

“We Care More About What It Does”: Priorities and Responsibilities in VR for Children and Families

Qiao Jin , Xiaoran Yang , Svetlana Yarosh 

Abstract—Families make key decisions about whether and how Virtual Reality (VR) enters children’s lives, but their priorities rarely shape the research agendas and accountability structures that guide what is studied and built. We examine children’s and families’ views on (1) which knowledge is most needed to support decisions about children’s home VR use, (2) which advances, tools, and content should be prioritized, and (3) which actors they see as responsible for addressing these priorities. We first conducted a secondary analysis of prior interviews with children and guardians to distill a structured set of family-perceived alternatives for home VR use. We then engaged 46 child-involved groups (84 children, 40 guardians) to collaboratively prioritize the perceived importance of these alternatives and assign responsibility to different actors. We found that families prioritized knowledge about VR’s effects on brain development and behavior as the most needed, viewing it as the underlying mechanisms with downstream consequences for other effects. They treated safety monitoring as a prerequisite that should not depend solely on parental control, and ranked safety above affordability, comfort, and visual realism. This work contributes to the VR community by offering a children- and family-informed VR research agenda, along with insights into who families believe should be responsible for addressing these priorities.

Index Terms—VR, children, families, research prioritization, VR ethics, Home VR.

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1 INTRODUCTION

Virtual Reality (VR)¹ is increasingly entering children’s daily lives, with expanding applications in education, entertainment, social interaction, and therapeutic support [28, 32]. As VR moves from specialized domains into everyday family settings, children are no longer just occasional users but are becoming primary users in homes. This shift requires families to weigh potential benefits against emerging risks such as eyestrain, obesity, distraction, and addiction [33]. Previous research has highlighted the value of involving children in shaping the future of new technologies, as their perspectives often differ from those of adults and lead to designs that better reflect their developmental needs, preferences, and lived experiences [25, 55]. However, children’s involvement often remains limited to the design level, which focuses on interfaces, content, or functionality rather than influencing upstream research and development priorities that determine which technologies are built in the first place [57].

Existing studies have raised significant concerns about children’s VR use among both children and guardians [20, 32]. But we still lack empirical evidence on how children and their families perceive and prioritize these concerns, how they weigh trade-offs, and whom they believe to take responsibility. Notably, such family perceptions may not always align with expert assessments [13]: families often have less technical knowledge or fewer resources than researchers [54]. These perceptions remain critical because they directly shape families’ everyday adoption and use decisions. Understanding these perceived priorities and responsible actors is thus essential for guiding responsible design, policy, and industry practices.

In this paper, we aim to center those voices. We first conducted a secondary directed content analysis of interview transcripts from a prior study that involved 67 children and 55 guardians, focusing on family-related scenarios. Guided by our research questions, we used this analysis to deductively code for three overarching categories (knowledge needs, technological advances and tools, and responsible

stakeholders) while remaining open to inductive refinement of new themes. This process generated a structured set of agenda alternatives that reflected families’ perceptions of VR use at home. Building on these findings, we then carried out a separate mixed-method study with 46 child-involved groups (84 children, 40 guardians) using structured activities that combined speculative design videos and ranking tasks to elicit families’ perceived priorities and the actors they considered responsible for addressing them. Through this two-stage process, we address the following three research questions:

- **(RQ1)** What types of knowledge do children and families perceive as priorities when deciding on children’s use of VR at home?
- **(RQ2)** What technological advances, tools, and content do children and families perceive as priorities when deciding on children’s use of VR at home?
- **(RQ3)** Who do children and families identify as responsible for addressing their priorities in shaping home VR for children?

2 RELATED WORK

2.1 Immersive VR for Children

Immersive VR is a technology that creates a sense of physical presence in a virtual environment. These systems typically involve head-mounted displays combined with motion tracking or handheld controllers, allowing users to engage with 3D spaces [22]. Due to its immersive and interactive nature, immersive VR has shown promising impacts as a therapeutic and educational tool for children [18, 65]. In healthcare contexts, VR has been used to support pediatric treatment and rehabilitation for children. It can reduce children’s anxiety in clinical settings [59], provide distraction from pain during medical procedures [7], and support sustained attention in children with ADHD [66]. VR interventions have also helped children and adolescents on the autism spectrum manage emotional distress [2, 8], and have been applied to address specific phobias (e.g., helping children aged 4 to 6 overcome fear of the dark [64]). Beyond healthcare, VR has been widely adopted in educational settings to support children’s learning across a variety of subjects. For example, it has been integrated into gamified platforms to foster collaboration and problem-solving skills [72]. It is also used in safety education to provide children with realistic, risk-free environments in which to develop hazard awareness (e.g., to teach safe boating practices [61] or knife-handling skills [53]). By increasing engagement and immersion, VR-based educational tools have shown promise in enhancing both the effectiveness and enjoyment of learning experiences for children [22].

A growing number of studies have begun to explore how children

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¹In this paper, “VR” specifically refers to immersive VR systems that support head rotation or full six degrees of freedom (6DoF), as they provide more immersive experiences and have significant potential to impact children’s lives [28, 32].

engage with VR in everyday and home settings. For example, VR serves as a medium for strengthening family bonds, evoking nostalgia and memories [17], resolving conflicts [63], and facilitating remote communication [17, 27]. Maloney et al. [42] found that young people perceived social VR (e.g., VRChat and Altspace) as an enjoyable way to connect with others and even strengthen family bonds. Although many VR platforms implement age restrictions, Fiani et al. [21] reported that children under 13 ($N = 50$) regularly used social VR with nearly half (47%) engaging on a daily, weekly, or biweekly basis through a questionnaire study.

Those studies highlight the growing interest in how children engage with VR. However, much of the previous work (e.g. [21, 28, 42]) has focused on perspectives from adults, such as parents or specialists, rather than from children. In prior VR studies involving children and their families, children often participated as testers, co-designers [20, 32], or end users [21, 42]. Yet few studies have directly invited children to share their concerns about VR or to help shape research agendas around these concerns (notable exceptions include [32] and [20]). This study takes a step further by engaging children and families from the outset, as active contributors who help define research questions and priorities based on their experiences and needs.

