A Novel Approach to Extended Reality EULA Presentation for Improved Child Safety

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Abstract. As an emergent technology, XR poses new risks to users. As they are currently designed, EULAs fail to effectively communicate these risks to users. The resulting lack of information can be especially harmful for children, who may be more susceptible to online risks and cannot be expected to make informed decisions in their best interest. This research focused on developing new guidelines for presenting the information contained in XR EULAs to children. We analyzed sample XR application EULAs ($n = 18$), focusing first on how difficult they are to read followed by what concerns should be communicated to the user. This work motivated the final guideline design, which details a novel method for improving EULA display, and demonstrates a prototype EULA with our guidelines applied.

CCS Concepts: • **Security and privacy** → *Usability in security and privacy*; • **Human-centered computing** → *Mixed / augmented reality*; **Virtual reality**.

Additional Key Words and Phrases: XR, Virtual Reality, VR, Augmented Reality, AR, End User License Agreement, Children, Readability, Child-Computer Interaction

1 Introduction

Extended Reality (XR) is a rapidly developing field of technology which poses unique physical/mental health and privacy risks for children [8, 11]. Unfortunately, these risks tend to be presented only through applications' End-User License Agreements (EULAs), documents which are often dense, linguistically complex, and filled with legal jargon [6]. These issues affect children more than other users, as they tend to have less developed linguistic proficiency skills. However, no research has yet addressed the information disparity between children and developers created by XR application EULAs.

Previous literature has focused on techniques to improve EULAs for adults. Researchers have employed methods like paraphrased or summarized agreements [6, 19], representative pictograms [13], or "textured agreements" [14], among others. A few works even focused on automated EULA simplification [17, 18]. However, research has not focused on whether these techniques are effective for children. Furthermore, the transfer of EULAs into an XR environment changes how text is shown to the user. EULAs in XR tend to be displayed as a scroll-able, floating wall of text. Although some research has been done on child textual consumption in XR [22], it has not focused on possible presentation variants.

In this paper, we take several steps towards improving child understanding of EULA content. We do so by addressing three research questions:

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RQ1. **How difficult are current EULAs to understand?**
EULAs seemed difficult to read, but current literature lacked a concrete understanding of just how advanced the texts are. We wished to quantify the readability level of XR application EULAs through the use of various readability algorithms. There are many such algorithms, from the popular Flesch-Kincaid [10] to the more niche SMOG Grading [16]. We chose six of the algorithms that had been identified as the most effective across various levels of document difficulty [1] to run on sample EULAs. This resulted in a clear quantification of EULA readability, and motivated our further work.

RQ2. **What user risks and rights are commonly identified in XR application EULAs?**
To present EULA content to children more effectively, we needed a strong understanding of what content they should be informed of. Some previous literature had surveyed adults about what they perceive to be the primary concerns during child use of XR [11, 9], but no literature tackled concerns mentioned in application EULAs. To answer this question, we used a combination of manual and semi-automated techniques to read and analyze sample EULAs ($n = 18$) for common themes. Through this work, we collected a comprehensive list of EULA themes and their frequencies of occurence.

RQ3. **What guidelines can simplify XR EULAs in line with the specific needs of child users?**
We undertook development of guidelines for a more effective EULA presentation style in XR. Based on our work for RQ2, we extracted the most important information from each EULA. We then described detailed instructions for creating an effective EULA to communicate information to child users. Finally, we developed a prototype EULA and applied our guidelines to create an interactive EULA display in XR.

2 Background/Related Works

2.1 Concerns About Extended Reality

Because XR technology is an emergent and developing field, there are many under-researched concerns [9]. Parents especially have a wide range of concerns about their children's safety [8, 11]. Jin et al. conducted a study at a Minnesota state fair, finding that while parents are generally optimistic about the technology, they tend to be worried about possible downsides. These fears came to light when parents were shown scenarios of XR technology being used in potentially harmful environments, such as a family sitting together, each lost in their individual XR world.

Some of the most common fears that were identified in previous literature are online harassment [5] and possible risks to privacy, which is of particular concern in the realm of XR due to the large amount of data collected. Tracking data on user behavior and movement, for instance, can be used to re-identify users, who are also largely unaware of the sensitivity of this data. [21, 20]. This demonstrates the importance of increasing user awareness of what data is being collected and how it is used. Other recognized concerns include nausea, eye strain, and physical risks from the movement aspect of XR [11]. As the field develops, concerns are becoming better understood, but there is still much room for improvement.

