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Understanding calm in the context of smart toys

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Abstract

Smart toys, which integrate sensing, processing, physical movement, sounds, and even internet connectivity, offer a range of new play opportunities. However, compared to traditional toys, current smart toy products can be limiting in the play they support, and they have received criticism for a range of reasons with calm being a potentially valuable design feature for smart toys. This work explores the application of a revised set of calm design principles applied in the context of currently available smart toy products in an expert evaluation inspection study. The specific focus of this paper is on understanding the challenges encountered by the evaluators in the study. This paper contributes four key recommendations valuable to researchers and practitioners conducting similar studies. These relate to the challenge of simulating play experience, the diversity of play context, the interpretation and understanding of principles, and the consideration of design intent vs. play experience. We propose "calm smart toys" as a strong concept that can potentially assist others interested in designing calm smart toys.

RESEARCH HIGHLIGHTS

- Evaluators often lacked enough info to judge principles, especially in rare or unseen toy behaviours.
- Play context varied widely, making "calm" difficult to assess across noisy or quiet environments.
- Principles can be misunderstood due to vague terms like "distracting" and unclear definitions.
- Design intent was easier to judge than play experience, which required deeper, hands-on engagement.
- "Calm smart toys" can be framed as a strong concept guiding coherent, resilient, and context-aware design.

Keywords design principles, calm design, smart toys, strong concepts, evaluation

While smart toys open up a wide array of new and novel play possibilities, many current products are highly demanding of a child's attention and restrictive in the play activities they support. Examples include Ozmo[1], CogniToys Dino[2], Cue Robot[3], and LEGO Spike Prime[4], which offer various interactions such as flashing lights, programmable interfaces, app-controlled, voice-activated dialogues, and autonomous movements. These enhanced capabilities have, in part, contributed to the rising criticism directed toward smart toys in recent years (Mascheroni & Holloway, 2019). One pertinent example is Hello Barbie, which has undergone significant scrutiny regarding its privacy and security vulnerabilities (de Albuquerque *et al.*, 2022; Mertala, 2020). These, and similar, concerns have spurred the emergence of "anti-tech for kids" advocates, including the Campaign for a Commercial-Free Childhood and the "Hell No Barbie" campaign (2015). The concerns voiced by these campaigns are not unfounded, as research has identified negative effects on children (Ihamäki & Heljakka, 2021; Mascheroni and Holloway, 2019) related to cognition, social engagement, attention fatigue (Bakker *et al.*, 2012; Wang *et al.*, 2020), and the quality of family relationships (Radesky & Christakis, 2016).

In our previous work, we identified how "calm," as identified by Weiser (1995) as being unobtrusive, seamlessly integrated, subtle, and socially expected, provides a potentially valuable design goal for smart toys. We previously took inspiration from Case's (2015) calm technology design principles that were inspired from Weiser and Brown (1997). These principles act as guides (Fu, 2016) for creating technology that stays in the background and supports users without overwhelming them. They focus on guiding the design of technologies so that users can remain focused on their primary task, rather than the technology itself. Case (2015) distilled Weiser and Brown's (1997) early visions of calm technology into eight calm design principles and provided context to the vision in relation to today's society and technology

1 https://www.playosmo.com/
2 https://www.cognitoys.com/
3 https://www.makewonder.com/en/robots/cue/
4 https://www.lego.com/en-gb/product/lego-education-spike-prime-set-45678

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landscape. Our work progresses the works of Weiser, Brown, and Case (Case, 2015; Weiser & Brown, 1997) focusing calm design within smart toys. We revised the eight principles in relation to smart toys or creating calm smart toys (Thompson *et al.*, 2024) and used these to evaluate (via expert inspection) the level of calm in a set of existing smart toy products. That study revealed that certain principles posed challenges for the evaluators in terms of comprehension and application, often due to inadequate information regarding the toys' features and the lack of experience with them in a real play context. The findings from our previous work (Thompson *et al.*, 2024) revealed that calm design principles cannot be directly applied to smart toys, though they offer a promising insight for future design. Many of the evaluated toys were found to be reliant on companion applications, leading to the focus being on the app rather than physical interaction of the toy, and the toy becoming plastic "ornaments" when disconnected. The study highlighted challenges in having adult experts evaluate toys designed for children and identified that experts required a greater quality of toy material and playtests to provide comprehensive rationales for their evaluations. Additionally, the principles themselves sometimes needed further reframing to effectively convey meaning and context. Despite these challenges, certain principles (P7 and P8) received strong agreement, suggesting that calm can be measured to some degree using the reframed principles, and the work contributes a revised set of principles and a novel evaluation method for Internet-connected toys (IoToys).

