EyeFind is a smart, IoT connected, interactive educational toy for outdoor use which encourages curious minds to safely explore and develop new interests.

EyeFinder is the guardian controlled safeguarding app, designed for smartphones, that connects to registered EyeFind and monitors their wellbeing during product use and to observe the progress of their educational confidence.

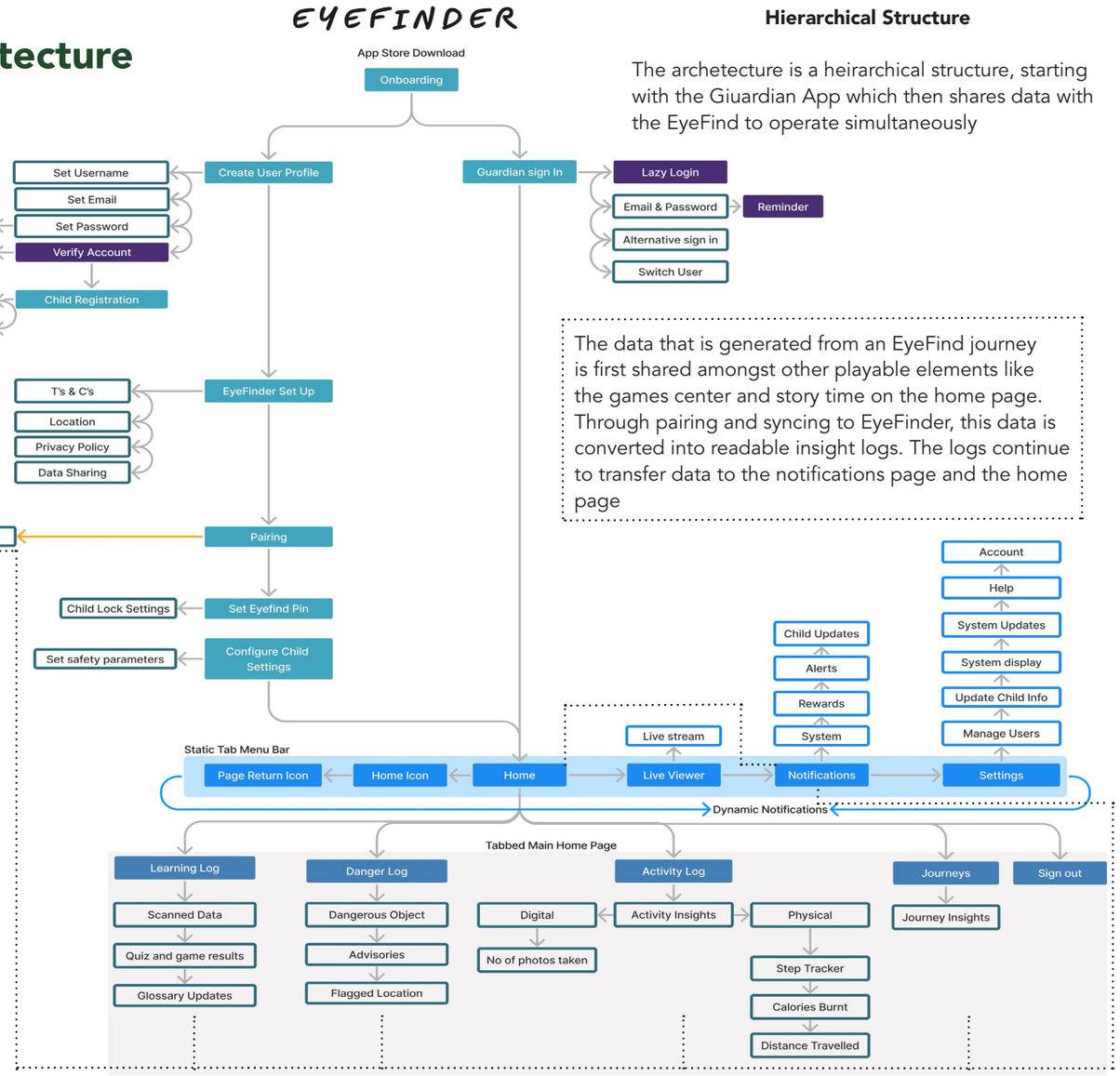
Interest based learning provides an inclusive experience to all individuals, regardless of personal differences, as it is acknowledged that education is not a one size fits all model (Özarslan, 2010). It is proven that such learning improves cognitive function and has a positive impact on learner motivation and future user intentions (Alexander et al., 1995). EyeFind's inclusivity extends to children who are deaf, dyslexic, colourblind, ADHD, mute, neurodivergent or just solitary learners.
"Interest is a powerful motivational process that energizes learning and guides academic and career trajectories" (Renninger & Hidi, 2016). EyeFind encourages the 4 stages of the development and deepening of learner interest: triggered situational interest, maintained situational interest, emerging individual interest and well-developed individual interest.

Layout

The Information Architecture shows the proposed navigation of the system hierarchy and highlights the point at which real time data is being generated and synchronised between the two apps to provide safeguarding and insights.