2.2 Techniques for Accessible EULAs

Previous studies explored a variety of different approaches to craft more readable and accessible EULAs. Textured agreements, first presented in 2010 by Kay and Terry, modify traditional agreements through the use of typographic manipulations (highlights, headings, etc.), and make important information more visible with factoids and symbols. The modified agreements were

promising–comprehension scores increased for textured agreements when compared to traditional ones [14].

Schneider and Garnett expanded upon this work and examined automation of textured agreements. They created ConsentCanvas, a system that identifies relevant phrases and adds texture to EULAs automatically using regular expressions and correlation functions [18]. ConsentCanvas was not formally evaluated and ultimately had mixed results. Out of 15 documents chosen for a preliminary evaluation, five were found to be highly readable. The remaining ranged from satisfactory to having multiple errors that led to a decrease in readability.

Kay and Terry also developed a system of pictographic summarization of risks identified in online agreements [13]. Using sets of comic-inspired images, they portrayed methods an app might employ to collect and use user data. This allowed for the potential of communicating warnings through language barriers, but required significant effort by the developer and the resulting pictographs were often misunderstood by users.

One common method studied by researchers was summarized or paraphrased EULAs [6, 19]. Good et al. found in a study on 222 subjects that users were significantly less likely to complete installation of three test programs when presented with a summary of risks either before or after install [6]. They found that a summarized EULA tended to significantly increase reading time of the EULA compared to the control where users often skipped the agreement completely. However, summarized EULAs have the added downside of not giving users complete context for the agreement [14], so cannot be viewed as a perfect replacement.

We found that there is a dearth of child-centered research about EULA readability. Almost all previous literature has focused on how adults engage with EULAs and methods for improving engagement.

3 Methods

Our research was conducted through three related sub-studies, with the results from each inspiring the methodology for the next. The research was performed in a semi-linear process, with previous findings contributing to the next topic. In this section, we present the tools and methods used for each sub-study in the order they were conducted.

3.1 Readability Analysis

Our first sub-study aimed to evaluate how difficult XR application EULAs were to read. We first selected 18 sample EULAs which were popular among child users. We decided this based on online sentiment around the applications. We split each EULA into two sections[1], Terms of Service and Privacy Policy, for ease of application of our methods. Additional effort was made to 'clean' the text files to better use them with our algorithms. A custom web scraper and text cleaner were created for this. We then found six unique, popular algorithms to assess readability of documents:

- Coleman-Liau [3] calculates grade level based on the number of sentences per 100 words and letters per 100 words.
- SMOG Grading [16] selects random sections from different points in a document and counts the number of polysyllabic words (at least 3 syllables).
- Gunning-Fog [2] combines average sentence length with percentage of words in the document that are polysyllabic.
- Flesch-Kincaid [10] uses the average number of syllables per word as well as the average sentence length in the document.

[1]We did not split the Superhot EULA, as the text was too short. We divided the McGraw Hill EULA into three sections: Terms of Use, Terms of Service, and Privacy Policy

- Dale-Chall [4] combines average sentence length with percentage of words not in an "easy word" list.
- Spache-Allen [1] is a similar algorithm to Dale-Chall with different coefficients and a different word list that tends to be more comprehensive. We ran two variants of Spache-Allen: one with an "easy word" list of length 1,000, and one with the intended "easy word" list of length 67,000.

Each of these algorithms takes a document and returns a grade level difficulty. We wrote Python scripts that ran each readability algorithm on a provided document. Finally, we fed each of our 18 EULAs into the readability algorithms and collected the results. To counteract the randomness of SMOG Grading, we ran each EULA 100 times and averaged the grade level result.

3.2 Thematic Analysis

Next, we performed thematic analysis on the same 18 XR application EULAs. We began by reading through each EULA manually, noting every time either a potential user risk or a user right was mentioned. When we had finished our initial collection, we began a discussion phase. Based on our observations, we created five overarching categories for our risks/rights: Kids, XR/Physical Safety, Liability/Waivers, Data, and Other. Within those categories, we sorted each of the risks/rights that we had manually collected, combining any with significant overlap. We discussed the results, iterating on our findings until we had a comprehensive list. With this list, we moved on to the semi-automated qualitative analysis phase.