In this paper, we conduct new analysis, using data not considered previously in (Thompson *et al.*, 2024), to understand why some calm design principles were difficult for evaluators to apply. Through new analysis this paper presents four recommendations, valuable to others conducting similar work, related to simulating a play experience, diversity of play contexts, interpretation and understanding of calm design principles, and design intent versus the play experience. Additionally, these findings help to frame calm smart toys as a strong concept; with the potential to inform designers and researchers in the creation of innovative and novel ideas (Höök & Löwgren, 2012).

1 Related work

This section on related work examines the progression of toys and the impact they have on play types while also introducing the design philosophy of calm technology. The discussion delves into the concept of calm technology in relation to other relevant works, highlighting where the characteristics of calm technology design are evident in alternative forms.

1.1 Toys and play

Toys have evolved rapidly since the days of wooden spinning whips and hoops, skipping ropes, stuffed teddy bears, and yo-yos (Walsh, 2005). The 19th century saw a major evolution where mechanical toys were starting to make an impact due to their low-cost motors (Coates, 1989). Toys such as carousels comprised of moving parts, wind-up mechanisms, and coiled springs; these were durable and facilitated dynamic, playful, and imaginative play experiences for children. Later, toys evolved to incorporate electricity; electric train sets used electricity to replace the wind-up mechanisms and powered movement in the toy (Coates, 1989). By the 21st century, most of these toys were equipped with self-moving components and digital elements, thus marking the advent of an era characterized as the digital toy era (Wang *et al.*, 2010). Digital toys afforded new types of interactions and experiences giving children an interactive play experience that previously relied on imaginative play. By the 21st century, more toys comprised of components that facilitated new types of experiences where the toy could connect to the Internet and offer intelligent decision making.

Considerable research exploring digital toys exists within the Human–Computer Interaction (HCI) and Child-Computer Interaction communities (de Albuquerque *et al.*, 2021; Rusanen & Vesikukka, 2023; Yamada-Rice, 2019). In this literature, toys are generally classified into three distinct categories of IoToy, connected toys, and smart toys (Wang *et al.*, 2010). In this definition IoToys connect and respond to an Internet connection (Ling, 2021), connected toys transmit data between objects (another toy), and smart toys sense and respond to behavior. Smart toys are additionally designed to exchange and capture data, while exhibiting physical movement, producing sounds, providing visual cues, and enriching the play experience (Wang *et al.*, 2010). While not all smart toys possess Internet connectivity, an IoToy may also be considered smart.

Research on smart toys frequently focuses on technical and ethical dilemmas (privacy and security issues), with less work focusing on play experience. Berriman and Mascheroni (2018) argue that the affordances of play in smart toys have shifted the child-toy dynamic, where play practices are now demanded rather than merely requested or encouraged. As demanding play practices increase, consideration of play context or context of the cultural affordances risk becoming marginalized.

In their pursuit to understand children's perspectives regarding internet connected toys, Ihamäki and Heljakka (2021) found that children explore toys differently depending on the context in which the play is taking place, arguing that the context, whether it be exploratory, constructive, creative, pretend/fantasy/socio-dramatic, physical locomotor, language/wordplay is what determines the affordances or social dynamics a child will unlock during play, further echoing Berriman and Mascheroni (2018) who emphasized studying play context as a gateway to understanding how children understand use smart toys.