Key

Information Architecture



Hierarchical Structure

The archetecture is a heirarchical structure, starting with the Giuardian App which then shares data with the EyeFind to operate simultaneously

The data that is generated from an EyeFind journey is first shared amongst other playable elements like the games center and story time on the home page. Through pairing and syncing to EyeFinder, this data is converted into readable insight logs. The logs continue to transfer data to the notifications page and the home page

Stakeholders

Educational Providers

Parents, Guardians and Carers

Focused Target Market are 8-10 year olds

The key stakeholders are the children who can explore new interests using EyeFind. Secondary stakeholders are guardian, responsible for the wellbeing of their child including those who home educate and in the wider scope, educational providers who are invested in quality education.

AI Nudge Theory

AI uses large amounts of data to provide personalized, dynamic feedback and interfaces (Lanzing, 2019, p. 549; Yeung, 2017). Such nudging tools are the result of reinforcement learning systems that constantly adapt to the behaviour of users in ways that are often unpredictable (Sætra, 2019; Yeung, 2017). The AI companion collates data on the behaviour of its user, understanding the things they are interested in and what they are drawn towards to modify itself so as to be appealing to its child. This is to encourage user engagement, where unconsciously the child associates going outdoors and exploring as having fun with their AI 'friend' and sees incentives from doing this through rewards, games and stories. The benefit of AI is that is acts as a mediator to mitigate risk to the user. In the case of EyeFind, AI is used to shape the educational experience for children whilst protecting them from potential dangers they come across whilst protecting them from potential dangers they come across.

Design Pattern

Tabbed Menus

The tabbed home page features dynamic island notifications with easy access to app insights. There is a visible static tabbed bar to allow for quick access of key features displayed across each page to minimise the user's memory load through simple recognition. These static features carry equal weight in their importance and are in easy reach.

UI Design

Universal design can be distinguished by its goal of creating a single design solution that can serve as large a diversity of users as possible. However, when analysing the behaviour of leaners with digital systems, Souto et al. (2006) found that learning style, cognitive style and emotions are of great importance when ensuring a learner correctly interprets instruction. Specifically, in the case of young children Passig and Levin (1999,2000) found that boys were more attracted to movement such as fast navigation, control, and choice, whereas girls were more attracted to visual aspects such as colour, drawing, and writing. With this in mind, EyeFind and EyeFinder are designed with the 7 principles of universal design and offer a balance of system functionalities and patterns that would appeal across both genders young or old and disability.

Principles

EyeFind is a tool to bridge the gap in education and outdoor enjoyment across all children regardless of physical or cognitive ability. Therefore, its system is designed with the 7 principles of Universal Design in mind

1. **Equitable use**
2. **Flexibility in use**
3. **Simple and intuitive use**
4. **Perceptible information**
5. **Tolerance for error**
6. **Low physical effort**
7. **Size and space for approach and use**

Design Patterns

Floating action button
Found on the EyeFinder home page, this quick access button allows the user the option of logging out or staying logged in.

Dynamic Island Notifications
When pressed and held, notifications are expanded on the home-page to improve clarity for the user when reading in EyeFinder.

Steps Left
Indicate how many steps are left to achieve a reward in the rewards center in EyeFind.

Gamification
The generation of tokens and rewards incentivise the user to continue engagement with EyeFind.

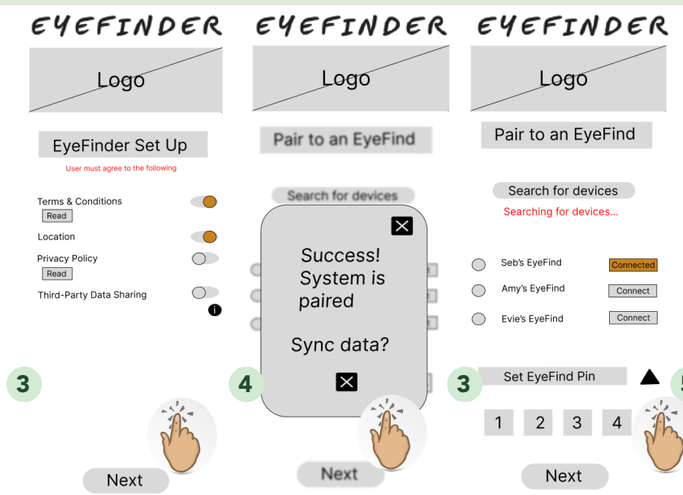
Dialogue Notifications
Pop ups informing the user over the collection of their data and confirmation of changes in the system's status.

Lazy Login
Allows for quick and easy sign in on EyeFinder.

Clear Primary Action
The use of contrasting colour to make features stand out so a user understands what to do or what has changed.

Progressive Disclosure
A step-by-step onboarding process to reduce cognitive overload.

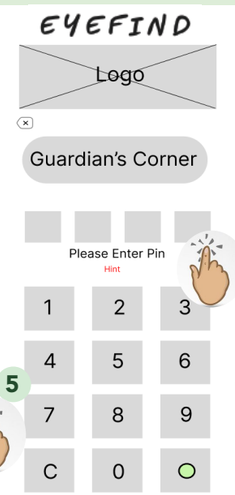
App Gestures



Recognition across other apps of the simple toggle control makes this intuitive to the user.