2.2 Concerns about VR Usage

Concerns around children's VR usage span multiple domains and highlight the interdisciplinary nature of this emerging research area, involving a wide range of stakeholders such as parents, educators, ophthalmologists, neurologists, psychologists, pediatricians, and other relevant experts who examine VR's impact from diverse perspectives [28, 32, 33]. A recent interdisciplinary systematic review by Kaimara et al. [33] analyzed 85 peer-reviewed studies published between 2010 and 2020, summarizing the potential risks of VR use for children across three key domains: physical, cognitive, and psychosocial development. Physical development includes changes in the body and brain, sensory systems, motor skills, health, and overall well-being [62]. Commonly studied risks include cybersickness [51, 69], eyestrain [60, 67], obesity [34], sleep [23], cardiometabolic [11] and radiation exposure [19] issues. Cognitive development refers to changes in mental abilities such as perception, attention, memory, language, learning, and reasoning [58]. Concerns in this area focus on how immersive VR might alter or disrupt these processes in developing children [44]. Psychosocial development encompasses emotional growth, personality development, and interpersonal relationships. Frequently cited concerns include addiction [4], anxiety [14], emotional dysregulation [37], reduced prosocial behavior [5], social withdrawal [42], and risks related to online harassment or isolation [20].

Beyond these developmental concerns, prior research has also identified issues related to privacy and data collection, particularly in relation to commercial tracking and platform accountability [38, 43]. Other concerns include disparities in equity and inclusion [32], as access to VR for educational and developmental purposes may be limited by socioeconomic status or by a lack of support for children with disabilities. To mitigate these issues, prior research has emphasized the need for stronger safety mechanisms, such as incorporating human or guardian oversight [20, 21, 42], better alignment with children's health, developmental, and societal needs [6, 32], and the promotion of bidirectional communication and active discussions among parents and other stakeholders [32].

Most existing work focuses on identifying risks or proposing top-down solutions. Less is known about how children and families themselves perceive and prioritize these ethical concerns, and whom they believe should take responsibility for addressing them. These perceptions are crucial, as families may be less technically informed than researchers or clinicians, but their judgments directly shape real-world adoption and use decisions. Therefore, understanding family-perceived VR agenda and priorities complements expert perspectives by revealing how end users make sense of VR's risks and benefits in everyday contexts. Our work explicitly centers children's and families' perceived alternatives and involves them in shaping a research agenda for home-based VR use. The categories used in our prioritization tasks were

informed by a secondary analysis of prior qualitative studies on VR ethics with children and families [32]. The process of generating and refining these categories is detailed in Section 3.

2.3 Child-Informed Prioritization Research

Children-informed prioritization is an umbrella term referring to the practice of consulting children who are directly affected when making future research and design decisions [52]. This approach engages stakeholders collaboratively to determine priorities for innovation [47]. Children are key stakeholders in shaping research and design directions that influence their own lives and those of their families, particularly as they are directly impacted by technological outcomes and are often active users [16, 24], as is the case with VR in our study. In child-oriented prioritization techniques, the primary factor to consider is task duration. Stakeholder engagement is inherently time-consuming and complex [26], and this challenge becomes more pronounced with children due to their unique behavioral norms, communication styles, and cognitive complexity [15]. To address this, the concept of "rapid prioritization" has been proposed, where "rapid" specifically refers to the time children spend participating. For example, Mahyar et al. [41] successfully engaged the general public in research through online micro-tasks that each lasted about 10 minutes. Rapid methods are especially well-suited to children's limited attention spans [31]. Many co-design studies with children structure sessions as short tasks lasting 15 to 45 minutes, distributed across a longer project timeline [30, 73]. Another key factor is the degree of autonomy granted to children in participation. Some participatory design practices risk falling into "tokenism," where children are merely asked to provide feedback rather than being treated as true design collaborators [48]. This issue is further complicated when children participate in research and design, as many interactions between children and technology are mediated by parents. As such, child-computer interaction is inherently a multi-party engagement involving families and caregivers [10, 46].

In this paper, in attempting to formulate the VR agenda with both children and parents, we run the risk of discounting children's opinions [48]. We took into account the practical consideration of children's limited attention spans and the presence of guardians [31], who often prioritize participating in event activities (as recruitment took place during a large public event in our study). We therefore organized on-site sessions with open recruitment and designed the entire study to be completed within 20 minutes to minimize attention fatigue in children.

3 DEVELOPING VR AGENDA ALTERNATIVES AND RESPONSIBLE ACTORS

3.1 Datasets and Data Analysis

We conducted a secondary analysis of data from our prior study on children's VR use [32]. The dataset includes interview transcripts from 122 participants (67 children and 55 guardians) from 52 families. We labeled participants with anonymized identifiers: F# (family ID), C# (child ID), and P# (guardian ID). In this study, each family first explored a VR environment together, then viewed speculative scenario videos across education, healthcare, and family contexts, completed short surveys, and participated in individual semi-structured interviews. Whereas the original analysis examined ethical concerns across all three domains, our reanalysis focused specifically on interview segments where participants discussed desirable alternatives or actor responsibilities for family-based VR use. This allowed us to generate a structured set of agenda alternatives that could be ranked and assigned to responsible actors in our subsequent study.

We employed a directed content analysis approach to analyze the interview data [29]. We selected this method because our research was guided by three distinct research questions, which allowed us to create a deductive coding framework. Our initial framework consisted of three primary categories: (1) Knowledge Needs (RQ1), (2) Technology, Tools, & Content Needs (RQ2), and (3) Responsible Actors (RQ3). Two authors independently segmented transcripts into utterance-level meaning units and developed a codebook specifying definitions, inclusion/exclusion rules, and anchor quotes for each category. In the deductive phase, both authors coded segments into the three categories

using the codebook, with a third author consulted to resolve disagreements when necessary. In the inductive refinement phase, we derived more granular sub-codes within each category from participants' language and intentionally retained participant-grounded labels (e.g., *brain development*, *happiness*) when they were clear and actionable. In some cases, we applied light abstraction (e.g., grouping teachers and doctors under *domain experts*) to consolidate related expressions while preserving participants' original intent. To support reliability, at least 15% of segments were double-coded; disagreements were resolved by discussion to consensus. Finally, we synthesized sub-codes into VR agenda alternatives and actors aligned with the three RQs and presented findings with illustrative quotes.

It is important to note that our use of labels grounded in participant language was a deliberate methodological choice. Academic constructs such as *cognitive development*, *mental health*, or *cybersickness* offer precise clinical definitions, but framing the agenda alternatives in these terms risks imposing researcher-centric categories that may not have been meaningful or accessible to children and families during the prioritization tasks. Our analysis aimed to capture how participants themselves articulated concerns, so we preserved their wording to ensure that the alternatives were both understandable to child participants and faithful to the ways families discussed these issues in everyday contexts. In Section 6.1, we revisit these terms and relate them back to established academic constructs in order to position our findings within the broader literature, while also noting the trade-offs of this participant-centered framing (see Section 6.3).