1.2 The evolution of calm

Weiser proposed a technological future characterized by ubiquitous, immersive technology that is fully integrated into all facets of daily life (Weiser, 1995). Weiser and Brown (1997) speculated that the future could potentially become so distracting that individuals might experience feelings of being overwhelmed and disconnected from human interactions. They critiqued the intrusive nature of technology, proposing calm technology as a design philosophy that positions information at the periphery of human awareness, patiently awaiting its opportunity for engagement (MacIntyre, 2001). Since the early 1990s, research on calm technology has evolved focusing on awareness (Cho & Saakes, 2017), interaction (Kučera *et al.*, 2017), and user control (Åkesson & Ihlström Eriksson, 2006). Researchers have explored concepts related to calm technology under different terms, such as ambient design, which emphasizes the creation of subtle; background information displays (Aylett, 2015; Jafarinaimi *et al.*, 2005); pervasive computing, which focuses on seamlessly incorporating computing into ordinary environments (Rogers, 2006); wise technology, which autonomously minimizes human input (Alloui *et al.*, 2015); and slow technology, which focuses on meaningful

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engagement and mindful interactions with technologies (Hallnäs & Redström, 2001). These varied interpretations contribute to the broader understanding and advancement of the field, despite not explicitly being labelled as calm technology. Hallnäs and Redström (2001) frame technology as a continuous presence in a designed environment, rather than a tool for specific tasks. They argue that technology should be integrated into our lives in a way that considers mental overload and time, aligning with Weiser and Brown's (1997) principle of "Increasing Peripheral Use." (Maglio, 2000). Similarly, Cho and Saakes (2017) introduced the concept of "Wise Objects," which refers to autonomous systems that require minimal human input and are context aware. Past work has also sought to quantify the presence of calm technology (Brown *et al.*, 2014; Riekki *et al.*, 2004; Tan, 2021), by investigating calm as a spatial experience (where calm design is used to shape the interactive experience between the technical and physical environment) and as an holistic experience (where calm design considers the broader technical ecosystem as means to embody all aspects ubiquitously; Wu *et al.*, 2024).

The position we take in our work is that calm smart toys might offer many play benefits in addition to potentially helping to address concerns regarding "unhealthy" toy-child relationships (Fuller *et al.*, 2017). These unhealthy relationships range from lack in curiosity, imagination, and creativity, where the toy prevents children from engaging in open-ended, imaginative play, and an excessive demand for attention (Mascheroni & Holloway, 2019; Radesky *et al.*, 2016), where the toy offers interactions involving flashing lights, voice-activated dialogues, and app-controlled interfaces. These features often restrict the types of play activities supported, resulting in attention fatigue, as well as cognitive and social engagement issues that impact family relationships (Radesky *et al.*, 2016). To address these concerns, Mascheroni and Holloway (2019) state that the inducement of unhealthy risks regarding IoToys centers on design flaws and commercial practice, and by reducing external risks, such as data breaches and inadequate privacy protocols, which they attribute to poor design and aggressive commercial data gathering we can protect children's data and privacy rights and mitigating the displacement of family relationships. To do so, they proposed a set of privacy-by-design principles and general guidelines aimed at increasing parental awareness of data usage in toys and the impact of unhealthy relationships with technology (Mascheroni & Holloway, 2019).

2 Methodology

The authors' previous work (Thompson *et al.*, 2024) evaluated calm design principles developed for smart toys. These principles were reframed from existing generalized calm design technology principles (Case, 2015) and are listed in Table 1. In that study, an inspection method with HCI experts—with over 50 years of experience in the field of HCI—were selected based on their familiarity of the inspection method and methodology was performed that considered five off-the-shelf smart toys. Each smart toy (Cue Robot, Yoto, Sphero, Osmo, and LEGO Boost) included features that connected to a companion object/app or connected to the Internet.

The study took place within the University of Lancashire's usability lab and lasted two hours. During this time, six HCI evaluators participated in a 30-min unstructured group playtest, following this, all participants watched short promotional videos from each toy manufacturers (ranging from 3 to 5 min in length), which provided experts a consistent understanding of the features for 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). Where the purpose of the form was to capture the toys alignment to each of eight calm design principles using a 5-point Likert scale. For each answer given (numerical score for alignment with a principle) evaluators also answered an accompanying open-ended question asking them to explain why that score had been given. This resulted in 240 individual alignment ratings with associated explanations. It is the explanations relating to the codes "Misunderstanding" and "Insufficient information," which are the focus of this paper.