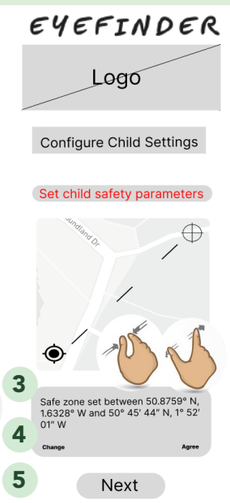
Clear feedback of system change and CTA prompts via Dialogue Notification.

In this screen, the user want to pair to a device and set a pin for it. System status is shown through visual indicators and messages to keep the user informed of progress and success or failure of the action.



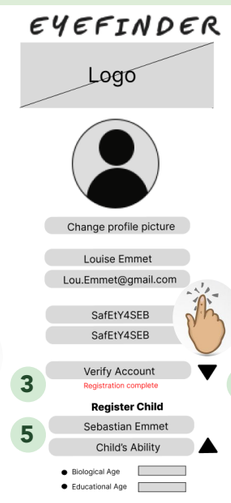
To prevent the child making changes to the guardian settings on the EyeFind by mistake, they are protected by a pin-code.

Lazy login or using an alternative sign in speeds up the login process, reduced input error and takes the minimum user effort.



Familiar app gestures, expand and pinch, allow the default exploration range to be set using a visual representation.

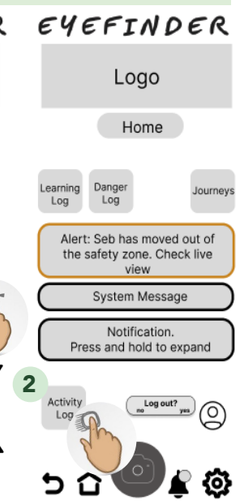
System feedback checks the user intention to avoid human error.



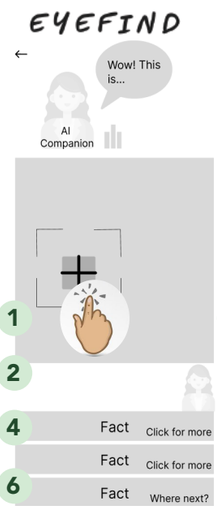
System feedback confirms status.

Password set up avoids careless error by asking for verification.

The onboarding process is hierarchal, each top level option reveals subfields for data entry to reduce cognitive overload.

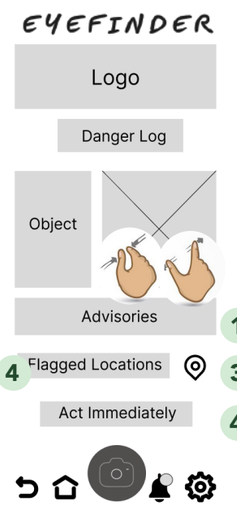


The Guardian app home screen can be user customised to relocate the non static tabs like the logs and notifications using drag and drop to better suit their needs.



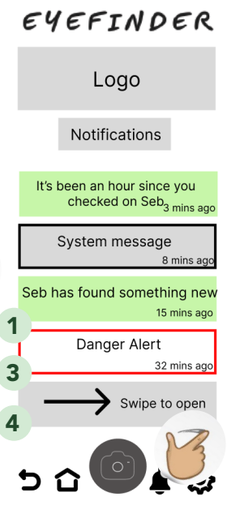
The AI Companion extends the accessibility of the EyeFind to provide choice to diverse users by engaing with them visually, hapatically and through audio. Thereby, accomodating individual differences and physical effort.

In storytime, EyeFind delivers content in short, easy to understand text supported by optional AI audio.

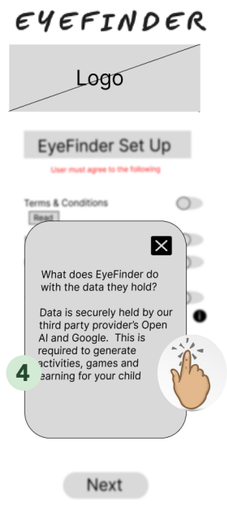


On recording a danger, EyeFind flags details to EyeFinder with a call to action (CTA).

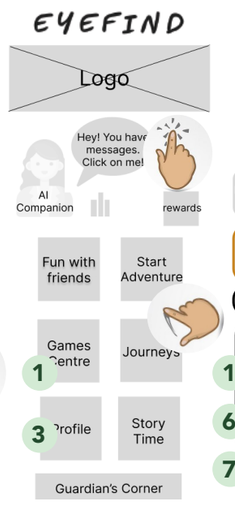
Pinch and expand gestures help the guardian to see and analyse the threat.



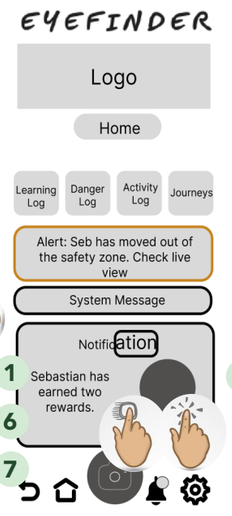
Notifications are colour coded based on priority and meaning and are colour contrasted to draw user attention.