3.2 Identified Alternatives and Responsible Actors

3.2.1 Knowledge Needs

Participants described a range of areas where more knowledge is needed to understand the consequences of VR for children and families. For *effects on relationship*, participants warned of losing shared time with loved ones ("You should always ask adults if you can...because if you don't, you might miss out on family time." [F1-C1]), while others imagined VR as a way to co-play with relatives ("Especially in long distance, you know, connection with the grandparents." [F36-P36]). In terms of *effects on long-term happiness*, youth frequently stressed the excitement of VR ("VR would be so much fun...a lot of fun" [F44-C57]) but also noted the risk of overuse ("... but if I did it every day, I don't know if it would actually make me happier in the long term." [F44-C57]), with parents cautioning that immersion "if it keeps kids satisfied or just makes them want more." [F26-P26]. For *effects on learning*, children described VR as a way to learn together with family members or learn online ("I know it can help kids...if they're doing homeschool, but they still want to learn with a teacher." [F23-C28]). Parents, however, stressed the importance of family oversight, noting that "parents need to be aware of what and how their children are learning in VR" [F23-P23]. Knowledge was also sought about *effects on brain development*. Children raised concerns about how VR might interact with developing brains, noting that "some kids...don't get it using VR that much at home...their brains aren't really being exercised, but kids' brains are still developing" [F26-C33]. Others emphasized developmental timelines ("your brain's mostly developed at 25, we don't know how VR can influence brain development before then" [F33-C42]) and linked use to possible neurological risks ("it's gonna cause brain problems" [F32-C41]). Families similarly identified the need to better understand health, behavioral, and broader impacts. For *effects on physical health*, children reported discomfort ("You can get dizzy ..." [F8-C10]; "I'm getting a headache." [F12-C14]) and worried about "a lot of eye damage" [F32-C41]. Parents also emphasized sedentary risks ("It kind of reminds me of WALL-E (an animated film) where they're in those chairs and never moved." [F1-P1]) and eye health risks ("What would that do to his eyesight, day in and day out using it?" [F1-P1]). Concerning the *effects on behavior*, participants noted that VR use could shape children's everyday conduct. Children worried about ignoring parents or neglecting family routines ("You might be on your VR too much and not hear your mom and dad... or forget to actually do stuff with your parents." [F1-C1]) and described situations where VR replaced in-person interaction. Parents emphasized concerns about

designs that encourage compulsive use ("It makes it so addicting that kids can't put it down." [F13-P44]). Parents also highlighted the need to know *what data is collected*, voicing worries about manipulation and surveillance ("people can try to trick you into revealing your information" [F6-P6]). For *other families' experiences*, adults contextualized concerns beyond their own household ("... recommendations on how much is appropriate, otherwise your kid could be living isolated in physical reality ..." [F23-P23]). Finally, at the level of the *effects on society*, participants noted the equity issues because of the price ("It's expensive...not every family can have one." [F36-P36]) and questioned whether social ties could be maintained ("if everyone is in VR,...you don't build connection with the real one." [F46-C60]).

3.2.2 Technology, Tools, & Content Needs

Participants articulated several expectations for the future development of VR. Many highlighted the importance of *social experiences*, such as multiplayer play that enabled them to "join your family or friends" [F1-C1]. Others underscored the demand for *educational content*, with parents pointing to its value beyond entertainment and linking it to formal learning contexts ("It would be helpful if VR is used for academic learning or professional training." [F6-P6]). To sustain engagement, families called for *comfort for longer use*, participants emphasized both physical strain from prolonged wear and discomfort with controls. Parents noted risks of fatigue if headsets are not ergonomically designed ("His eyes looked fatigued... day in and day out it could be exhausting." [F6-P1]), while children described challenges with the controllers ("I don't really like the way you hold the handle — the circles on top make it hard to move my wrists around." [F27-C34]). Visual quality was another focus, with children calling for *more realistic graphics* to make experiences more believable ("Very realistic and you can go anywhere you want." [F46-C60]). Alongside realism, participants also wanted opportunities for *support physical movement*, suggesting games and experiences that promote activity ("He should be doing the exercises...I thought that was good for the kid." [F23-C28]). At the same time, families stressed the need for safeguards and accessibility. Parents and children alike called for *safety monitoring*, particularly to avoid harassment or bullying and ideally "detected by the platform automatically" [F5-C6]. It also highlighted the need to "make sure that...physical safety, the location safe for them to move around" [F1-P1]. Relatedly, adults stressed *privacy protections*, raising concerns about how data could be collected or exploited ("concerned around privacy...people can try and trick you into giving you information." [F6-P6]; "My daughter always uses really basic passwords...Inputting the password with the VR controller also prevents her from setting up a more secure one." [F43-P45].) Financial barriers were also noted, with references to *make it cheaper and available* as key obstacles to broader adoption ("I know what one of those costs, because I have one. They're about 500 bucks each. So if you have a family of two, three, or four and you want to do this together, that's easily \$1,500 or more. That's not realistic for your average family; it's really only for people who have extra money to spend." [F49-P52]). Finally, parents emphasized the need *tools for parental control* that allow them to set limits and monitor use ("It's kind of like their phones: you don't know what they're doing...Our daughter has a phone, and we use family child controls on it. We would need something similar for VR." [F52-P55]).

3.2.3 Responsible Actors

When asked who should take responsibility for guiding the development and use of VR, participants frequently pointed to three groups. First, they identified *university researchers* as important for providing evidence-based knowledge and evaluation. Some parents stressed the need for researchers "to study how VR affects kids before it becomes too common" [F51-P54], while children also acknowledged the role of "people who know more about how the mind works and how games will affect your mind" [F26-C33]. Second, participants emphasized the obligations of *technology companies*. As one parent explained, "big corporations need to take responsibility, and sometimes we're just so beholden to stock price that it's not always the right choice...the thing that makes more money is not the thing that's right socially or for

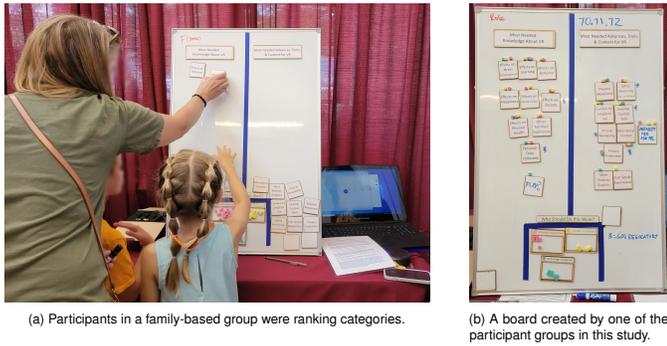


Fig. 1: Overview of the study setup and an example of activity boards.

betterment” [F12-P12]. Finally, participants called on *domain experts*, including doctors, teachers, and other professionals, to guide safe and beneficial uses. For instance, children referenced teachers as central to deciding when VR is appropriate in education context, while parents wanted medical professionals to advise on health impacts (“I’d be concerned about vision...getting opinions from doctors to understand the longer effects.” [F1-P1]).