Table 1 Calm design principles for smart toys from Thompson *et al.* (2024).

Principle
1. The technology in this toy becomes distracting during play.
2. The technology does not let you know it is functioning properly.
3. The toy uses only one channel to communicate.
4. The toy does not apply affective computing appropriately.
5. The technology in this toy uses conversational language to communicate its state changes.
6. Play quality is reduced when the technology is depleted.
7. The toy uses more technology than what is needed for enhanced play.
8. The technology in this toy does not respect social norms.

The extent to which individuals applying the principles could be considered to have understood the principles was analysed using a collaborative thematic analysis (Braun & Clarke, 2006) approach with three coders, who began by familiarizing themselves with the data (explanations and associated alignment scores). Codes were then developed inductively and collaboratively by considering the principle being applied, the score, the toy, and the coherence of the explanation. The codes were developed by all three coders to focus on understanding, application and information. These includes, "Understanding and Application" used to demonstrate the evaluator had been able to understand and apply (give an agreement rating) the principle, "Understanding" was used to demonstrate the evaluator understood the principle but not able to apply it effectively. The final two codes focused on misunderstanding and insufficient information. For an explanation to be coded as "Misunderstanding" the evaluator's interpretation of the response didn't demonstrate any evidence of understanding of the principle. Finally, "Insufficient information" related to an explanation where the evaluator evidenced a lack of information about the toy and its features to apply the principle. For further code description and examples, see Table 2.

The coders then proceeded to assign codes to the data individually (one code per explanation) then, when finished, discussed their coding to check for agreement. Where disagreement occurred, 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 3 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-responses are shown in the far-right column in Table 3.

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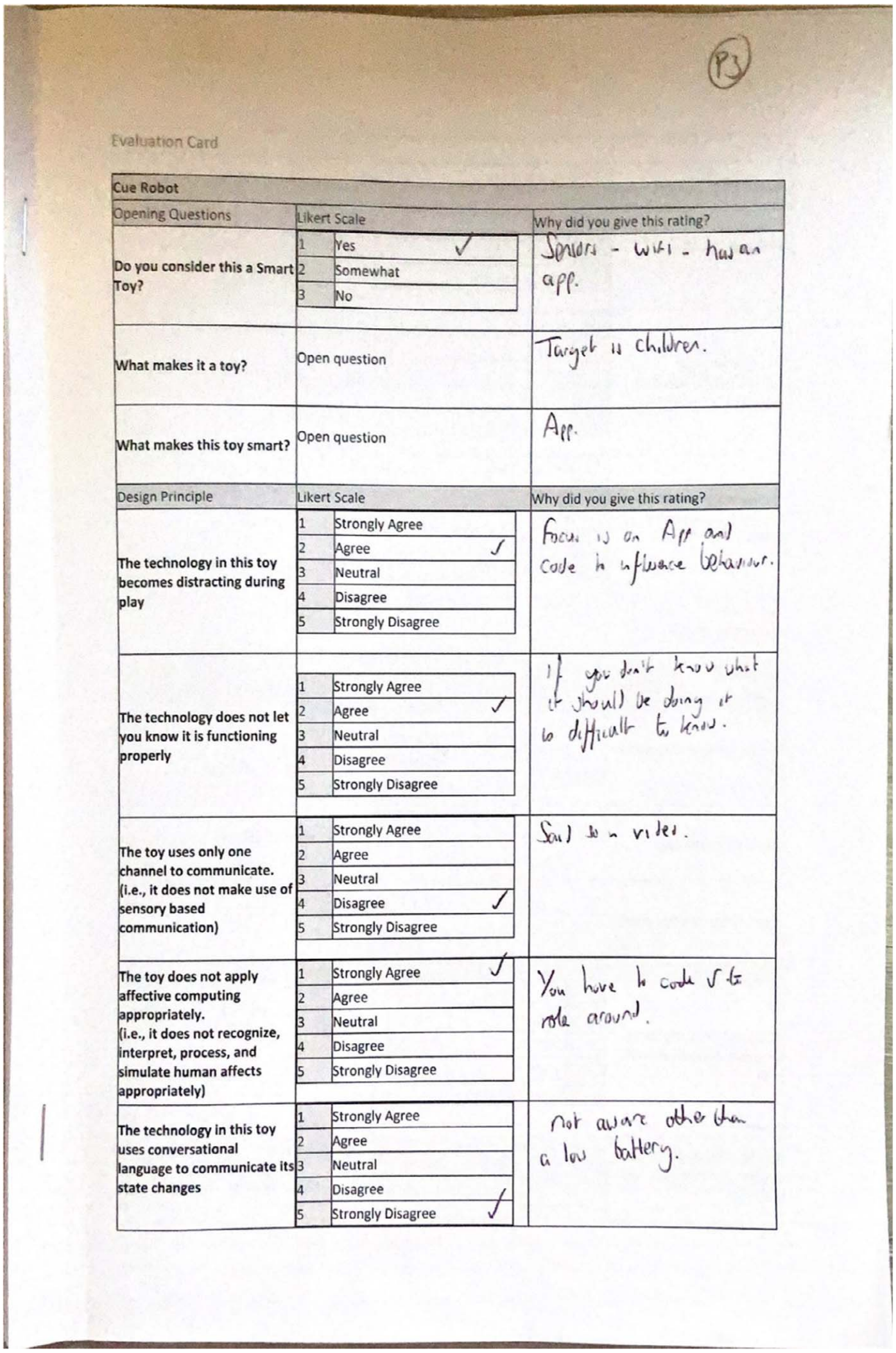