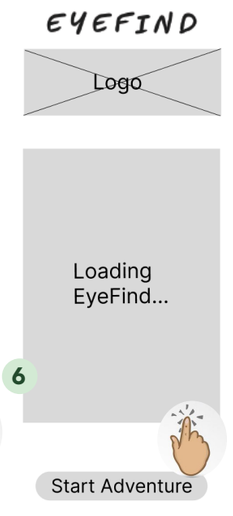
The purpose of data collection is clearly set out and explained to the user via Dialogue Notifications.



A simple and uncluttered visual hierarchy of large buttons in the Home Page indicate the primary tabs of the EyeFind. These are expected to be used the most often and are easy to reach.



The EyeFinder Home Page minimises clutter by allowing notifications to be expanded and further magnified. The static tab provides quick access to key functions within thumbs reach and is consistent across all screens.



The EyeFind landing page only requires a single button press to launch to the Home screen.

Human Data Interaction

L Legibility

Legibility is making data transparent and comprehensible to its user. Upon creation of an account, EyeFinder's T's and C's are stated clearly outlining the app's intentions which have to be agreed by the user before finalising sign up. Changes can be later made in settings. Reports are simplified into visual graphic and data formats for easy processing by the user

A Agency

Agency is putting users in control over the management of their data. As EyeFind is for young children any private data is managed and password protected by their guardians through EyeFinder. General system changes can be made in the device's settings but for the safeguarding of a child, this is also guardian pin protected. During onboarding, all users are made aware of the data they need to provide for initial set up and this can later be later altered or cleared entirely.

N Negociability

Negotiability is keeping users informed about the intention and use behind data collection, allowing where applicable for users to make changes in the permissions according to their own changing attitudes towards the use and retention of their data. The User can change their preference for Location in the permissions settings of EyeFinder to only allow sharing whilst in the App thereby retaining their privacy at all other times.

Multimodal Interactions

Inputs

AI Companion

Guardians input safety measures via the EyeFinder app which are then implemented into EyeFind's interface. When warnings are to be verbalised, this is communicated through the AI companion to focus the child's attention.

When a child takes photos of their interests, it provides data for the AI to identify, research and relay information to the child in return.

During onboarding, users input their personal data and preferences to influence the app's interface

Outputs

Haptic vibrations are used to communicate different meanings to the users. For a child it can be used to symbolise rewards or periods of inactivity and for an adult it may be in the form of notifications where depending on the scenario may be urgent or general

Haptic Key: Eyefinder

Long buzz - Signals for a child to come home
Two quick buzzes - Child is out of the safe zone
Rapid buzzes - Danger is detected

Haptic Key: Eyefind

Quick buzz - Period of inactivity longer than 10 minutes detected
Two quick buzzes - New reward achieved
Rapid buzzes - Danger is detected, step away

AI Companion

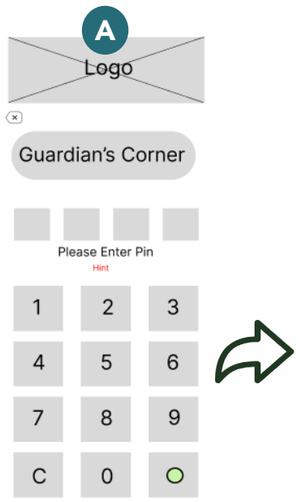
EyeFind's AI companion converts text into speech when clicked and offers suggestions to the user based on their inputs, especially when creating and organising collections. It also nudges a user with encouraging and explanatory notifications during operation and navigation of EyeFind.

System notifications frequently appear to instruct, offer explanation, remind and provide confirmation to users.

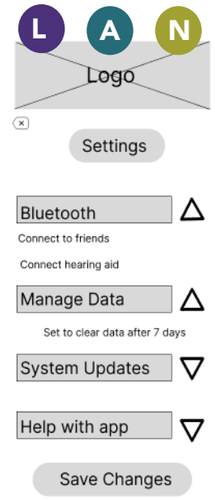
Key Elements

Human Data Interaction (HDI) is an ethical framework that places its user at the centre of a system's design and allows them autonomy over the management of their data.

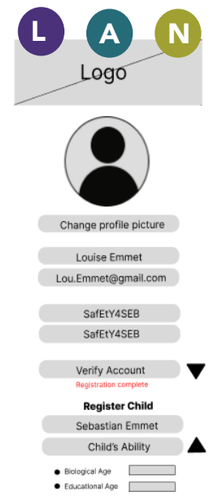
Professor of Informatics Paul Dourish argues that "individual attitudes towards personal data and privacy are very complex and context dependent" (2004) therefore in order to build user trust and engagement, being transparent over the use of their data and allowing control over it allows for a more positive relationship with the user. In regards to EyeFind and EyeFinder, key design considerations demonstrating the HDI principles of Legibility, Agency and Negotiability are shown below.



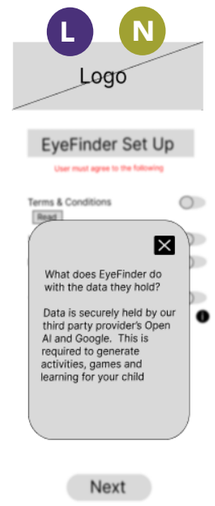
The EyeFind device Guardian controlled Child settings are secured by pin entry to prevent child access. These can be altered by the Guardian from the device as required.