4 PRIORITIZING ALTERNATIVES AND ASSIGNING RESPONSIBLE ACTORS

We used a mixed-methods approach to investigate how children and families prioritize VR research topics, technological advances, and content for children’s use at home, how they reason about these priorities, and who they believe should be responsible for addressing them. In our case, quantitative rankings provided structured evidence of what concerns families considered most and least important, while qualitative data from focus group discussions enabled us to understand the reasoning, values, and negotiations behind those rankings. We specifically used child-involved focus groups to support collaborative reasoning in family contexts, which is critical when studying intergenerational technology decisions. Prior research has shown that focus groups are particularly effective in eliciting rich insights from children when tasks are interactive and socially grounded (e.g., ranking boards and actor assignments) [71]. This approach captured both individual perspectives and the ways families co-constructed views and negotiated differences, an essential process for examining values and responsibilities around emerging technologies such as VR.

Each alternative (shown in section 3.2) was represented as a custom-printed magnet to support hands-on interaction, along with dry-erase blanks that enabled participants to contribute their own ideas. This tangible format was designed to foster engagement and collaborative discussion, particularly with children [3,56]. The actors were presented with colored magnets that could be easily placed in relation to each alternative. Participants worked in small groups to collaboratively rank the alternatives on a whiteboard and reflect on their choices. This setup yielded both ranked data for analysis and conversational insights to answer our research questions. We conducted a pilot with two groups (ages 8–12, N=3; age 17, N=2) to assess the feasibility of materials and tasks. The pilot confirmed that children could understand the alternatives and actor roles, complete the ranking and assignment tasks within 20 minutes, and engage in meaningful discussion. Participant feedback informed wording refinements to the researcher script used for introducing the tasks (see supplementary materials).

4.1 Settings and Participants

This study was approved by the university’s Institutional Review Board (IRB). We partnered with the Driven to Discover research facility at the Minnesota State Fair, a lab-in-the-wild site that supports in-person recruitment and data collection with a diverse participant pool, especially families. We recruited families as they passed by the facility, where the study took place. A total of 124 participants (46 groups) were recruited, including two roles in the family: guardians (primarily parents) (N

= 40) and children or adolescents (N = 84). Among guardians who reported their age and relationship to the participant child, in most cases, the role is parents, with 2 siblings, 2 grandparents, and 1 other family member, with an average age of 46.769 (SD = 9.834).² For guardians that reported gender and ethnicity, there were 22 females, 16 males, and 2 identifying as another gender, with 30 identifying as White, 7 as Latino, 2 as Asian, and 1 as American Indian or Alaska Native. Among the adults that reported the highest level of education and household annual income, 4 did not hold a college degree, and 5 reported annual incomes below \$75,000. Additionally, 21 adults had previous VR experience. Children participants had an average age of 13.223 (SD = 3.062), with 36 females, 37 males, and 11 identifying as another gender. Of these children who reported ethnicity, 54 identified as White, 7 as Asian, 7 as Latino, 2 as American Indian or Alaska Native, 1 as Black, 2 as mixed ethnicity, and 11 as other ethnicity. 56 children had prior VR experience.

Participants were organized into either family-based groups (including at least one child and one parent; 27 groups) or child-only groups (19 groups). Group composition was determined primarily by participant availability and interest. Each group consisted of 2 to 5 members, with an average group size of 2.70 (SD = 0.764). The study environment (Figure 1a) was a public-facing space that included tables, whiteboards (an example is shown in Figure 1b), recorders, and tablets for consent and demographic data collection. We assigned anonymized labels to participants for coding and reporting: G# (group ID), C# (child ID), and P# (guardian ID). Participants received either two toys or one backpack as compensation.

4.2 Procedure

The study lasted about 20 minutes in total. Participants were first introduced to the study purpose: to understand how children and families prioritize the key questions about children’s home VR use, and who they believe should be responsible for addressing them. Then guardians provided consent for themselves and completed a brief demographic questionnaire on the tablet. If they had one or more children participated, guardians also completed a separate consent form and demographic section for each child. For children aged 8–13, researchers explained the assent form verbally and obtained verbal assent. Teens aged 14–17 reviewed and signed the consent form themselves and completed their own demographics.

After consent, participants watched two one-minute scenario-based videos on a tablet. These videos illustrated potential future uses of VR in family settings: one showed a positive scenario of long-distance family members connecting through shared VR gameplay, while the other showed a negative scenario in which family members, though physically together, were individually immersed in separate VR experiences. Two scenarios were developed using an anticipatory approach from [32]. The goal was to prompt reflection and discussion before starting the prioritization activities.

Participants were then organized into small child-involved groups to complete three tasks. In the first task, participants collaboratively ranked a set of predefined items on a board labeled “Most Needed Knowledge about VR,” ordering them from most to least important. In the second task, they followed the same procedure on a board labeled “Most Needed Advances, Tools, and Content for VR.” In both tasks, participants were also given blank magnetic cards, allowing them to contribute their own additional items if they felt something important was missing. In the third task, participants used small color-coded magnets to indicate which actor (university researchers or non-profits, domain experts (e.g., schools or hospitals), or technology companies) should be responsible. Participants could select one or more responsible actors for each agenda item. They also had the flexibility to assign new actors by writing directly on the board if needed.

A total of four trained researchers supported data collection. For each session, one researcher facilitated each group using a standardized script. When two groups ran concurrently (our setup supported

²Not all participants reported their ethnicity, income, family role, age, or relationship to the child participant, which accounts for the discrepancy in the totals.

up to two groups at a time), two facilitators led in parallel while the other researchers handled recruitment and logistics; roles may rotate across sessions. Researchers only intervened if participants explicitly requested assistance or if the entire team was unable to progress and became stuck. Researchers recorded the full discussion for three tasks and documented each session by collecting audio recordings and photographs of the boards for later analysis.

4.3 Data Analysis

4.3.1 Quantitative Data

To answer the first two RQs, we analyzed the ranking data from board photographs using a Plackett–Luce (PL) model [40, 50], fitted separately for the two item sets (knowledge; advances/tools). From each photo, we transcribed row-wise ranks, retaining ties, and each row was mapped to a dense rank form (present ranks compressed to 1, 2, ... while preserving ties). Models were fit in R using the Plackett–Luce and psychotools packages; we reported exponentiated, normalized item weights $\theta_j = \exp(\beta_j) / \sum_k \exp(\beta_k)$ so that $\sum_j \theta_j = 1$ (identification via normalization). To quantify uncertainty, we computed 95% confidence intervals for θ_j via a group-level cluster bootstrap with $B = 5,000$ replicates [68] (clusters = groups), refitting the PL model in each replicate and taking percentile limits. Because group composition (family-based vs. child-only) is outside our research questions, we provided only an exploratory descriptive stability check: we refitted PL models on family vs. child-only subsets and obtained two-sided pseudo- p values from a group-level bootstrap ($B = 5,000$; resampling groups).