(P3)

Evaluation Card

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	Said 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 role 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 Photo of a completed evaluation form.

3 Results

The key takeaway from the study was that evaluators could understand and apply the calm design principles in 50% (n = 119) of cases and a further 21% (n = 50) of cases explanations demonstrated understanding even if the evaluators struggled with applying the principle. This suggested that the method and principles showed some promise in evaluating calm in smart toys. Of the explanations coded as Understanding and Application, principles 7 (n = 21, 18%), 3 (n = 19, 16%), and 6 (n = 19, 16%) performed the best, suggesting they might have been the most useful for identifying calm design in smart toys. Of the explanations coded as just Understanding, principle 8 (n = 13, 26%) and principle 7 (n = 6, 12%) performed best, which might suggest these as additional plausible principles for evaluating calm in smart toys.

The findings suggested that the method and principles showed promise in evaluating calm in smart toys, but that there were some difficulties encountered by the evaluators in applying the principles. In the following section we consider these difficulties by exploring the reasons underlying the 25% (n = 60) of explanations that were coded as “Misunderstanding” (n = 30) or “Insufficient information” (n = 30).

Looking at the eight calm design principles (from Table 1), it is apparent that some principles (3, 4, 5, 7) are possible to understand

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Table 2 A table shows the four codes used in the study analysis.

Code	Code description	Explanation example
Understanding and application	The evaluator provided an explanation evidencing they can understand the meaning behind the principle and provided a correlating agreement rating.	“Robot uses conversational language to communicate state changes” P5. “Just enough options without being overwhelming” P1. “Well you could still spell word with the tiles but it won’t be as good” P6.
Understanding	The evaluator provided an explanation evidencing they understand the meaning behind the principle. However, it did not provide a correlating agreement rating.	“Would likely be obvious if the tech was not working” P2. “Uses audio in a limited form” P5. “Could build something else” P6.
Misunderstanding	The explanation from the expert did not evidence any legitimate comprehension of the principle, nor did the agreement rating correlate.	“Could still draw or play with letters” P5. “From wat I’ve seen there don’t seem to be a lot of sensors” P4. “Seems to recognize things in distance” P3.
Insufficient information	The evaluator provided a neutral agreement rating and an explanation indicating they did not see or experience enough of the toy to evaluate it against the principle.	“No evidence” P2. “Not able to comment about that” P6. “Not for its state, I don’t think. I am guessing it just said stuff” P5.

Note. Each code includes an example explanation and the coders’ explanation for coding explanations.