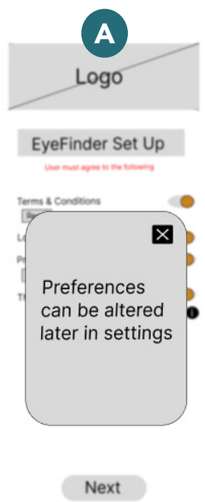
The Child settings above give a visual indicator that there is drop down data that can be selected and changed.



Information that has been committed during onboarding, such as Child's Ability and Password creation, can be changed by the user at a later time.



During the onboarding process of the Eyefinder App, the user has transparency of the reasons data is collected, used and stored before giving consent.

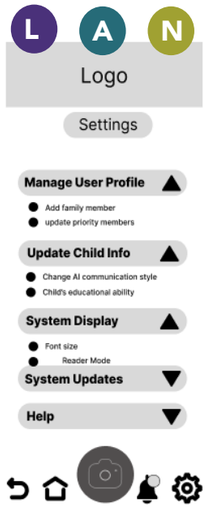


The App will advise the user if preferences can be altered at a later time.

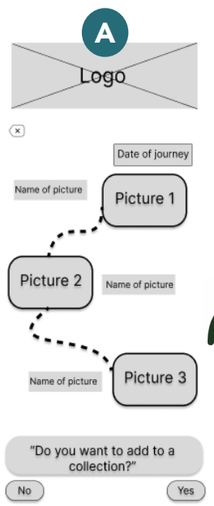
The T&C's, Privacy, Location and Third Party Data Sharing can be deselected after sign up but the system will warn the user if this will affect the usability of the app.

The Activity Log, as with the other logs, simplifies data by graphical representation so that data smog is reduced and the user can digest complicated data more intuitvely and quickly.

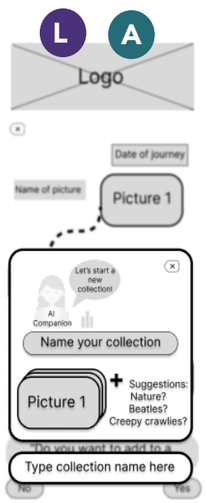
The child is given the autonomy to update their own interests and favourites through the home page, account.



In the adult settings, the user has control over both the data and the presentation of the EyeFinder app and the child profile data in the EyeFind.



During the use of EyeFind, the child has autonomy over the data they collect and choose to keep which is managed through collections.



The app encourages the child to manage their collections representated by graphical albums. AI offers suggestions but final decisions are controlled by the child.

Usability Evaluation

To develop EyeFind and EyeFinder, three testers were asked to demo a basic digital prototype of each app's proposed functionality as demonstrated through the mid fidelity wireframes and Information Architecture. This involved completing tasks in the perspective of the Guardian and the Child from initial onboarding to general app use.

Each tester was a university student, chosen as they had younger siblings which were a close age range to EyeFind's intended demographic of 8-10. Both quantitative and qualitative techniques were used to obtain the evaluee's perspectives.

Users were asked to comment if any screen could be improved, either due to a lack of functionality or because the wording of certain elements were unclear or confusing. They were also asked to assign a numerical value from a scale of 1-5 of any value, representing how strongly they agreed or disagreed against a set of statements that were focused on the Content, Usability and Efficacy of the two apps.

Efficacy

Users were asked their general opinion on the following, "Were you aware the app provides safeguarding through notifications and warnings?", "Do you think the app would encourage outdoor exploration and independent learning?" and "Is it useful to collect data on educational use and exercise?"

- "That wasn't immediately clear"
- "Absolutely, I would be excited to use this as an adult"
- "Yes, parents will want value from the app and they must be buying it for a reason"

Content

Users were asked a series of questions such as, "Visually, would this app appeal to children?", "Is the use of icons and language age appropriate?" and "Did you find the AI companion useful to this app and would you regard it as a USP?"

- "Yes, the colours give it a real outdoorsy feel like there is an adventure to be had"
- "Yes, It seems in line with other products aimed at children"
- "Absolutely, I think kids would love it and maybe see it as a play mate and I can see how it would work for lots of different types of children"

Evaluation

Evaluation was split between EyeFinder and EyeFind because being a prototype system, there wasn't data available to test them equally. EyeFinder uses a task driven exercise to test Usability. Content and Efficacy for both Apps use a comment based evaluation based on appearance and impression.

When conducting Heuristics, it is important to remember that user's bring their own subjectivity to their evaluation and therefore, what is good to one person may seem poor to another.
"In their article, "Usability testing vs. heuristic evaluation: A head-to-head comparison," Robert Bailey, Robert Allan and P. Raiello found that 43% of 'problems' identified by experimental heuristic evaluations were not actually problems. Furthermore, evaluators could only identify 21% of genuine usability problems in comparison with usability testing." (Interactive Design Foundation) Relying on Heuristic Evaluation alone, could lead to design changes that are unnecessary and it would be more appropriate to focus on Usability Evaluation to benchmark this App.