In this step, we used MAXQDA to search through our EULAs. We first entered our user risks/rights into the software as a list of codes. We then developed a list of keywords corresponding to each code. For example, "epilepsy" and "seizure" corresponded to the epilepsy code. We added each of these keywords to a MAXQDA "Dictionary". Doing this allowed us to search each EULA manually for each keyword, and automatically assign the matching code to sentences containing that word. We then checked each coded sentence manually to remove any false positive sections.

During this process we checked for keywords that we had missed and any adjustments that should be made. We discussed our results and observed the frequency of each code to determine if any should be split into smaller or more specific codes. We then repeated the same process with our updated list of codes and keywords. From our resulting coded documents, we collected the number of EULAs that each code appeared in. We also used MAXQDA to analyze frequency of word appearance across all the EULAs. We adjusted the results slightly by removing common words that supply no information (e.g. the, it, as) and any brand names.

3.3 Guideline Development and Prototyping

Based on our work for RQ2, we developed guidelines to present information contained within a EULA to the user. Through iterative discussion and experimentation, we arrived at a formalized set of instructions to construct a EULA display from any XR EULA. These instructions require identifying whether a collection of themes appear within the EULA. We paraphrased each of these themes to be readable by children, then paired them with a representative icon inspired by Kitkowska et al. [15].

We then created a VR scene to demonstrate the guidelines. The user is placed within a 'EULA room' before they can access the desired application. Within this scene, each section of the guidelines has its own dedicated area. Each section includes an interactive object that is thematically linked with the topic (1). For example, the Data section is presented on a large computer, and the Kid-specific section is placed on an easel. On the computer screen is a list of all information that the

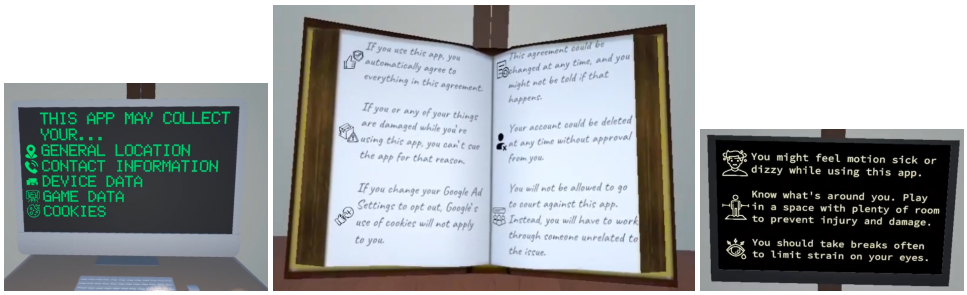

Fig. 1. Objects in XR displaying risks and rights for users. Computer: Data collection, Book: Miscellaneous, TV: Physical/mental health. See Appendix A for list of all concepts, icons, and icon image credit.

application is allowed to collect, which the user can scroll through. These diegetic uses of the guidelines aim to increase the user's comprehension of the EULA.

This 'EULA room' scene was developed in Unity for use in VR. The visual aesthetics of the room were a greater priority than the functionality. When choosing the object to use for each section, additional consideration was also put into the interactivity of the object. For example, a book is included rather than floating text, to give the user the appearance of interacting with real objects.

4 Results

Our results consist of our EULA readability analysis, our thematic analysis, and our guidelines. The analyses are used to not only better understand the risks presented to the user, but also to help influence our guidelines in an effective and positive direction.

4.1 Readability Analysis

We collected the results from our readability analysis, sorted by readability algorithm, and took the average grade level that they returned. Five out of seven algorithms returned a grade level from 11-16. Both Spache-Allen algorithms were significantly lower, with the 1,000-word model averaging 7.86 and the 67,000-word model averaging 6.11 (2). We chose to ignore those algorithms, as previous research has shown that Spache-Allen is most effective on documents intended for fifth grade and below, tending toward inaccuracy for reading levels ninth grade and above [1]. The variance between the other algorithms can likely be explained by differences in how they are formulated.