Table 3 A table presenting the frequency of coded qualitative responses as to why ratings were given.

Principle	Codes				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	3
5	14	8	1	6	1
6	19	10	1	2	0
7	21	6	1	2	0
8	15	13	0	2	0
Total	119	50	30	30	11

if they have been met by looking for evidence in the toy (Table 3), of where a specific technology or interaction, has been included (e.g., principle 3: The toy uses only one channel to communicate). Two of the principles that were considered to be easy to understand and apply, (3 and 7) were from this group which demonstrated little evidence of misunderstanding when coding the explanations. Principle 5 appeared to mainly be understood but did have 6 instances of the “Insufficient information” code, suggesting the evaluator did not have enough information to evaluate the principle in the toy. Being coded in many ways by the coders, principle 4 was clearly either explained in diverse ways or was possibly poorly understood, e.g., the explanation “Does not seem to be able to sense emotion” aligns to the principle and was understood by the evaluator. Whereas “There was a hint in the video that it was a bit effective” was coded as insufficient information as the evaluator recognizes that there might be evidence of the principle but doesn’t have a first-hand experience of this during the play experience. This was also the case with “no evidence it does this.” Finally, the evaluator misunderstood the principle “Agree, but I didn’t try talking to it.”

The calm design principles that seem to refer more to experience (1, 2, 6, 8) could be hypothesized to be harder to apply and understand unless the evaluator has a good length of time to play with the toy. That said, principles 6 and 8 were not flagged as at all problematic; for principle 6 that related to whether the toy still worked without power, whilst many scored this low on the Likert scale, it was felt by the coders that certainly evaluators understood the principle; similarly for the social norms’ principle (8). Principle 1 (if the toy became distracting during play) had the largest number of misunderstanding (n = 18) explanations given. Examples include “tech is just lights etc.,” “focus is on the app and code is to influence behavior,” and “the technology seems to be added just to say it is there.” Principle 2 also had a few misunderstandings but also quite a few coded as insufficient information; this principle, about the technology letting you know if it is functioning properly *could* be evaluated without playing but, quite clearly, some evaluators felt unsure to give this a rating. Possibly given they hadn’t played long enough as highlighted by the following explanation: “I could not figure out if what I coded was entered or not” (principle 2).

While the results show clear evidence that evaluators could understand and apply calm design principles to smart toys, there were higher-than-expected levels of Misunderstanding and instances of Insufficient information in the coding results (Table 2). Based on our

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consideration of the study's results and observations, from this paper and from prior work (Thompson *et al.*, 2024), we now propose four interrelated problematic areas evident in this work and discuss relevant recommendations for future work studying calm in the context of smart toys.

4 Discussion

4.1 The challenge of simulating play experience

There was some evidence that evaluators came across isolated incidences where it seemed like they had Insufficient information to decide whether a principle applied (or not). When evaluators explained why a code had been given, insufficient information typically manifested as an explanation such as "Don't know"—principle 2, "Not sure"—principle 2, "unsure"—principle 3, "did not see"—principle 6. For example with principle 2 (Table 2), evaluators found it difficult to evaluate calm where n = 3 (10%) instances were "unsure" and n = 7 (23.3%) "found no evidence" of the technology letting or not letting the user know how it is functioning, resulting in misinterpretation to whether the principle was misunderstood, or the information was insufficient.

This lack of visibility of aspects of design is a wider challenge inherent in this kind of work; smart toys typically have many features, some of which are only revealed after extended periods of play. Understanding the toy in the context of play can help identify where and if the technology fails in relation to a specific principle. To address this issue further play testing and familiarization with the toys may be required, potentially even observing children familiar with the toys playing with them or involving such children directly. This is a challenge we attempted to address by playing a promotional video of the toy to evaluators, in the hope that the key features of the toy would be highlighted in marketing material, and through group play testing where there were possibilities for evaluators to observe others using the toy and potentially accessing features which they themselves may have missed. However, even with this approach, there are still the challenges of experiencing (or not experiencing) more exceptional cases where the toys need to communicate to the user (such as low battery, lost Wi-Fi, etc.), which were not considered in this study.