Fig 2: Not enough data Mid Fidelity Wireframe

Usability

Users were set three EyeFinder tasks

Task 1 Create a child account and pin from onboarding

- "Seems a standard sign up"
- "I had no problems"

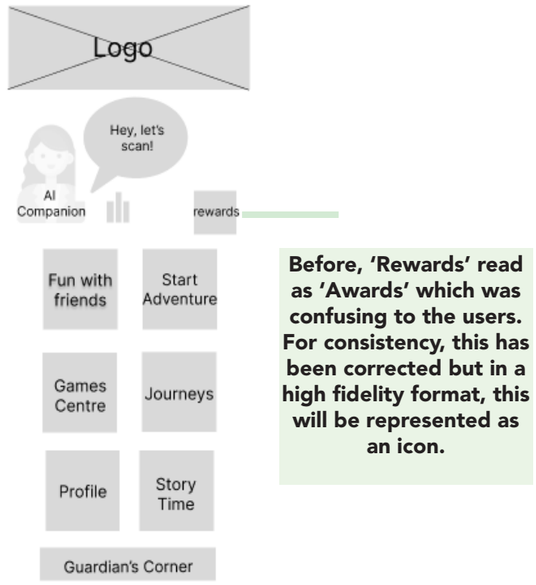
Task 2 Check an activity log

- "Easy navigation but there was nothing I could check"
- "Was I meant to see the data?"

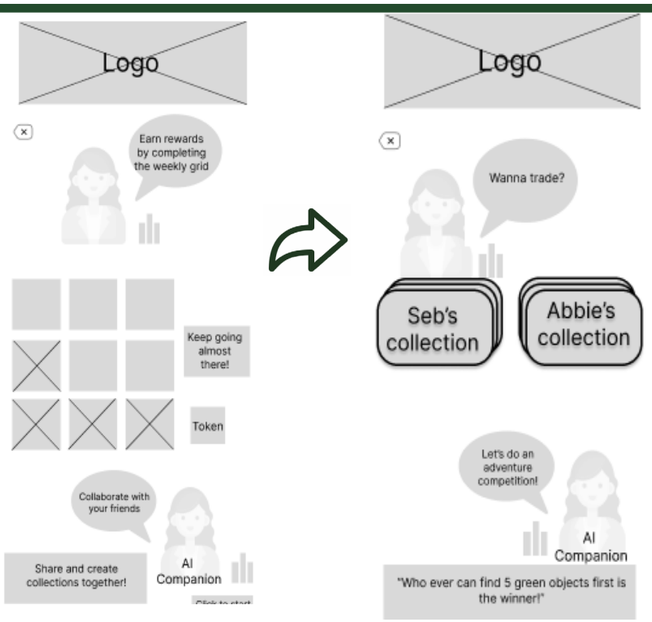
Task 3 Update child Information

- "I remember this from creating the child account"
- "Easy"

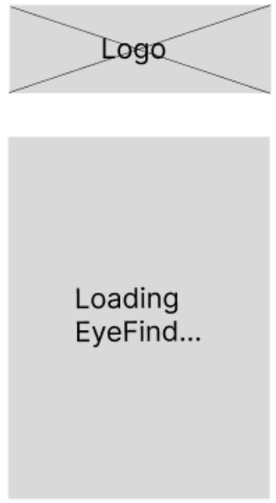
Solutions



Before, 'Rewards' read as 'Awards' which was confusing to the users. For consistency, this has been corrected but in a high fidelity format, this will be represented as an icon.



Previously, 'Fun with Friends' combined the Rewards Centre with the collaboration with friends. This was confusing to all users because there didn't seem to be any relationship. They have now been separated into their own screens for better understanding and clarity.



The initial Landing Page started the app by pressing'Start Adventure'. This didn't make sense to the users because having selected this, they were then taken to the Home Page and had to select 'Start Adventure' again. To address this, the Landing Page now says 'Let's go!' which goes to the Home Page.

Storyboard

Louise is concerned Seb spends too much time indoors being passively entertained on tech devices and is missing out on interaction and outdoor activities. She also worries that Seb at 8 years old is falling behind in some areas of learning and lacks the motivation to explore new things independently. Safety is her No.1 concern when he is unsupervised. Seb's friends live too far away to play after school. He prefers to spend time on his xBox because his mum is always busy and he feels there is nothing to do outside.

The storyboard shows the shared experience of using EyeFind and its guardian app from both points of view.

Seb Pov

Seb starts EyeFind to open homepage

His AI companion prompts him to start an adventure

Seb taps the screen to activate the scanner

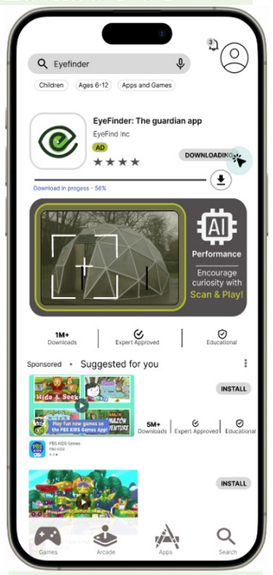
AI identifies a risk! An alert goes back to Louise to intervene.

Now the adventure has ended. Seb can continue having fun in the games center.

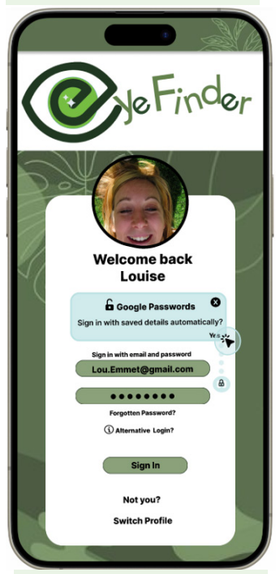
He makes collections of his findings that day.