To answer RQ3, responsibility assignments were multi-label: for each item, each group could mark zero or more actor categories. We first categorized data from 46 groups into three specific groups (domain experts, university researchers or non-profits, and technology companies) and then calculated the frequency of each group within separate research items. After determining the raw frequencies, we converted these into percentages to reflect the relative proportions within each group.

4.3.2 Qualitative Data

To analyze the audio data collected from group discussions, we first converted all audio recordings into written transcripts. Some audio segments were unclear (e.g., overlapping speech or room noise). We used only the intelligible portions for qualitative analysis; when helpful, we consulted the facilitator’s notes to preserve context without filling in missing content. We followed Braun and Clarke’s [9] detailed guidelines and reproducible procedures for thematic analysis through the following steps. First, the initial two authors carefully read the textual data and wrote analytic memos to identify content relevant to our three RQs. Second, they collaboratively generated initial codes from the first three transcripts to calibrate their interpretations and coding process. The remaining data were then independently coded by the two researchers. Afterward, they met to consolidate the codes and eliminate redundancies through an iterative open coding process. Third, the authors collaboratively organized the codes into thematic topics aligned with the RQs, based on participants’ reasoning on their rankings and the responsible actors for priorities during the group discussion. Using a constant comparison approach, two researchers refined the themes by continuously checking new data against emerging categories. Each code’s placement was discussed, and disagreements were resolved collaboratively, with a third author involved as needed. Next, all authors worked together to review, refine, and name the final set of themes. At this stage, we considered the relevance and significance of each theme to answer the RQs across the full dataset. Finally, all authors collaboratively selected representative quotes and structured the findings to present a coherent, compelling narrative, ensuring that the final findings we report are especially relevant and novel to the VR research community. In the next section, we present the overarching themes that emerged from this analysis process.

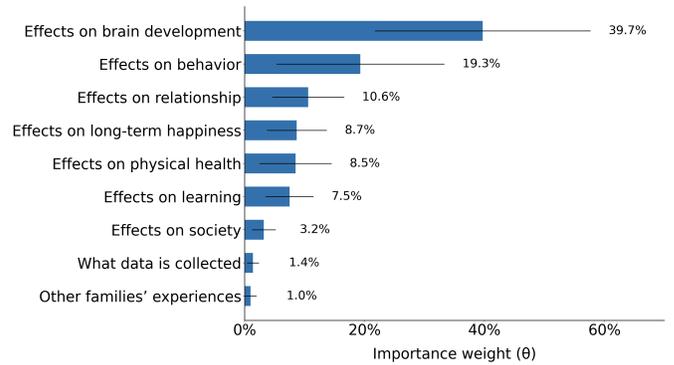


Fig. 2: Distribution of importance weight for most needed knowledge. Error bars indicate 95% cluster-bootstrap CIs ($B = 5,000$; clusters = groups).

5 RESULTS

5.1 RQ1: Prioritized Knowledge Needs

5.1.1 Overview of Prioritization Outcomes

As shown in Figure 2, *effects on brain development* received the largest weight and was viewed as the most needed knowledge, followed by *effects on behavior*. A middle tier included *effects on relationship*, *effects on long-term happiness*, *effects on physical health*, and *effects on learning*. Lower weights were assigned to *effects on society*, *what data is collected*, and *other families’ experiences*. The exploratory stability check showed similar item orderings for family-based and child-only groups; no bootstrap pseudo- p values were $< .05$.

In addition, participants also raised other VR knowledge needed to know by adding their own alternatives. Several participants emphasized the importance of knowing *how to use VR technologies appropriately* (rank 4/10)³, *potential emotional harm that may arise from its misuse* (rank 3/10) and *how to protect children in VR* (rank 4/10). Some participants also noted the potential impacts on *pets* (rank: 3/10), *family time* (rank 1/10) and *fun* (rank 5/10).

5.1.2 Inductive Themes

Theme1: Foundational effects on brain and behavior shape all other concerns. Across nearly all groups, participants viewed the long-term effects of VR on brain development and behavior as foundational, shaping a wide range of downstream impacts. These two categories were consistently ranked among the most important, with many suggesting that they “will affect everything else” [G22-C29], including learning, social relationships, and physical and emotional well-being. Rather than treating brain and behavior separately, participants often discussed them as deeply interconnected. One participant described this layered structure: “It affects learning and it affects society and relationships and happiness, etc. It also kind of like trickles down from how it affects your behavior and brain development” [G22-C29]. Another explained how brain development underpins cognitive functioning: “Brain development can affect your learning, like, if your brain’s not developed enough, you might not be able to focus or understand stuff as well” [G8-C10]. Similarly, as to brain effects, participants saw behavioral effects not only as outcomes of VR use, but also as factors that influence how users engage with VR and what social or emotional impacts they might experience. Participants linked effects on behavior directly to the motivational draw of VR, as one child mentioned: “Effects on behavior make you interested in playing VR” [G18-C21].

Understanding how VR affects the brain and behavior helped participants reason about its influence on screen time and usage frequency at a deeper level, which are factors associated with the biggest concern of parents and noted in many groups: VR addiction. While addiction is,

³We report ranks as x/y where x is the item’s position and y is the total number of items the group ranked in that task. Rank 1 is the highest priority; larger rank values indicate lower priority.

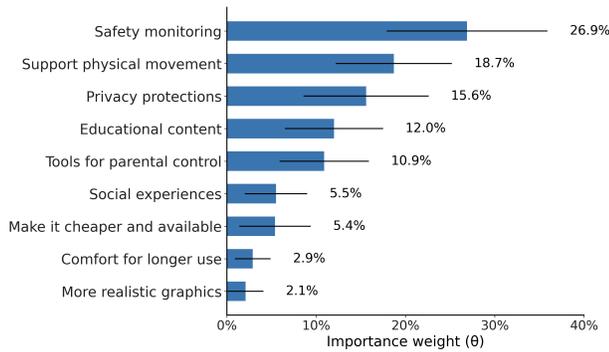


Fig. 3: Distribution of importance weight for most needed advances. Error bars indicate 95% cluster-bootstrap CIs (B = 5,000; clusters = groups).

in many ways, a concrete manifestation of broader behavioral effects, participants consistently singled it out as a key outcome stemming from underlying shifts in cognition and impulse control. As one parent explained, “If VR changes how their brain works, how they focus or get rewards, then it makes sense they’d want more of it.” [G8-C10] Once this compulsive use pattern was established, participants described it as opening the door to a wide range of secondary concerns. These included physical symptoms, one parent mentioned “It makes me nauseous” [G12-P16], as well as emotional and social withdrawal, “You’re just avoiding the world” [G12-P16], and some general accountability of online behavior. Another parent explained “They think they can do whatever they want because they’re online and they won’t have consequences” [G10-P12]. Together, participants positioned brain development and behavior as mutually reinforcing mechanisms through which VR could reconfigure not just individual cognition or action, but the broader fabric of children’s daily lives, including how they learn, relate to others, and maintain well-being over time.