- **Recommendation 1**: Consider all functionality provided by the smart toy, including those encountered in typical play experiences in addition to those encountered in exceptional or unexpected situations and ensure all this functionality is conveyed clearly to evaluators.

4.2 Diversity of play context

Play occurs in a variety of different contexts, involving different numbers of children, different places, from a quiet home space to a noisy classroom or playground and with different adult support. These different spaces influence the type of play that is possible, appropriate, and desired by children (Harrison, 1996). Crucially, the concept of calm within play is not static but rather dynamic and contextually dependent. What constitutes a "calm" experience in a quiet bedroom may differ significantly from a "calm" experience in a noisy playground. In the former, calm might need to support focused independent activity, while in the latter a "noisy" toy with flashing lights may not prove distracting from play at all. Therefore, the design of calm smart toys must acknowledge this variability and embrace a nuanced understanding of calm which considers a range of appropriate factors. Furthermore, the child's individual interpretation of calm, influenced by their developmental stage, personality, and emotional state, adds another layer of complexity. Thus, the design should, ideally, support a personalized experience of calm.

Although the playtest (Thompson *et al.*, 2024) facilitated exploration of the toy products, a specific play context was not specified. An example was that when asked whether the technology in a smart toy was distracting during play (principle 4), one evaluator marked this as not distracting commenting that, "Only lights and audio." However, depending on the play context, it could be argued that lights and sounds may entirely detract from certain types of play. Furthermore, when promoted to align "the play quality is reduced when the technology is depleted" (principle 1) with a smart toy, evaluators rationalized positive Likert scores with explanations that they "Did not experience battery loss," or "Did not experience this issue," viz., the context of a toy being played without technology escaped theoretical consideration.

- **Recommendation 2**: Consider play experience holistically (i.e., from onboarding to typical play, to group play, to differing contexts where the toy may be used) then choose which contexts are most important and how these can be experienced by evaluators and/or captured then conveyed clearly to evaluators.

4.3 Interpretation **and understanding of principles**

This related primarily to the understanding of the calm design principles by the evaluators as captured by the "Misunderstanding" code. Overall, the findings showed that principle 1 was the most challenging for the evaluators to understand and apply, and as discussed earlier, we attribute this to lack of specificity in the use of the term "distracting." Other examples where the evaluators explanations were coded as "Misunderstanding" included "focus is on the app and code is to influence behavior,"' "Still be played with without tech and technology is integrated well" "from what I've seen, there don't seem to be a lot of sensors," "only reacts with card." To fully understand what is meant by these explanations would require additional insights into how the principle had been interpreted by the evaluator (and potentially what evidence or experience the evaluator was using to make a judgement) but for the purposes of this study the view was taken that where there was no evidence that the evaluator has understood the principle this was coded as "Misunderstanding" and is attributed to potential problematic phrasing of the principle being applied.

- **Recommendation 3:** Ensure that key terminology is clear and unambiguous when related to all the functionality and contexts considered in the evaluation of smart toys.

4.4 Design **intent vs. play experience**

The calm design principles (adapted from work by Case (2016) as discussed earlier) used in this work relate to some degree to the *designer's intent* (3, 4, 5, 7) when creating smart toy features, while others (1, 2, 6, 8) focus on facets of the *user's play experience* during play with the toy. These different framings may need different evaluation strategies. For example, a toy adhering to principle 3 (*The toy uses only one channel to communicate.)* may use only lights to communicate and this can be easily observed. Conversely, a toy adhering to principle 1 (*The technology in this toy becomes distracting during play.*) requires much more careful consideration, as discussed previously.

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Evaluators may have had clearer criteria for judging intentional design elements, even without extensive play testing. Conversely, principles relating to *play experience* are inherently more complex due to the subjective nature of the experience and toy. Evaluators faced greater challenges in accurately interpreting and judging the nuanced aspects of play.

Whilst our evidence of differences between these two different foci in the calm design principles is small, we can hypothesize that those relating the play experience will benefit from the evaluators being more engaged in play—we posit that where evaluators may not have an opportunity to play it might be beneficial to focus only on those principles concerned with design intent.