These results demonstrate that the reading level of EULAs is generally unsuitable for child readers. Moreover, 28% of U.S. adults read at the lowest PIAAC reading level [7]. This suggests that EULAs are often unreadable for even an adult audience. In some cases, EULAs scored even higher. For example, the McGraw Hill AR Terms of Service reached an astounding 19th grade reading level. Only a small percentage of the population can parse such complex documentation.

These results answered Research Question 1, and provided us with further motivation to work towards Research Questions 2 and 3.

4.1.1 TOS vs. Privacy Policy Readability. Software providers often have separate terms of service and privacy policy documents. Terms of service include rules to use the service, as well as information about liability and user conduct. Privacy policies primarily inform the user how their data is being collected, stored, and used by the service. We sought to determine if there was a difference in readability between the two– a significant difference could suggest designing guidelines differently for various document types.

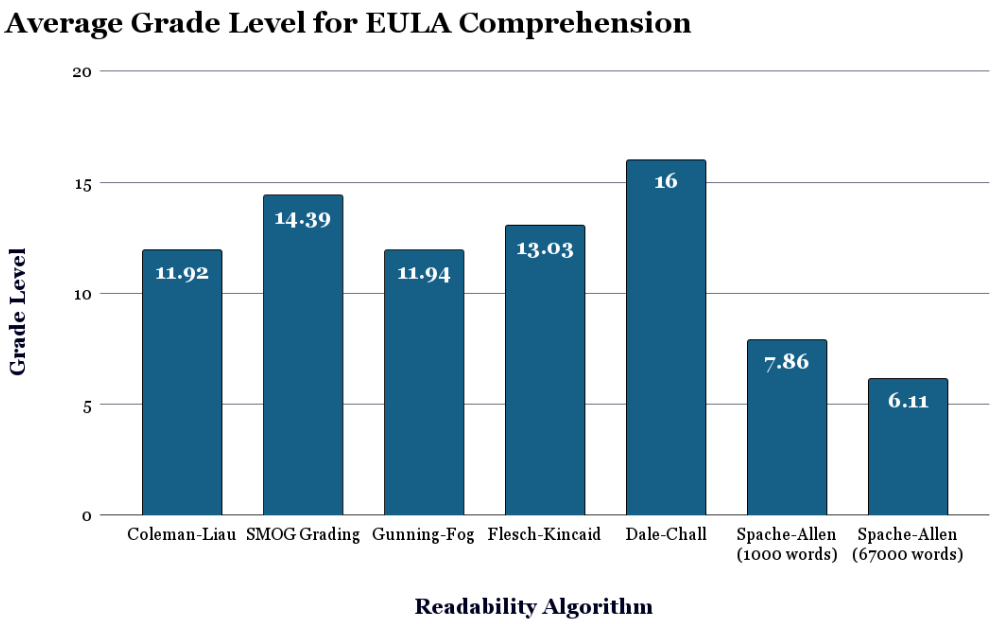

Fig. 2. Average grade level of 18 sample EULAs under each readability algorithm.

A Wilcoxon rank-sum test to compare the average readability scores of each readability formula for each terms of service and privacy policy document indicated that there was no significant difference in the average readability, $W = 219, p = 0.07053$ (3). This suggests that terms of service and privacy policy documents are of similar difficulty to read and led us to take a general approach during guideline development.

4.2 Thematic Analysis

The results of our thematic analysis paint a picture of which user risks/rights appear most often in EULAs (4). A few codes appeared in every EULA we analyzed: warnings about how long data would be retained, warnings about how it was stored, a waiver for damages, and a notification about how the agreement could be changed. Several others appeared in most EULAs, and every code we identified appeared in at least three. This indicates that EULAs tend to share much content between applications.

Of special note for our project was the prominence of mentions of minors. 17 out of 18 EULAs specifically referenced underage users in their documents. This makes it clear that developers believe it necessary to prepare for the eventuality of children using the applications. Hence it is important to provide children with an effective understanding of their risks and rights when using the application.