Theme2: Perceived inevitability of data collection lowers the importance of knowing what is collected. Participants generally ranked knowledge of what data is collected as a low priority. This was not due to a lack of concern, but because participants viewed data collection as routine and unavoidable when using digital technologies, including VR (e.g., “It’s hard to avoid this unless you give nothing out.” [G10-P12]). As a result, the issue felt less actionable or worth prioritizing. As one participant explained, “I’m not concerned about it because you already have, like, social networks, and you already know that when you talk with somebody, and you say any kind of word, they’re gonna send you everything in ads” [G11-P13]. Another echoed this acceptance, stating, “I think personal data collection is near the bottom because I think our phones already know what we do” [G13-C62]. For many, this normalization of surveillance technologies meant data collection was not a deciding factor in whether VR should be adopted.

Some participants even highlighted the potential benefits of responsible data use, particularly when it led to improved user experiences. They noted personalized recommendations and adaptive features as worthwhile outcomes when personal data were collected and used appropriately (“It needs to collect personal data to understand what we actually want” [G2-P3]). Importantly, participants distinguished between data collection and privacy violations. Their reasoning suggested that trust in the entity handling the data was more important than the specific knowledge of what is collected. As one participant stated, “Personal data should be handled by technology companies, but they shouldn’t be stealing it or misusing it.” [G39-C67]. These views about responsible data stewardship are discussed further in RQ3 (see section 5.3.2).

5.2 RQ2: Prioritized Technological Advances, Tools and Content Needs

5.2.1 Overview of Prioritization Outcomes

As shown in Figure 3, *safety monitoring* received the largest weight and was viewed as the most needed technological advance/tool, followed by *support physical movement* and *privacy protections*. A middle tier included *educational content* and *tools for parental control*. Lower weights were assigned to *social experiences*, *make it cheaper and available to all*, *enhance comfort for longer use*, and *more realistic graphics*. The exploratory stability check again showed similar item orderings for family-based and child-only groups; no bootstrap pseudo-*p* values were < .05.

Participants also suggested additional alternatives, including *tools for real-world awareness* (rank 4/10), *parent communities* (rank 6/10), *safe movement* (rank 3/10), and *accessibility for individuals with disabilities* (rank 3/10).

5.2.2 Inductive Themes

Theme3: Safety ranked first, but not reducible to parental control.

Concerns about safety were ranked as the most important priority in the most needed advances among parents and children. Whether it is learning, entertainment, or social experience, these system features are meaningful only when safety is guaranteed. Issues such as cyberbullying, harassment, inappropriate content, and scams were frequently raised in group discussions. Although some participants noted that safety issues in VR could be avoided through existing technical features (e.g., muting, exiting) or user actions (e.g., reporting), they emphasized that VR’s immersive nature can amplify harm and make safety more urgent than in traditional digital spaces. As one participant explained, “It (bullying in VR) could affect kids a lot, as it looks like it happened in real life.” [G42-C76] Harassment was also a major concern due to avatar anonymity: “There’s a lot of criminals that use that game...fake avatars, you don’t know their age unless they tell you. And if you have a girl voice, you’ll be harassed, even if you’re muted.” [G44-C79]

These concerns were often tied to worries about the lack of effective parental controls. As one youth explained, “I put these two to each other because they’re basically the same thing—parental control tools and safety monitoring. Because the whole point of both of them is to be safe for your kids, or whatever.” [G39-C68] While many saw these controls as a necessary safeguard, children frequently questioned their effectiveness and limits and ranked the tools of parental control lower. They emphasized that safety cannot rely solely on parental control, especially in immersive VR environments where risks emerge in real-time and can be social or emotional rather than purely content-based. Child participants called for protection that didn’t restrict their autonomy or enjoyment. One participant noted, “The stricter the parent monitoring, the less freedom of speech.” [G45-C81]

Theme4: Physical movement prioritized over fun and learning due to its link to health.

Physical movement was consistently prioritized across participant groups, often ranked directly after safety. Unlike items such as educational content or entertainment, physical movement was not viewed as a feature or enhancement, but as a necessary condition for maintaining health and avoiding harm. Participants drew direct connections between physical activity and overall well-being, treating it as a foundational support for other developmental needs. As one participant explained, “Physical health is kind of like a pillar to a lot of the things higher up on the list” [G2-P3], suggesting that physical health was not just one priority among many, but a prerequisite that enabled others.

This health-centered view of movement extended to concerns about inactivity in VR. One youth stated, “Physical movement is ranked before fun because you won’t be stuck sitting” [G2-C5], framing movement as a safeguard against sedentary behavior. VR was seen as potentially encouraging long periods of immobility, which participants believed could negatively affect children’s health over time. In this logic, if a VR experience compromises physical activity, its educational or entertainment value becomes secondary. In contrast, educational content was not assumed to be inherently valuable. While learning

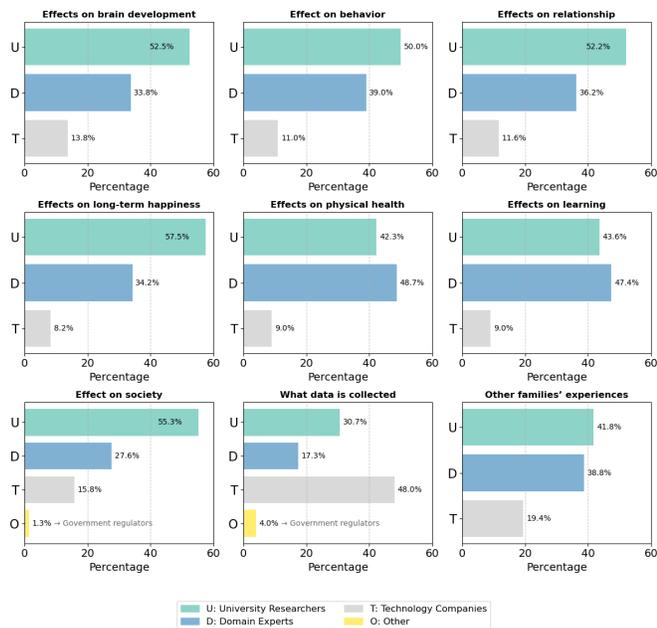


Fig. 4: Ranking of stakeholders responsible for delivering the most needed knowledge.