At the end of the day, Seb and Louise are free to spend time together watching stories his AI companion has generated for him

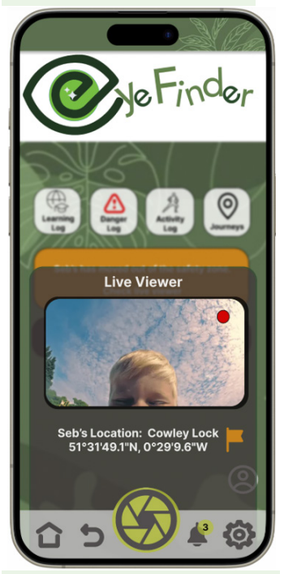
Louise Pov



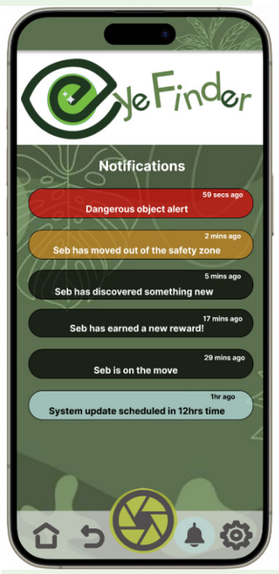
Louise downloads the EyeFinder app from the playstore and sets up her account



She logs in to keep an eye on Seb whilst she is working



An alert on her dashboard indicates seb is outside of out her set safety range. She checks her live viewer



This is followed by second alert that there is also now a danger present but Louise is on a work call

Louise could go straight to Seb or check the danger log to decide what to do

Later, she checks on Seb's progress to see how well he is using his EyeFind

Social Ethics Impact

There are ethical risks associated with the adoption of AI such as paternalism, consent, privacy and manipulation, especially in the context of protected categories such as children (Smith & de Villiers-Botha, 2021).

Nudges steer a user's choices by influencing the less rational parts of their cognitive architecture (Kahneman, 2011). Young children who are not yet fully cognitively developed are vulnerable to such manipulation. Furthermore, they are under the age of independent consent over the collection and management of their personal data. They remain a category of users who should be carefully protected.

Current legislation protecting children from AI interaction is the UK Children's Code (2021) and 'COPPA' (2013).

Therefore, an AI nudge system should maintain a level of moral inertia and neutrality by following some basic guidelines that aim to mitigate risk and **unintended consequences.**

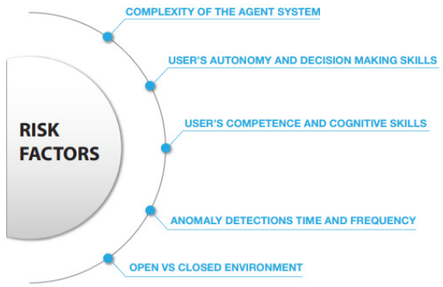


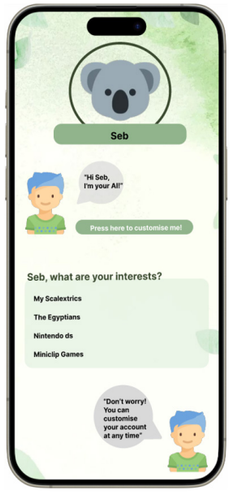
Fig 1: Risk factors associated with AI-nudges (Tech Ethics Lab,2023)

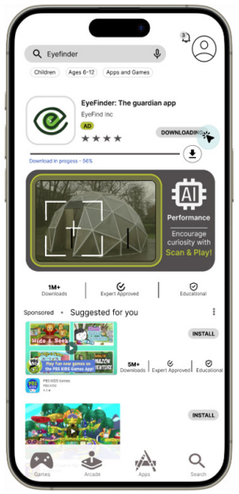
Smartphone users are equally susceptible to ethical risks such as the uncontrolled harvesting and selling of personal data to multiple undisclosed and unknown third parties.

In 2017, 1 in 5 apps on Google Play Store shared consumer data with more than 20 third parties and almost 1m Android apps harvest and share 90% of smartphone data back to Google. (Ram A, Wisniewska A, Kao J S, Rinisland E, Nevitt C, 2018)

GDPR is a regulatory body that lists the rights individuals have over the control of their personal data being processed. In EyeFinder, user agency is encouraged by the request of clear consent given in the processing of his or hers personal data

EyeFinder is upfront over the terms in which users must agree to and why in its T's & C's, Privacy Policy and Third Party Sharing. Disclosure is transparent and offers the user the option of managing the data of their child and their selves in settings.





Unintended Consequences

An outcome produced by an AI system is often unpredictable as it depends on the behaviour of its user (Sætra, 2019; Yeung, 2017). Even in the case of positive consequences, reinforcement mechanisms are required. The following considerations are from an audit concerning the importance of child safety from AI nudging, EyeFind is compared aganist this to see if it addresses these key concerns in its design. Verification of such data remains a conern due to their highly sensitive nature and the fact it necessitates a trade-off between necessary personal data and the purpose of their use.

