Look What the Cat Tapped In: Exploring Digital Interactive Systems Designed for the Cat Café Experience

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(A) (B) (C) (D)

Figure 1: We gained insight from observing how a cat interacts with a tablet (A), cats watching video footage of birds on a laptop screen (B), human cat café visitors' use of traditional toys for interaction (C), and a visitor using MewTube for interaction at a cat café.

ABSTRACT

Cat cafés are environments where visitor experiences centre on human–animal interactions. At the same time, the animals' side of the experience has led to widespread ethics concerns, connected with the overstimulation potential of direct, intense animal–human interaction, with concomitant effects on animal welfare. Investigating how technology could bring balance to this relationship, the paper presents MewTube, a tablet-based application designed to engage cats through curated videos while allowing humans to adjust playback speed in response to feline behaviour. From a five-month study with 28 human and 16 feline participants that compared tablet-based play at a cat café with traditional toys' use there, analysis revealed that overall enjoyment stayed constant between the two conditions yet toy-focused interactions led to a stronger sense of connection with the cats. Reflecting on our findings – e.g., in the absence of clear responsiveness from the cats, humans in the MewTube condition felt less confident that the animals enjoyed the interaction – reveals gaps in technology for supporting interaction in human–animal relationships. The paper offers recommendations for tackling the challenges of designing systems that respect feline autonomy and sensory preferences.

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CCS CONCEPTS

• **Human-centered computing → Interaction devices**.

KEYWORDS

Animal–Computer Interaction, Pet, Tablet, Video, Human–Animal Interaction, Animal–Visitor Interaction,

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1 INTRODUCTION

Numerous public spaces facilitate human–animal interactions, primarily aimed at human entertainment. These environments remain contentious. Plagued by persistent animal-welfare concerns [14, 29], they have sparked efforts by animal–computer interaction (ACI) researchers to start investigating how technology could genuinely support visitor education and animal welfare in human–animal spaces [37, 53]. This research has cohered largely around zoo environments, while other, far more immersive interspecies interaction has largely escaped academic attention – that at 'animal cafés'.

As the name suggests, these are spaces in which humans order food and beverages while in the presence of multiple freely roaming animals. Another defining characteristic of said settings is that visitors too may move freely, throughout the animals' habitat, and they are often encouraged to interact directly with the non-humans. There are cafés dedicated to many species, from

rabbits and reptiles to owls [43], but the first and most ubiquitous are those established around cats [43]. Cat cafés have gained global popularity in the years since 2004 [35], offering spaces for relaxation and cat-based interaction [38, 44]. This prominence notwithstanding, the question of ensuring feline welfare while meeting visitor expectations remains unanswered [46].

Prominent animal-welfare charities, such as Britain's Royal Society for the Prevention of Cruelty to Animals, have argued to lawmakers that direct physical contact with humans at these venues can cause overstimulation and/or stress to cats [39]. Meanwhile, from a scholarly perspective, many researchers characterise cat cafés as sites of animal labour that align cats with commodities even though much of the Western world does not regard cats as mere inert or passive objects [59]. Taking an alternative stance, cat café patrons have cited these places as an avenue to healing and relaxation and as a way to learn about cats. Hence, these environments where animals work and live embody a fundamental tension between service provision by animals and their wellbeing [17]. As animals perform emotional labour for human patrons [38], their living conditions may, on the other hand, improve – ultimately better speaking to species-specific requirements [59]. Therefore, we cannot discount the possibility that cats too may have meaningful encounters within café scenarios. Since they might benefit from enrichment, socialisation, and interaction with visitors [59], introducing computer entities into this ecosystem holds promise. This is accompanied by important design and ethics questions bound up with how computers can support meaningful, respectful interspecies interactions that balance humans' needs with those of cats, honouring both.

Tentative work by ACI scholars offers a lens for exploring animal–human relationships, thanks to examination of emerging technologies that may facilitate such interspecies engagement tailored to both sets of needs [31, 53, 55]. Albeit limited, some ACI work with cats provides a starting point [36, 50, 56]. With that grounding, we explored how an interactive video application presented via a tablet might yield benefits in cat cafés. Aiming to expand awareness of ways in which such design can reshape human–animal relations in public places in a way that respects both species' needs, our research asked two main questions:

- **RQ1**: How can interactive screen-based systems be designed to accommodate the needs and requirements of cats and humans?
- **RQ2**: How does the use of a tablet system in cat cafés affect visitor experience and human–cat bonding?