was frequently discussed, it was treated as a conditional benefit rather than an automatic one. Participants, especially parents, emphasized that VR-based learning must be supported by research evidence and implemented in ways that respect developmental readiness and avoid trade-offs with well-being. As one participant highlighted: "If educational content interfered with other priorities, like physical movement and mental health, it was more likely to be deprioritized." [G7-P7]

5.3 RQ3: Assigned Responsibility for VR Priorities

5.3.1 Overview of Responsible Actors

For the most needed knowledge (see Figure 4), for *effects on brain development*, participants generally believed that university researchers should be responsible (52.5%). This pattern was also observed in *effects on behavior* (50%), *effects on relationship* (52.2%), and *effects on long-term happiness* (57.5%). In contrast, for *effects on physical health* (48.7%) and *effects on learning* (47.4%), participants preferred domain experts to take responsibility. For *effects on society* (55.3%), university researchers were again seen as the most appropriate responsible party. When it came to *what data is collected*, participants overwhelmingly chose technology companies (48%). For *other families' experiences* (41.8%), participants believed that university researchers should be responsible.

For most needed areas for development (see Figure 5), participants assigned responsibility for key development areas as follows. For *safety monitoring*, they most often selected technology companies (36.7%) and domain experts (36.7%). For *support physical movement*, they preferred domain experts (37.5%). For *privacy protections*, they most often selected technology companies (54.4%), with some groups noting that government regulation should also be involved. For *educational content*, domain experts were seen as the most appropriate group (44.8%). For *tools for parental control*, participants most often selected technology companies (49.3%). For *social experiences*, participants preferred domain experts to take the lead (40%). For *make it cheaper and available to all* (75%), *enhance comfort for longer use* (59.2%), and *more realistic graphics* (76.7%), participants overwhelmingly assigned responsibility to technology companies.

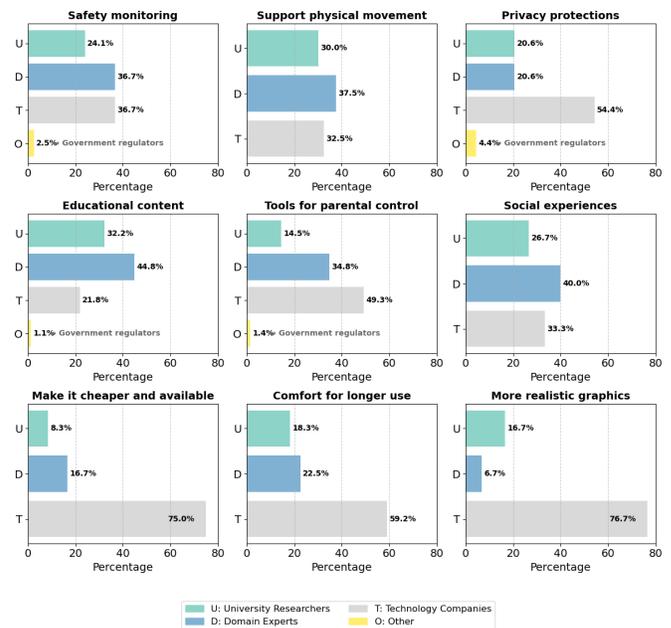


Fig. 5: Ranking of stakeholders responsible for the most needed advances.

5.3.2 Inductive Themes

Theme5: Low trust in tech companies calls for open collaboration

While participants recognized the important role technology companies play in shaping VR experiences and believed they should take responsibility for many aspects, they also voiced trust issues about these companies' motives. It was often rooted in specific critiques of how companies might frame their technologies. One participant reflected, "I don't think technology companies should do a lot of things on this side (most needed knowledge), because a lot of the time, they just... kind of just want to make more money" [G9-C12]. Another participant extended this concern that commercial interests often conflict with child-centered goals, suggesting that companies might be selective in how they present information about VR's effects: "They're gonna make their money by selling more technology, not what's best for kids" [G4-P7]. This distrust led many participants to question whether tech companies alone could be responsible for evaluating and communicating the risks and benefits of VR. Instead, they called for shared responsibility and external input from more trusted parties. As one teen noted, "I don't trust the tech companies... but that doesn't mean they shouldn't be doing it. They just need help from schools or researchers" [G3-P4].

In discussions about data collection and privacy, participants often expressed a sense of resignation about tech companies' power: "They already know what we do" [G17-C19], "It's just how things work now" [G11-P14]. Yet, rather than apathy, these statements often led to appeals for better safeguards and clearer lines of accountability. One participant argued, "Tech companies have too much control... they need to get input from schools and nonprofits" [G18-C21]. Importantly, collaboration was not framed merely as a desirable ideal, but as a pragmatic necessity. Participants recognized that no single actor holds all the expertise or public trust to address the ethical, technical, and developmental needs of child-centered VR. Instead, they envisioned a model of governance where industry builds, research informs, and public institutions guide and protect.

6 DISCUSSION

6.1 Reflection on Alignments and Gaps Between VR Literature and Most Needed Knowledge

Our study contributes to VR community by foregrounding children's and parents' perspectives in generating agenda items and shaping research priorities for children's VR use. To examine whether the prioritization aligns with the amount of the existing literature, we try to align terms and compare our findings with those reported in a recent systematic review by Kaimara et al. [33] in this section. This review categorized 85 peer-reviewed studies on the risks of VR use for children into three developmental domains: physical (N = 28), cognitive (N = 38), and psychosocial (N = 29). In our study, participants also prioritized knowledge related to these areas (from brain development to learning) but additionally emphasized topics such as effects on society [23, 32], what data is collected [12, 32], and other families' experiences. Since the last three topics were rated as less important by participants, we focus our analysis on the top-ranked areas.

Physical Development: Kaimara et al. found that the most frequently studied concerns included cybersickness, obesity, sleep disruption, and visual symptoms. These concerns are echoed in our data, but participants in our study did not focus on these symptoms as isolated issues. Instead, they framed brain development as a foundational knowledge that affects all other aspects of VR use. However, only one study in Kaimara's review explicitly mentioned brain-related physiological effects due to radiation exposure of VR [19]. While families express strong concern about developmental impacts on the brain, empirical research has rarely focused directly on these mechanisms.

Cognitive Development: Most studies in the cognitive domain focused heavily on learning outcomes and attention (e.g., ADHD management [35], cognitive task training [49]). In our study, learning was discussed, but was less important than the rest of the topics and noted the trade-offs with well-being. This contrasts with the more optimistic tone of many existing studies that highlight motivation and engagement as clear benefits of VR-based learning.