1. Are there risk mitigations that are age-appropriate, including pause buttons and save features, as well as nudge techniques, conditioning, or persuasive tactics that support wellbeing?

2. Is the data handler aware of the user's age and what content is age appropriate for a protected user? How well is this filtered?

3. Is the AI equipped to handle anomalies? Is there a mechanism for tracing anomalies and non-predictable anomalies?

4. Does the user have an adequate level of understanding of the system? Age and ability (linguistic, cognitive, cultural) are discriminators which should be considered by the AI.

5. During registration processes, AI must be able to identify the real understanding of the receiver.

6. Is the appropriateness of messages (texts, images, sounds) assessed? For self-generated content this should go through approval.

7. Is special attention given to children with disabilities?

8. Are nudge techniques in favor of the child's best interests? Many nudge mechanisms are developed to promote the learning and wellbeing of children but must have constant review.

9. Children should not be profiled unless this is necessary for the purpose of the application.

10. Are system nudges based on cognitive abilities or on sensorial responses (colour, sound, touch)?

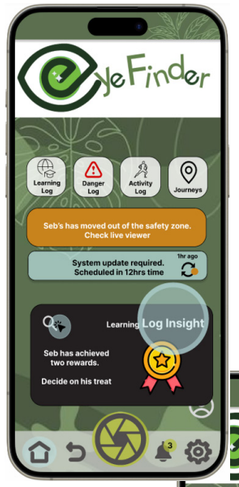
EyeFind has a series of sophisticated filters and preloaded meta data enabling complex scrutiny and blocking of unsuitable content, all of which fall to the parent to later review that data perceived appropriate is correctly identified.

When registration is launched, the AI notes the interests of the child, with regards to their age and ability, to filter into its algorithm. It doesn't take any unncessary data about its user other than what is required for safetly and content generation, this is particularly important for those who are under the age of consent over their data.

Furthermore, EyeFind is a product that promotes inclusivity for all children regardless of gender or disability. Its personalised system, use of icons, colour, navigation, typography and content appeals to all whilst having accomodating features such as text to speech and colour theory.

Parents assess EyeFind content reguarly but there are third parties responsible for the generation of content that perform regular checks in order to comply with ethical legislation like COPPA.

Throughout, EyeFind uses a series of nudge techniques to be engaging and stimulating for a child through the use of the AI commands, haptic reminders and reward systems to encourage continued learning and independance.



Reducing Digital Divide

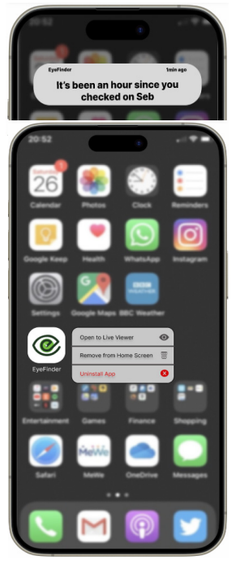
EyeFinder anticipates that guardians responsible for a child can vary in age, ability, cognitive understanding, skill and motivation. Furthermore, maturer guardians who may have impacted clarity of vision and are unfamiliar with modern applications may struggle with the operation of the EyeFinder interface.

In order to remove any digital barriers that contribute to digital divide, the EyeFinder interface has been made as simplistic and intuitive as possible. On dynamic island notifications, a magnifying icon is provided to allow a user to enlarge text where needed and a tutorial walkthrough is provided to aid new and existing users understanding over the navigation and functionality of EyeFinder.

In addition, both EyeFind and EyeFinder have been designed with a complementary palette against a neutral space in order for notifications to contrast well for a user's attention and engagement

Colour Theory

Secondary Interactions



On a mobile device's home screen, the EyeFinder app icon can provide quick access options like accessing the Live Viewer when long press touch is maintained by the user.

This can be in response to EyeFinder giving feedback in the form of interactive system notifications to encourage a guardian's attention when a period of inactivity has been noted with their child or when immediate supervision is required. This time saving feature (Liu et al,2020) is an essential part of safeguarding. Time is of the essence when potential dangers are nearby and a guardian needs to act quickly to understand the situation. It also allows the user to multitask other responsibilities digitally or physically as EyeFinder runs in the background.

A highlighted cursor is always present during navigation so that the user of EyeFinder understands where they are on the screen and ensure that what they select matches their intention.

Hard Of Hearing users have also been taken into consideration. The use of Haptic and audio feedback provide clear indication of changes, alerts and commands across both interfaces.

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Appendix I: High Fidelity EyeFind & EyeFinder Wireframes

LINK TO EYEFIND PROTOTYPE: https://www.figma.com/proto/SIpfDvoxysDrLQnvUe9suS/EyeFind-Usability-Testing?type=design&node-id=45-1142&t=zBlaaN3tJEQZszGe-1&scaling=min-zoom&page-id=0%3A1&start-ing-point-node-id=1%3A1237&show-proto-sidebar=1&mode=design

LINK TO EYEFINDER PROTOTYPE: https://www.figma.com/proto/JNBYuWpU73iDzBRxewVPBf/EyeFinder-Usability-Testing?type=design&node-id=1-368&t=58kSkAGQLgtglOuk-1&scaling=min-zoom&page-id=0%3A1&start-ing-point-node-id=0%3A660&show-proto-sidebar=1&mode=design