To address RQ1, we began by conducting observation-based testing with 16 residents of a cat café, monitoring their responses to various pre-existing touchscreen applications and video material presented on tablet computers. Tablets served as a fitting jumping-off point since they are portable and adaptable to the dynamic environment of a public cat café. Furthermore, since screen-based technologies are particularly suitable for cognitive enrichment, they are a highly relevant tool for exploring feline engagement in a shared public setting [27]. Then, to develop the case application, we solicited insight from a design-feedback group: reflections on prior experiences of cat cafés thereby informed the design of MewTube, a tablet-based system enabling human visitors to interact with a café's cats by playing curated videos. The system lets visitors adjust the playback speed in response to feline engagement, and, to encourage respectful, non-invasive interaction, it incorporates concise educational guidance in interpreting feline behaviour.

Over five months, we evaluated the effects of MewTube use on interactions between on human–cat interactions, again between human visitors and the 16 resident cats. To answer RQ2, we compared data between users of MewTube and a baseline group who used only traditional toys during their visit. By means of questionnaire and interview data, we compared responses between the two conditions. This enabled us to assess enjoyment by the humans, the sense of feline engagement, and perceived human–cat bonding. Our findings suggest that, while MewTube can enhance the cat café experience, particularly for less confident visitors, it functions best as a complement to, not a replacement for, traditional forms of play. Furthermore, the system's success depended heavily on feline responsiveness. This finding underscores the complexity of designing for multispecies interactions that unfold in dynamic environments.

With animal cafés and cat ownership still expanding globally [58], this paper contributes to the ACI field in a timely fashion by examining several ethics questions that swirl around development of non-invasive technologies with potential to reshape human–animal engagements in public spaces. Our findings inspired us to articulate practical design guidelines for interactive systems that foster interactions respectful of the animal's autonomy, and the study's evaluation of engagement in a multi-user public setting advances research into technology-mediated play and cat computing. Also, for the human–computer interaction community and beyond, this work demonstrates how to reframe design through a multispecies lens sensitive to joint human and animal user experiences.

2 THE BACKGROUND LANDSCAPE

Although ACI scholarship has increasingly explored interactive systems to support domestic species, research into feline-centred technologies remains scarce, as noted above. The same is true for technologies that facilitate animal–human interaction in human-visitor settings. Nonetheless, we review the literature relevant for interactive computers for animals, with special focus on cats, auditory and visual interfaces, and technologies that overlay animal–human interactions in shared public spaces.

2.1 Animal–Computer Interaction

Deployment of technology to enrich animals' life, address their cognitive and sensory needs, and foster meaningful interactions with humans is on the rise. These computer systems often exploit auditory, olfactory and visual stimuli to initiate engagement or pave new avenues for such interaction as collaborative play between humans and animals.

Auditory-focus systems take animals' sensitivity to sound as a starting point for social-interaction, wellbeing, and enrichment support. Researchers who often work with this faculty examine how sounds of particular types affect animals' wellbeing [12] equipping themselves to advocate giving animals control over their own auditory environment, control that might well enhance their autonomy and welfare. For instance, highlighting sound's potential as a medium for interspecies communication, Gupfinger and Kalternbrunner [16] probed how parrots can use interactive sound mechanisms (traditional instruments and computer systems both) for collaborative creation of audio with humans and other parrots; they found evidence that shared auditory play can promote cognitive stimulation and cross-species social bonding. Building on that work, Kleinberger et al. [28] developed a music system comprising a branch that a macaw can move to

trigger music playback within their enclosure. In combination, the macaw's initiative in activating playback, particularly during interactions with visitors, and positive behaviour indicators (such as nibbling and dancing) point both to comprehending the interaction's nature and gaining from it. However, just as humans' music preferences vary, other animals' auditory-enrichment desires and outcomes depend on the species and individual. Some scholars, observing that anthropogenic noise often induces stress, recommend naturalistic or calming sounds, to reduce strain from the environment [12], while others claim that any problems stem from the sound's features rather than its human origin [26]. Studies from both camps accentuate what audio-based interaction systems offer in support of animals' agency, wellbeing, and social connectedness.

Visually based systems likewise engage with animals by taking advantage of natural behaviours and attractions. Touchscreen applications have been developed for cognitive stimulation of dogs, birds, monkeys, and other species [8, 52], while general environmental enrichment has been sought via screens in animals' homes [22]. Screen-based interfaces might indeed improve some animals' wellbeing: for instance, in one study of such systems, most dog-owners surveyed indicated that their pet enjoyed engaging with the system studied [52]. As for touchscreen interfaces, non-human primates have demonstrated engagement with touchscreen systems (on tablets etc.) designed for humans, thereby showing both physical compatibility with this technology and understanding of it [8]. The relevant study, with marmosets, spotlights low-cost, robust touchscreen devices' feasibility for enrichment and research in the ACI domain. Yet issues remain. For example, while research into white-faced sakis' video-based enrichment revealed these animals' preferences (for worms and underwater jellyfish videos) [21], it pointed to the possibility of novelty effects also: importantly, engagement with systems' screens might decline over time, with acclimation to the system's presence. Accordingly, early studies, whether pointing to benefits or to moderating effects, both offer valuable insight into how video-stimulus devices can be implemented for animals' interaction, across species, and highlight the need for deeper examination of their use by animals. Clearly, vision-anchored systems, employing touchscreens, video displays, or some other mode of interaction, show strong potential for affording rich experiences by animals, via support for cognitive and sensory experiences for animals.