- **Recommendation 4:** Consider carefully what aspect of the smart toy or play experience the principle refers to, what information the evaluator will need in order to make a judgement, and how this information will be gathered during the smart toy evaluation activity.

4.5 Calm smart toys: a strong concept

Through our work we propose "calm smart toys" as a strong concept (Höök & Löwgren, 2012). Strong concepts are central to guiding an idea that provides coherence, direction and resilience to a design product. They act as clear, memorable and resilient underlying principle that informs and shapes all subsequent design decisions. It the purpose of the design that provides the foundations for features and interactions to build on. Strong concepts are positioned as anchors (Höök & Löwgren, 2012) functioning as a form of identify that governs design exploration and constrains decision-making.

Our recommendations emphasize the need, in studying calm toys, to consider diverse application scenarios, thereby enhancing the core conceptual understanding and potential of the concept. This remains consistent with the overarching ethos of calm design and strong concepts throughout the design process. This ensures the design of smart toys are driven by solid foundations to underpin calm design. In summary, integrating calm design principles into technologies as a strong concept ensures that the resulting design is not just calm in intention, but calm by construction throughout the entire design process. This is where the strong concept acts as a guard against technological overreach, stakeholder pressures or feature creep. This ensures every design decision aligns with the underlying delivery of unobtrusive, supportive, and emotionally considerate technology.

Furthermore, by focusing on the dynamic gestalt (Höök & Löwgren, 2012), we advocate for evaluating interactive states and temporal human-toy interactions rather than static features alone. Furthermore, the consideration of varying play contexts aligns with the abstracted, cross-situational nature of strong concepts, allowing for generalized applicability. Similar to the need for clear, context-independent language, strong concepts must maintain core design elements across diverse functionalities.

We hope that future research will explore the operationalization of calm design within smart toys through strong concepts. Utilizing strong concepts as a design framework allows for the development of engaging, playful toys that mitigate negative impacts on attention and well-being. These recommendations aim to transition design focus from specific instances to an intermediate level of conceptual knowledge, informing future design and evaluation of smart toys.

5 Limitations

Overall, the findings showed that expert evaluators had some success in evaluating calm design in smart toys. More specifically, the work highlights the challenges and recommendations when conducting such evaluations with experts where play is needed to be experienced.

The limitation has several limitations that should be acknowledged. First the evaluation was conducted in a university lab with a small group of HCI experts. The sample size included six expert evaluators which limits the statistical generalizability of the insights. Moreover, these experts were selected on their knowledge of the evaluation method and therefore selection bias should be highlighted. Second, the playtest permitted short exposure time for each toy, limiting the play experience in a study environment which limits natural context of play (i.e., home) which could affect how play was experienced. Finally, the choice of toys was commercially available at the time of writing, these toys were typically themed around programming, robots, and education.

6 Conclusion

This paper investigates the results of a study to understand how expert evaluators used a set of calm design principles to evaluate calm in a set of commercially available smart toys. Calm in smart toys in an underexplored research area within the HCI community and offer many potential play benefits. This paper focused on analysis of textual explanations given by evaluators of their responses when scoring a toy as aligning with a calm toy principle. When analysing this data related to how the evaluators applied the principles, "Misunderstanding" (of the principle) and "Insufficient information" (about the toy in order to judge align with the principle) were evident. The paper considers explanations for ("Misunderstanding" and "Insufficient information") in the context of the calm toy principles, the evaluation study carried out, and analysis of the explanations. This led to the identification of four challenges inherent in the evaluation of smart toys (both in terms of calm and more generally). These challenges and subsequent recommendations are important for others embarking on similar work (in research or commercial settings). For each challenge, we contribute a recommendation that others can take action to minimize against the challenges. Through this work, we hope to raise awareness of the potential value of considering calm in relation to smart toys, along with practical guidance on how qualities such as calm can be understood in the context of smart toys and therefore, how *calm smart toys* can be considered as a strong concept.

Data availability

The data underlying this article cannot be shared publicly due to it not being documented in the participant information sheet and consent form.

Conflicts of interest

None declared.

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