The word cloud (5) also informed our understanding of these documents. We observed that many of the most common words–"information", "personal", or "datum", for example–come from the privacy policy rather than the terms of service. This indicates a stronger overlap of content between different privacy policies than terms of service. It also demonstrates an emphasis on user data, a field that young users likely have trouble understanding. We also noticed that "child" and "age"

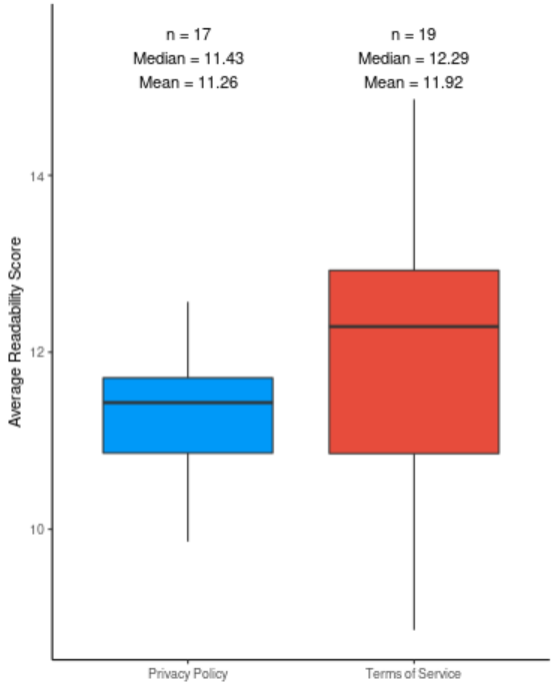

Fig. 3. Comparison of privacy policy and terms of service readability scores.

both made it into the top 100 most common words; another indication that there is information in these documents that children should read.

4.3 Guideline Development and Prototyping

After developing our guidelines for EULAs, we compiled our work into one document. The guidelines include specifications for what sections the EULA should be divided into and what content should be included in each section. These sections are child specific concerns, data collection, data usage and sharing, data retention and security, physical and mental health concerns, and miscellaneous concerns.

Each topic within these sections must also have a child friendly summary and an associated icon. These summaries and icons can be seen on the attached table in Appendix A. For these guidelines, we found related icons online. However, we recommend that any further research using these guidelines designs their own icons, ideally with help from child developers using co-design principles [12]. These icons help the user understand the content and work to retain reader attention.

Each section is placed on an object that represents its respective category. The user must navigate to each section, where they are given a display of the summarized EULA after interacting with the object. Once they have worked through all information in the 'EULA Room', the user is finally presented with the complete EULA. This guarantees that all information from the EULA is presented to the user and avoids any legal issues.

If the user is under the age of 13, a complete copy of the EULA is also automatically sent to their parent or guardian. To demonstrate these guidelines, we developed an example EULA on which to apply the guidelines. This new EULA, for the fake VR video game *Busters Big Adventure*, was put

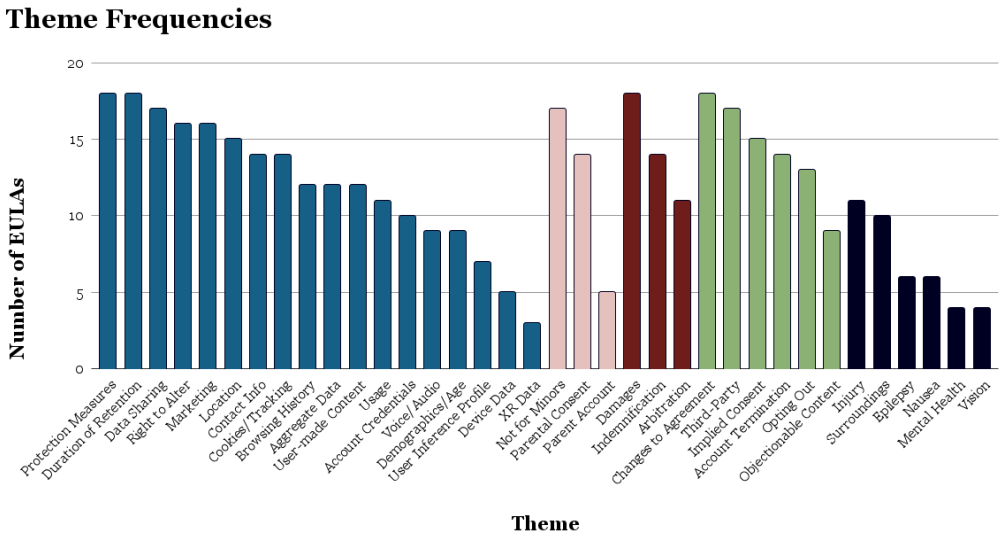

Fig. 4. Number of occurrences of each code. Codes are divided by higher-level category.