2.2 Systems Supporting Animal–Human Interaction

Animals in captivity interact with humans, and *vice versa*, in many settings, animal cafés, zoos, aquaria, etc. These interspecies spaces often permit an untrained member of the public to initiate contact and even touch a live animal directly. Research attests that properly managed human–animal interactions can improve both animal welfare and people's education [13]; however, negative effects too can ensue [46]. Studies in zoos have shown that regular petting of wombats does not alter their behaviour [24], while other work has found that close physical contact may even trigger biting responses in sea lions [7]. Proceeding from increased awareness of the interconnectedness of human wellbeing with animal welfare [34], a growing body of research is accumulating also with regard to humans' interactions with domesticated animals, including how digital tools, interactive devices, etc. are best developed to facilitate play between cats and humans.

Among the applications developed is Purrfect Crime, by Trindade et al. [50], intended for cats' and humans' joint play. Here, cats physically engage with projected stimuli controlled by humans using a Wiimote. While innovative in its use of physical space to accommodate natural feline hunting instincts, the game suffers from environmental constraints (e.g., the projection requires darkness). It illustrates another limitation in this space: lack of long-term behaviour data. Though the game positions cats and humans in competitive roles, its developers did not probe this dynamic's influence on emotional bonding or relationship-building. Another example of the gulf in ACI scholars' understanding of interspecies connection, which extends far beyond observable play, is visible through the virtual aquarium game Felino, designed by Westerlaken and Gualeni [56]. It lets humans adjust the movement of on-screen fish to respond to feline behaviour, thereby promoting collaborative play. While allowing humans to adapt stimuli in real time, Felino also encourages independent interaction from cats, by employing visual design solidly grounded in understanding of feline sensory perception (favouring blues and greens accommodates cats' colour vision, and utilising naturalistic-prey-style animations engages their hunting instincts). The development philosophy drew on Plessner's theory of positionality to highlight the importance of designing for the cat's perspective. Still, the thoughtful model behind Felino's design represents only a starting point for shared interaction that respects feline autonomy while letting humans retain some control of the experience. Building on this effort at exploring how a computer system could be sensory-aligned for humans and cats toward mutually responsive interactions between the species, Cat Cat Revolution, by Noz and An [36], introduced a dual-device approach that applies a movement-based technique similar to Felino's. Cats 'chase' a tablet-presented virtual mouse, the movement of which a human can influence via a connected mobile phone. This division of control supports more balanced interactivity and mitigates the human dominance typical of engagement with shared-interface designs. Results are not conclusive, though, especially with regard to felines' engagement or sensemaking. For their conclusion that participants enjoyed the shared play, the researchers relied heavily on human self-reporting. Also, the split-input model risks reducing physical co-presence; using separate devices might weaken the mutual awareness needed for deeper bonding.

Also, conditions particular to cat cafés bear examination. In such settings, where cats often face unfamiliar humans, body language becomes the primary mode of communication. Important behaviour cues such as tail position, eye movement, and posture reflect emotional state, from agitation or curiosity to relaxation [10, 25, 45, 47, 48]; however, visitors unfamiliar with feline behaviour may create a risk of stress or discomfort by misinterpreting these signals. Understanding such cues is critical for designing spaces of respectful digital interaction. This arena offers considerable room for technology to function both for education and as a bulwark for appropriate engagement between humans and animals interacting in shared spaces.

The studies discussed above illustrate how knowledge of cat–human interaction and the landscape of corresponding technologies might evolve. Their advances showcase the potential for digital tools to create genuinely collaborative experiences of engagement. However, the focus in creating these systems – which have yet to be implemented in real-world, public settings where

humans and cats interact – has been largely confined to cultivating engagement for the animals and humans simultaneously. There has been little attention to the ways in which interacting together through the technologies affects the relationship between cats and humans, and no research has been set in a cat café context. To tackle this gap in research and practice, we built on nascent work on animal–human interactions to explore a way to develop vision- and hearing-based tablet-computer interfaces supporting human–animal relationships in public settings (RQ1) and examine the influence of using such technologies (RQ2).

