the lack of specificity in the use of the term 'distracting'. For example, when considering a child playing with a IoToy is challenging to understand what may cause a distraction or even what the impact of a distraction on the play activity may be. Further work is require to understand how this could be addressed through re-formulation of the principle.

For seven of the eight principles it was evident that evaluators had insufficient information to make a decision about whether a principle applied (or not), we see this as being a limitation of this study. This is a wider challenge inherent in this kind of work. A specific challenge with IoToys is that they typically have a lot of features, some of which are only revealed after extended periods of play. To address this issue further play testing and familiarisation with the toys may be required, potentially even observing children familiar with the toys playing with them or involving such children directly.

6. CONCLUSION

The motivation for this work was to understand how calm can be applied in design of Internet of Toys (IoToys), this paper reports our work adapting existing calm principles for the context of IoToys and trialling them through an expert evaluation of five existing toy products. This is the first paper to apply the works of Weiser and Case by evaluating connected toys against the principles of calm technology. The evaluation process had four phases, as the evaluators had no prior knowledge of the toys the first two phases in the process were particularly important:

- Unstructured group playtest - to gain familiarity of the toys.
- Marketing material presentations - to learn more about the key features of the toys.
- Evaluation - conducted individually to assess the alignment to the principles using a Likert scale and qualitative explanations of why answers were given.
- Discussion - discussion and reporting of participants' experience of the study.

Our findings showed that in 71% of cases evaluators were able to understand the new calm IoT principles we developed in this work, this both indicates that they provide a strong foundation for future work and that a small number of principles (4 'Technology should amplify the best of technology and the best of humanity' and 1 'Technology should require the smallest possible amount of attention') need further refinement. We found that in 13% of cases evaluators did not have enough information about the toy in order to apply a principle. There was no clear pattern for when this occurred in the evaluations and is an inherent problem with adults evaluating complex toys for children. This may be addressed through providing reference material for use during the evaluations or longer play testing at the start of the evaluation sessions.

The position we take in our work is that the technology within IoToys should not necessarily dominate or dictate the play experience for children. It was evident in the toys used for this study that playing with the toys necessitated using it exactly how the designer had intended and the technology was used to reinforce this; i.e. the technology did not work or provided negative feedback if the toy is used in the 'wrong' way. We see calm as one way to address this issue and enable more exploratory, flexible and dynamic play experiences involving IoToys. We hope this work will both contribute to and stimulate debate around the design of future IoToy products and research work.

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