Fig. 5. A word cloud of text in our 18 sample EULAs. The larger the word is, the more often it appeared in the documents.

through the same processes that a developer would go through to adapt their EULA to a younger audience. We include some images from our XR prototype (1). For the full guidelines, see Appendix A.

5 Conclusion and Future Work

Notably, we found that XR application EULAs are not realistically readable for most children. Although unsurprising, this provides quantitative evidence that further safety measures must be implemented to protect children from exploitation online, even from large or well-known developers. This motivated us in our proposal of a set of guidelines for XR developers that can be applied to EULAs to create child-friendly EULA presentations.

Although we did our best to center children's needs in our design process by adhering to child-computer interaction, usability, and user experience principles [12], time limitations prevented us from working directly with children. Future studies should implement co-design principles by working with children to improve our design. By collaborating in this way, problems that may not be immediately apparent to adults can be identified and improved. It also bridges gap in understanding between adult researchers and younger developers.

Furthermore, studies should be conducted to compare our guidelines–or similar structures resulting from co-design sessions–to existing EULA presentation methods. Data should be gathered to assess the efficacy of this method for communicating information to child users. Through such studies, these guidelines should be assessed and iterated upon several times.

As a result of time and resource constraints, the interactivity of our guidelines was limited. We suggest that further "gamification" techniques could be implemented to improve our guidelines towards maximizing child interest and recollection. XR offers many unique tools, so further research could employ game developers who are experts in maintaining user attention.

As XR technology continues to develop, guidelines will need to change to fit the needs of children. XR is a rapidly developing technology, which means that any guidelines that work now may not work in the future. Long-term review could be important towards continuing to protect child interests, especially as new technologies–like AI–emerge, develop, and interact with XR.

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A Guidelines

We herein propose a novel method for presenting EULAs in a more child-accessible format:

EULA content will be divided into six subsections:

- Concerns that are specific to children.
- Types of data that are being collected.
- How data is used by the service, who it is shared with, and in what circumstances it is shared.
- How long stored data is retained for, and how it is protected.
- Any physical/mental health concerns related to use of the service.
- Other concerns (Account termination, objectionable content, liability, etc.)

We provide a list of information that should be presented to the user.

Each section shall be presented as a "summary" of all relevant content:

- Each piece of information shall be displayed on its own line.
- Each piece of information shall be represented by a relevant "icon" as an attention and understanding aide for the child reader.
- The user may only continue to the next section after a short waiting period as to dissuade skipping the content

The original EULA shall be shown in its entirety after the child-accessible format is presented.

A full copy of the EULA will be sent to the associated parental email for the user's child account.

A.1 Visual Guidelines

Setting

- The user will be placed in a "EULA display room" separate from whatever VR location they were previously in.
- Room decor will be minimalist to avoid distracting from the agreement
- Each item around the room will correspond to a section of the EULA.
  - An easel will display child-specific risks.
  - A computer will display data concerns (all three data sections)
  - A large TV screen will display physical risks.
  - A large book will display miscellaneous concerns.

User options:

- Interact with the current summary item.
  - Pressing on the current summary item will display the related summary.
  - After a summary item has been interacted with, the user will be able to interact with it again and see the summary for the rest of the time spent in the EULA room.
- Back button
  - Pressing this button will exit the user from the current summary.
- Exit button
  - Pressing this button will exit the user from the EULA room.
  - The user will not be able to download the application without completing each summary section in the EULA room.
  - This button will always be available.

At the end of this document, we provide a list of relevant concerns and accompanying icons that should be included in a kid-friendly EULA.

A.2 EULA Display

Introduction

- The user will be teleported to the EULA display room.
- The user will receive an explanation of the experience that is beginning.
  - “Read the hidden messages around the room and learn your rights as a user of [x] application!”
  - "Warning: these summaries may not contain all important information.”
- The user will be warned that some relevant information may not appear in the summaries.

Summaries

- Each summary line will consist of the “child-friendly wording” and “icon” from the appended table.

Full EULA

- The EULA in its entirety will be presented after the user has moved through all the summaries.
  - In case there are any details the summaries fail to present or the user missed, this gives the user one more chance to recognize any concerns.
  - This avoids legal issues for the developer by ensuring that the user is presented with the full legal agreement.
- The full EULA will also be emailed to the child’s parent/guardian.