3 PARTICIPANTS

Our study involved 16 cats housed at a cat café local to the main research institution (Fig. 2 characterises the feline sample by presenting participants' image, sex, breed, and age). The premises followed a layout common to many cat cafés, with two distinct areas: a public 'café' space and a restricted 'cat' space [59]. Accessible to visitors, staff, and cats alike, the former allowed them free movement throughout the café space. Furnished with seating, cat-related amenities (such as scratching posts, climbing platforms, and plush beds), and boxes of toys, this was an entirely open area, with no private sections. In contrast, the 'cat' space was restricted to cats and café personnel only. A cat flap granted access to this more private space, letting cats retreat from visitor interactions when needing to do so. Throughout the study, cats moved between the two spaces, creating variety in the groupings present.

Frequency of visits	No. of visitors
<1 per year	2
1 a year	16
1 every six months	5
1 in three months	5

Table 1: Cat café visitor numbers by visit frequency

The study's human participants were 28 people, aged 16–50+ (mean age: 30.5). Eight of them identified as male and 20 as female. Their frequency of visiting varied, with most reporting annual visits (see Table 1).

Participants 01-10 were sourced online, and partook in phase 1 of the study (n = 10). Participants 11-28 were sourced in person at the cat café, and were split evenly between the baseline and application conditions during phase 2 of the study (n = 18).

This sample's demographics, consistent with research into typical cat café visitors [40], supports generalisation from our study's findings.

The University of Glasgow Ethics Committee granted approval for conducting this research (EA01/10/2024). In addition, since matters of ethics were fundamental to our study design and research questions, we reflected on them throughout the project.

4 THE STUDY: METHODS

The method, outlined in Figure 3, followed a two-phase approach, with both phases informed by human and feline input. Phase 1 compiled design requirements by surveying cat café visitors and testing screen-based apps with cats, and Phase 2 tested the resulting system, MewTube, in real-world use.

4.1 Phase 1: A Survey for Compiling Requirements

The first phase encompassed canvassing for both human and feline requirements, in pursuit of a well-grounded application. We observed the 13 resident cats that interacted with two screen-based devices, capturing their interaction patterns via video logs of their behaviour. For the interaction devices, a touchscreen Samsung Galaxy Tab A (see Fig. 1: A) and a Dell Inspiron laptop (see Fig. 1: B) were selected, to reflect commonplace consumer technologies in their screen size, brightness, and interface dynamics. This choice allowed us to assess feline responses to systems that could realistically be deployed in a cat café setting. We monitored the cats as they engaged with a range of visual stimuli that included pre-existing applications developed for babies, pre-existing applications created for cats, videos of real animals, and videos of animated ones (Appendix A gives full details of the applications and videos used in Phase 1). We filtered stimuli for inclusion of high-contrast movement, small rapidly moving objects, and naturalistic soundscapes, all features aligned with feline predatory instincts and cats' visual-processing capabilities [19, 32].

Evaluating animals' interactions with technology presents inherent challenges, as non-human users cannot write down or verbally articulate their experiences [41]. In consequence, researchers must adopt context-specific, often subjective methods tailored to each species and environment. Since there is little precedent for assessing digital engagement amid the many confounding factors present in cat cafés, where cats interact with unfamiliar humans in a dynamic social setting, developing appropriate evaluation techniques demands special attention.

Taking lessons from prior research into cats' behaviour with screens [56], we monitored the responses for specific actions: tapping (quickly raising a paw to press the screen), swiping (sliding a paw along the screen), and dragging (placing a paw on a target, such as a rodent image, then drawing the paw across the screen). In addition to these direct interactions, we recorded instances of attentive engagement: sustained visual and behavioural focus on the on-screen content. Drawing from methods used in studies of non-verbal human infants [1, 6, 51], we identified engagement by means of behavioural indicators – namely, tail movement and posture, the head's or eyes' tracking of motion shown on the screen, and ear orientation relative to the screen. We classified cats as engaged if they maintained attentive behaviours for more than 30 seconds, a cut-off suggested by the cat café staff and dovetailing with evidence that screen-focused engagements between pet animals and technology typically occur in short bursts of interaction [22, 23]. In the context of a dynamic café environment with numerous external distractions, passing a 30 s threshold seemed to be a clear and conservative marker of focused attention, well suited to reliably distinguishing passing curiosity from meaningful interaction.

In parallel with our feline observations, we gathered the cat café visitors' perspectives via a brief questionnaire on their perceptions of the tablet-based cat interaction. The survey form, which combined Likert-scale and open-ended questions to ask about the visitor's preferences, perceptions, and attitudes to the idea of using interactive applications with cats, was given to and completed by 10 people, seven of whom had previously visited a cat café (see Section 3).