Psychosocial Development: Kaimara's review highlighted concerns around addiction, anxiety, emotional regulation, and social behavior. These themes were also salient in our data. However, families in our study connected psychosocial risks to broader, long-term outcomes like behavioral regulation and happiness, which they felt were influenced by underlying brain and behavioral changes. Our results also suggest that children and parents often view these risks not as isolated outcomes but as interconnected effects that shape daily life, relationships, and emotional well-being. This holistic framing is less visible in much of the existing literature, which tends to examine these concerns in narrower clinical or behavioral terms (e.g., [51, 69]).

Our findings highlight a potential misalignment between current research emphases and user priorities. Although Kaimara et al. identified key areas of concern, many of the most prioritized knowledge needs identified in our study are underexplored in empirical work. Our results suggest that future research should not only address these gaps but also approach developmental impacts as interconnected, rather than treating physical, cognitive, and psychosocial effects as discrete domains.

6.2 Opportunities and Challenges for VR Research

Building on our results, we outline several opportunities and challenges for advancing VR research for children and families:

6.2.1 Account for unknown effects on brain and behavior

Our participants ranked effects on brain development and behavior as the most important knowledge to know. Most VR research is short-term studies (e.g., [1, 35, 49]), yet parents and youth value the knowledge about how long-term use may affect brain or cognitive development and behavior. This presents an opportunity to investigate the long-term developmental effects of VR use in children. However, ethical and practical constraints make such longitudinal VR studies for children especially challenging to conduct. We encourage future VR research to pursue interdisciplinary collaborations with developmental scientists to design age-appropriate protocols, help enable more ecologically valid

exposure patterns (e.g., repeated home use), and interpret potential impacts across cognitive and behavioral domains.

6.2.2 Expand outcome measures of social-emotional and physical well-being

From the results of RQ1, participants consistently placed emotional well-being, behavior, and social interaction above traditional educational outcomes. This priority sits alongside prior work showing that children engage with VR in everyday and social contexts (e.g., [42, 45]), where experiences can produce both benefits (e.g., connection and enjoyment [32]) and harms (e.g., harassment and other negative social experiences [6, 33]). At the same time, RQ2 shows that supporting physical movement was prioritized immediately after safety monitoring, with participants framing it as a health need to reduce prolonged sitting in VR. This suggests that children's VR should be evaluated as a combined social-emotional and physical environment rather than primarily as a content-delivery platform. Future work should broaden outcome measures to capture (1) emotional and social benefits and harms and (2) whether VR use supports movement or reinforces sedentary patterns, and link these outcomes to design choices in home use.

6.2.3 Parental controls to ensure safety vs. motivations that make VR appealing to children

Prior work [32] highlights a tension between children and parents: children often report more positive attitudes toward VR than their parents, including for use scenarios that parents worry may have negative effects. Our findings of RQ2 show that children did not outright reject safety mechanisms such as parental controls or monitoring tools. Instead, they emphasized that these tools should be supportive without undermining their sense of autonomy. Future work could design parental controls that create collaborative and teachable moments [12], such as making constraints transparent to children and supporting age-appropriate negotiation.

6.2.4 Establishing trustworthy data and research policies

We found that participants expressed two views in parallel (see Section 5.3.1): they often pointed to technology companies as the actor most able to deliver many most needed advances in child-centered VR, while also noting that no single actor is likely to have all the needed expertise and public trust to address families' concerns end to end. Rather than treating these as conflicting, participants described a division of roles: industry builds, research informs, and public institutions guide and protect. This implies VR product experiences that make safety and data practices understandable and usable in everyday family contexts [12] (e.g., plain-language disclosure, accessible privacy controls, and defaults that minimize data unless families opt in). On the governance side, it implies mechanisms that allow claims about safety and privacy to be checked beyond the platform itself: independent research that evaluates long-term impacts and tests whether safeguards work as intended, and public standards that clarify baseline expectations so families do not have to infer them on their own.

6.3 Limitations and Future Work

Recruitment at a single public event may introduce self-selection and limited demographic diversity. Within sessions, groups were formed by availability and interest rather than random assignment, resulting in unbalanced group sizes and participant differences (e.g., age, prior VR exposure) that could influence rankings and responsibility assignments. Future research should diversify recruitment settings to broaden participant representation and use stratified quotas or randomization within time slots. Second, the short duration of sessions likely constrained deeper reflection and nuanced discussion of the complex prioritization trade-off, and also limited participant-generated alternatives and how broadly these could be shared across groups. In addition, some session audio was not fully intelligible, resulting in occasional transcript gaps that may reduce qualitative evidence for certain themes. Future work could run longer or repeated sessions, integrate the tasks with more open-ended participatory methods (e.g., workshops, speculative scenario building, storytelling [36, 70]), and strengthen data capture (e.g.,

sound checks, overlap-reducing facilitation, plus backup notes or brief post-session reflections).

This study did not specifically investigate differences in the prioritization of those VR topics by age group or participant role, as they were not targeted research questions in this study. Age reporting was optional; participants could self-identify as parent or child without providing their exact age. As such, we did not control for balanced representation across age groups. Some participants also chose not to report their own or their child's age, further limiting our ability to conduct reliable subgroup comparisons. We consider this a valuable direction and encourage future work to explore these differences in greater depth. Also, this study focused on setting the agenda for VR research topic, relevant technological advances, tools, and content. However, such agenda-setting faces practical challenges [39]. A key issue is that many "best practices" in VR design are not readily accessible or consistently used by participants, potentially affecting how they prioritize alternatives. Future work should build on this agenda by introducing recent developments or conducting longitudinal evaluations to examine how priorities may shift in more informed contexts.

Finally, we recognize that our study did not provide participants with a predefined academic taxonomy or detailed explanations of each term, a limitation that could be a valuable direction for future work. However, this design choice aligns with our goal of eliciting unprompted, authentic perspectives rather than leading participants toward established scholarly frameworks. We believe our findings still offer a unique and valuable insight into how non-experts frame their concerns.

7 CONCLUSION

This study offers end users' perspectives on priorities and responsibilities in home-based VR by foregrounding the voices of children and families. Through a mixed-method approach, we identified the prioritization of what families most want to know, what they believe must be built, and who they trust to act. Our results show that participants prioritize the knowledge of impact on brain development and behaviors as the most needed knowledge, as they influence other concerns like mental and physical health, also learning. Participants ranked safety monitoring as the most needed technological advancement, viewing it as foundational to all other features. Beyond identifying concerns, this study also articulated expectations for institutional responsibility to address the priorities. There was widespread skepticism toward for-profit tech companies and a desire for leadership from domain experts from schools and hospitals, researchers, and non-profits.

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