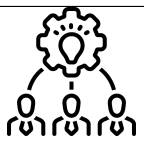
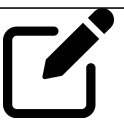
Opportunity to Back Out

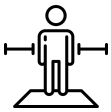
- After completion of the displayed EULA, the user will be given a chance to back out of the app download.
- If the user chooses not to back out, they must check a box indicating that they have read and understand the contents of the EULA.

A.3 User Concerns Table

Category	User Risk/Right	Child-friendly Wording	Icon[2]
Child-specific Concerns	Children under x age are not permitted to use this service.	If you are less than x years old, you are not allowed to use this app.	
	Parental consent must be provided for children under x age to use this service.	If you are less than x years old (or not an adult), you should ask your parent/guardian to look through this agreement with you.	
	Children under x age must have a parent-controlled account to use this service.	If you are less than x years old (or not an adult), you should use an account managed by your parent/guardian	
Data Collection	[The service will collect…]	[This app will collect…]	
	Approximate location / IP address	Your general location and IP address.	
	Usage data	Information about what you do on the app.	
	Contact Information	Your contact information.	
	XR Data (movement, eye tracking, facial expressions)	Information about your [movement, eye movement, facial expressions, etc.]	
	Demographics / Age	Information about your [age, ethnicity, etc.]	
	Voice / Audio	Recordings of your voice while you use this app.	
	Browsing History	This app might track what websites you have visited recently.	

[2]All icons found on flaticon.org. Credit to Prashanth Rapolu 15, Iconjam, Freepik, Gregor Cresnar, andinur, Lagot Design, Ongicon, Three musketeers, Sympnoiaicon, Those Icons, Smashicons, Pixel Perfect, AomAm, Irakun, SBTS2018, bsd, ibrandify, Mohamed Mbarki, zero_wing, Prashu Rapol, and mia elysia on flaticon.org.

	Cookies/other tracking methods	If you visit [website], we might store data to remember information about your visit.	
	Device Data	Information about the device you are using.	
	Aggregate Data	Information that can't be connected to you.	
Data Usage and Data Sharing	The service may/may not sell your data.	This app [might, will not] sell your personal information.	
	The service may construct a user "profile", connecting and inferring personal data about you.	This app might create a user "profile" from your personal information to store and guess things about you.	
	The service may use your information to market more effectively to you.	This app might use your personal information to show you ads for products you're more likely to buy.	
	The service may share your information with third-parties to assist with running the service.	This app might share your personal information with other apps to help run the service.	
Data Retention and Protection	Your data will be retained for x amount of time. [for any data types with a different retention span, there should be a new summary item]	Your personal information will be kept by [company/service] for x amount of time.	
	Your data is protected with x measures.	Your personal information is protected by x.	
	You have the right to alter or delete your stored personal information.	You can change or delete your stored personal information.	
Physical and Mental Health Concerns	Nausea / Dizziness	You might feel motion sick or dizzy while using this app.	

	Physical Space Concerns	Be aware of your surroundings. Play in a space with plenty of room to prevent injury and damage.	
	Eye Strain	You might feel strain or pain in your eyes when using this app.	
	Seizure/Epilepsy	This app could trigger a seizure if you have epilepsy.	
	Take Frequent Breaks	You should take breaks often while using this app.	
Other Concerns	This EULA may be changed at any time, the service [will/will not] update you at such a time.	This agreement could be changed at any time, and you [will/might not] be told if that happens.	
	Your account may be terminated at any time at the sole discretion of the service.	Your account could be deleted at any time without approval from you.	
	You waive your right to a trial by jury.	You will not be allowed to go to court against this app. Instead, you will have to work through someone unrelated to the issue.	
	You waive your right to join a class action suit.	You will not be allowed to sue this app along with other people. Instead, you will have to work individually through someone unrelated to the issue.	
	By using the service, you consent to everything contained in the EULA.	If you use this app, you automatically agree to everything in this agreement.	
	You can opt-out of x agreement by doing y.	If you do y, x will not apply to you.	
	The service is not liable for any damages stemming from use of service.	If you or any of your things are damaged while you're using this app, you can't sue the app for that reason.	

	The user may be exposed to objectionable content.	You might encounter rude language or other content.