Figure 2: The feline participants, with photos, sex, breed, and age in years.

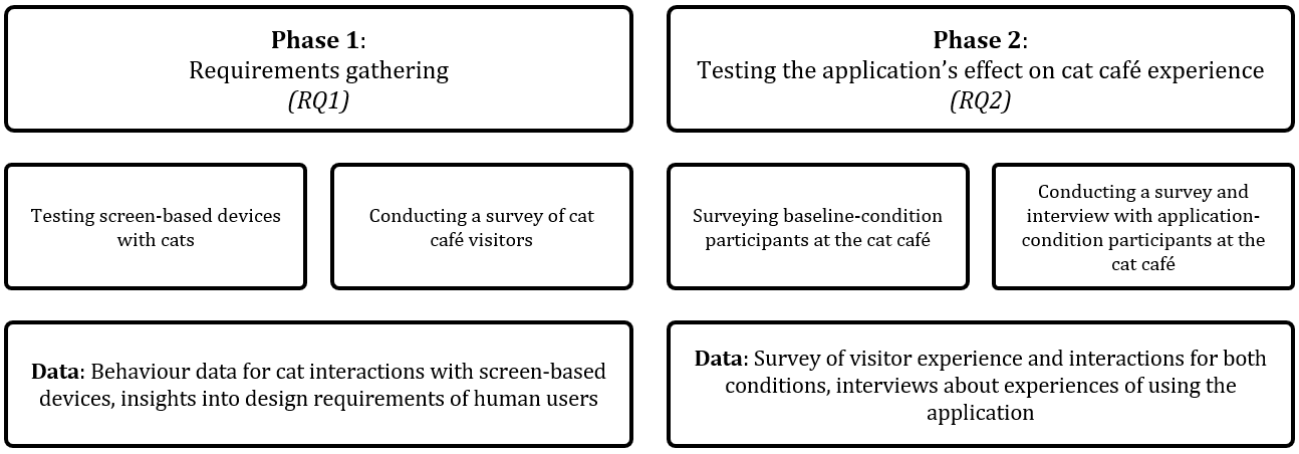

Figure 3: The study's two phases and their material.

4.2 Phase 2: Tests of a Novel System's Effects on the Cat Café Experience

The second phase explored the effectiveness of our application in supporting considerate interactions between humans and cats. For this phase, we analysed only data from humans (participants 11–28), who were exposed to two distinct conditions: a baseline one in which café visitors interacted with cats by using traditional toys and the application condition, in which visitors engaged with cats by means of our application and traditional toys. Both conditions were experienced at the local cat café during public opening hours. To ensure a diverse participant pool, data collection extended across several days of the week (Monday–Friday) and times of day (11am–5pm).

We adopted a between-participants design oriented toward the real-world setting of the café: visitors were paying for their time there, and many were present only for a short visit. This structure supported a broader sample without requiring extended engagement or participation in follow-up interviews. It contributed especially to understanding of the baseline condition, through the simple survey.

In the cat café setting, we identified visitors who were already engaging with cats through traditional cat toys (i.e., acting in the baseline condition). Figure 1's pane C shows an example. After they finished playing, we approached them and asked them to complete our survey assessing their overall enjoyment of the play with the traditional toys and their general experience at the café. The data thus solicited gave us a point of comparison for understanding how the application influenced visitor perceptions and actions.

For the application condition, we similarly approached visitors who had already been observed playing with traditional toys, then invited them to use our application, MewTube, on a tablet (see Fig. 1: D). After consenting, they were asked to use the application with the cats for five minutes, with the option of continuing beyond this if they so wished. During their interactions, they were to read the educational content supplied by the application, select at least one video to watch with the cat(s), and adjust the playback speed at least once during use. Being given these three tasks guaranteed testing of MewTube's three core functions (the educational content, video library, and adjustable playback speed) by every participant exposed to the application condition.

In the intervention condition, we observed and recorded participants' engagement with both the application and the cats. After

use, the visitor completed a post-experiment survey, structured similarly to the baseline condition's but with additional questions specific to the application. This was followed by a brief semi-structured interview in which the participant was asked about the experience of using the app, the feline enjoyment perceived, comparisons to traditional toys, and whether the application seemed to have influenced the sense of connection to the cats. Follow-up prompts for in-depth follow-up on responses allowed flexibility while keeping the core themes at the centre of focus.

Many participants had visited the café in the company of a friend or family member. In these cases, we conducted group interviews rather than one-on-one conversations. This not only had the benefit of being more time-efficient but also let interviewees take part in discussion among themselves, delivering richer, more considered responses [4].

5 SETTING THE STAGE: REQUIREMENT-GATHERING

Recording video footage of the cats as they engaged with various visual stimuli informed analysis aimed at identifying various behaviours indicative of engagement; these are outlined in Table 2. Our observations also captured the cats' engagement with applications vs. video footage; the results are captured by Table 3.

Table 2 identifies which cats exhibited which behaviours in the preliminary-testing stage. Cats 2, 10, and 13 are not represented here, since they remained in the café's private, visitor-inaccessible area throughout Phase 1. Most participants present showed interest in the screen-based content, with nine watching videos and four interacting with the applications. Four cats tapped the screen, two swiped, and none completed a dragging action. Visible response to the cat's action did not seem necessary for sustained engagement – several cats continued tapping the screen independently of obvious feedback from doing so. Most cats seemed satisfied by watching the screen without taking part in physical interactions.

The cats were noticeably more interested in the screen when auditory cues were being produced, with the nature of the sounds not appearing to have an impact. Likewise, the cats expressed no preference between visuals of real birds and animated mice; they did not engage any longer with either footage of tangible (real-world) animals or abstract images (animations).

Comparison between tables 2 and 3 reveals that, while every cat interacting with the application also watched the videos, not all video-watchers engaged with the interactive elements. This pattern implies that, for cat café environments, giving priority to engaging visual content may be more effective than focusing on responsive functions.

5.1 Survey-Based Understanding of Cat Café Visitors

In our survey of people who had visited the cat café before ($n = 10$), 80% showed interest in using a tablet application to play with cats, with 30% expressing strong interest. A sizeable minority, 40%, raised concerns about cats' ability to maintain boundaries during interactions, of whatever sort. Thematic analysis identified four key design considerations: **control over screen content**, **well-designed sounds**, **simplicity of the interface**, and **user interest**. The visitors desired an ability to adjust the elements on the screen (e.g., by colour and speed) in line with cats' responses and emphasised soft, natural sounds' importance in preventing distress. Many envisioned a simple, intuitive interface, akin to those in apps for children, and responded enthusiastically to the notion of digital play as a novel, accessible tool for those less confident around cats.

Cat	Tapping	Swiping	Dragging	Engaged
1	×	×	×	×
2	–	–	–	–
3	✓	×	×	✓
4	×	×	×	✓
5	×	×	×	×
6	×	×	×	✓
7	×	×	×	✓
8	×	×	×	✓
9	×	×	×	×
10	–	–	–	–
11	×	×	×	✓
12	×	×	×	×
13	–	–	–	–
14	✓	×	×	✓
15	✓	✓	×	✓
16	✓	✓	×	✓

Table 2: Interactions displayed by feline participants

Cat	Applications	Videos
1	×	×
2	–	–
3	✓	✓
4	×	✓
5	×	×
6	×	✓
7	×	✓
8	×	✓
9	×	×
10	–	–
11	×	✓
12	×	×
13	–	–
14	✓	✓
15	✓	✓
16	✓	✓

Table 3: Engagement observed from feline participants

5.2 Findings from Requirement-Gathering

Accordingly, we concluded that the application should function primarily as an engaging visual and auditory experience, rather than as a responsive gaming application. For feline users, it should be simple, hold visual and aural appeal, and not require that the cat's engagement comprise physical interaction. For human users, it should offer some form of physical interaction, be simple enough to serve as a background-agnostic introduction that is accessible to everyone, and allow some form of control or customisation. Phase 1's tests with cats enabled us to establish the following list of feline requirements (FRs) for our application for the forthcoming:

- **FR1: Prioritise visual engagement.** The application should grant precedence to engaging, motion-based visuals over touch-based interaction by cats. Since most cats

do not tap, swipe, or drag, the app's effectiveness should not rely on them interacting physically.
- **FR2: Include auditory stimulation.** Sound effects (such as soft bird calls or mice squeaking) should be included, to enhance engagement.
- **FR3: Avoid overstimulation.** The application should steer clear of flashing lights and loud/sudden sounds, which could startle cats.

We identified these three central human requirements (HRs) for the application:

- **HR1: Allow users control over content.** Visitors should be able to adjust the content shown on the screen. This promotes engagement and aids in interacting with the cats.
- **HR2: Keep the interface simple and intuitive.** The user interface should be minimalistic, with icons and self-explanatory controls instead of text-heavy menus. The application should be easily navigable, even for users with limited technical abilities.
- **HR3: Encourage consideration of cats' boundaries.** Features should help ensure that the application does not encourage excessive intrusion into any cat's personal space (e.g., there should be no need for physically guiding a cat to the screen).

6 THE IMPLEMENTATION

Developing the MewTube application demanded careful consideration of both feline requirements (FRs) and human requirements (HRs) identified in Phase 1 in aims of delivering an intuitive, engaging experience for both user groups. This section details the system's implementation by describing, in turn, its core design principles, the technologies we employed, and the key interactive features.

6.1 The System Developed

We intended our interactive touchscreen application to foster non-invasive interaction between human visitors and feline residents of a cat café environment. Informed by insight gathered in the preliminary testing with both feline and human participants, the application was designed to engage cats through a curated selection of videos (per FR1 and FR2) and to help humans respond to feline behaviour by adjusting the playback speed (per HR1). The resulting foundation for flexible engagement tailored to the cats' reactions should aid in meeting FR3: avoidance of overstimulation.

We identified a need to feature, alongside video content, educational content. Designing an application to guide visitors in how to engage with cats respectfully by delivering insight into key feline behaviours meets HR3, thus ensuring that it serves not only as an interactive tool but also as an education resource. Users gain better understanding of the needs of cats.

In light of evidence that tablets are suited well to ACI contexts because they allow users to interact directly with the visual output received, without having to employ external tools (such as a mouse or keyboard) [42], we developed and tested MewTube on a Samsung Galaxy Tab A, running the Android operating system. Our initial testing verified the suitability of tablet interfaces for a cat café environment.

We built the application with the Flutter framework, on account of its strong performance and flexibility, coupled with the exceptional suitability of its rendering engine (Skia) for handling graphics-intensive tasks such as the video playback that counts among MewTube's core functions. This too responded to FR1. The `video_player` package facilitated playback of our videos, which were stored locally to the application. To enable visitors to adjust video speed in accordance with their perceptions of the cat's preferences and behaviour, we customised the video-player to present a simple, user-friendly slider interface suitable for a person with any level of technical abilities (thus meeting HR2). With this implementation, café visitors can balance their focus between the cats and the MewTube system.

6.2 Design Criteria and Core Features

Developing a system to meet the needs of two, quite contrasting user groups – cats and humans – proved to be challenging. The discussion below addresses crucial aspects of the design ultimately created and explains how these mesh with the requirements articulated in Phase 1.

Educational content

We incorporated the introductory educational component (visible in pane A of Fig. 4) explicitly to support visitors in their interactions with the cats. Research indicates that providing guidelines for interaction with cats, along with insights into the meanings behind feline behaviours, promotes more mindful, appropriate interactions between human users and felines [18]. Rather than risk overwhelming the human user with masses of text, we structured the guidance in line with cognitive load theory [49]. Presenting the information payload in small, readily digestible segments that do not demand excessive memorisation, we offered concise, actionable insight that a visitor could immediately apply while using the application. Additionally, adhering to constructivist learning theory [20] equips the application to encourage learning through experience – observing how cats respond to certain stimuli and adjusting one's interactions accordingly. This design not only represents the intuitive experience required for HR2 but also promotes mindfulness in engaging with the cats; by helping to reinforce appropriate boundaries and respectful interactions, it honours HR3.

A rich video-library interface

The main interface of the application, shown in Figure 4, pane B, follows the design conventions of popular video-streaming platforms, such as YouTube and Netflix, to create an experience that human users find familiar and intuitive. Mirroring these widely recognised interfaces helped put visitors at ease: they could navigate the system easily without prior instruction. In addition to meeting the need for a simple and accessible user interface (HR2), we responded to the requirement for genuine interactivity (HR1), by means of control over video selection. The design choice of letting humans and, by proxy, cats adjust the content displayed on the screen also acknowledges that, as the cats engage with the visual and auditory stimuli, human users too benefit from a sense of agency in the interaction with the application.

Adjustable playback speed

One distinguishing feature that sets our application apart from traditional streaming platforms is its playback-speed control. Whereas conventional apps require users to enter a settings menu and manually select a playback-speed option, ours displays a slider-based control bar right beside the playback area (see Fig.

Figure 4: MewTube navigation: The human participant begins on a page that supplies educational text about cat(s) behaviours (A), then browses a library of videos to watch with the cats (B). Making a selection prompts displaying of the video chosen, alongside a playback-speed slider (C).

4: C), thereby affording fluid and dynamic adjustment. With this decision, for enhanced user engagement (per HR1), we sought to be sure that visitors can interact with the content seamlessly, without disruption to their experience.

Our slider implementation took into account the findings from our preliminary research, which indicated that cats do not typically engage in dragging-type interactions on a screen. (Table 2). Therefore, we placed this dimension of control firmly in the hands of human users. The feature is a practical measure that, by preventing incidents in which a cat might accidentally alter the playback speed, maintains a smooth and predictable experience (per FR3), but simultaneously, through the facility for experimenting with different speeds to see how the cats respond, it enhances interaction in aims of providing an engaging, truly interactive experience without requiring physical input from the cats themselves (under FR1). Thus, interaction ends up enhanced on multiple fronts.

6.3 Curation of Videos

We created a curated library of 12 videos sourced online, all of which were screened to ensure a cat-appropriate experience, without flashing visuals, rapid transitions, or sudden/abrupt noises. The videos typically feature smooth motion plus natural soundscapes or gentle music (per FR2 and FR3). We focused on two content types overall: footage of tangible stimuli (e.g., birds, fish, or insects filmed in natural settings) and abstract animations (moving shapes, stylised animals, etc.). A full list of the videos in our library is included in Appendix B. Our video selection was informed by previous research suggesting that cats direct greater attention toward screen-based visuals depicting small prey, such as birds/rodents, or friendly conspecifics [9]. These stimuli have demonstrated appeal to indoor cats, particularly those with restricted access to stimulating real-world views [9].

We also considered feline visual perception, with specific attention to the species' higher flicker-fusion threshold, which is bound to affect how cats experience videos. According to critical flicker frequency (CFF) research, they can discriminate between frames at 30–40 Hz under normal conditions [33], though some studies suggest that the threshold may be even higher under optimal conditions. Further complicating matters, such factors as luminance, adaptation state, and differences between individuals and (especially) between one breed and another [33] can produce large variations in CFF. Thanks to their generally high temporal resolution, cats might find videos displayed at lower frame rates choppy or flicker-prone. Although modern Android tablets' typical refresh rates (90–120 Hz) lie far above the thresholds implied, many games and video-content sources remain capped at 60 fps or lower, potentially putting them within detectable flicker range for feline vision. Our analysis concluded that, in normal conditions, domestic felines should not experience flickering from the MewTube app.

7 ANALYSIS MECHANISMS

The data for Phase 2' came from post-interaction surveys and transcripts of the semi-structured interviews. Quantitative data from questionnaires were subjected to Mann–Whitney *U*-testing for comparison of responses between the baseline and the application condition. Given the small sample and the non-parametric nature of the Likert-scale data, this test offered appropriate measurement of statistical differences. Six main metrics informed the statistical comparisons: for 1) the participants' enjoyment of the interaction, 2) perceived enjoyment by the cats, 3) perceived impact on the human–cat connection, 4) expected likelihood of returning to the café, 5) overall enjoyment of the visit, and 6) the overall perceived connection to cats. All tests were handled by the IBM SPSS Statistics package.

For the interview transcripts from the application condition, analysis employed reflexive thematic analysis by the first and last author, following Braun and Clarke's six-phase process [5]. Because the participants were interviewed in an operating cat café environment, disruptions from personnel and cats occurred on occasion; hence, the transcripts were cleaned of non-relevant content in preparation for coding. In coding performed inductively, we clustered codes under themes representing patterns in participants' experiences and reflections on using the application. While we did not opt for formal guidelines for the coding, we structured the themes around RQ2, focusing on experiences: visitors' perceptions of cat–tablet interactions, their relationships with cats, etc. Firstly, we uncovered themes by reviewing the café visitors' responses in the interviews and watching the video recordings of their interactions. This led us to our initial set of themes: feline engagement, user enjoyment, impact of the technology, and user perspective. Then, the first and the last author coded the interview material to reveal patterns falling under these themes. The final themes from our analysis, codes, and example quotes are presented in Table 4 and unpacked below through our discussion of the results and their implications.

8 FINDINGS

Four themes emerged from our analysis: 1) feline engagement and interaction with the application, 2) user enjoyment of the application relative to traditional toys, 3) the application's impact on the human–cat relationship, and 4) differences in user perspectives. These are summarised, with the corresponding codes and some illustrative quotes, in Table 4.

Feline Engagement and Interaction with the Application

Visitors' perceptions of feline engagement with the application depended on the cats' state (awake vs. sleepy) and on the felines' personal character and preferences. Visitors also recognised even when the cats were relatively unresponsive that the application **could** work if the cats were more alert. For example, P16 predicted that 'if we tried it now that the cats are a bit more awake, it might work'. Alternating playback speed between fast and slow was perceived as increasing cats' engagement levels, with, for instance, P19 stating: 'Some cats didn't change behaviour' when playback speed changed but 'some grew more interested'. In general, participants exposed to the application were significantly less confident that the cats enjoyed the interaction in sum than those using only traditional toys were (p = .040; see Fig. 5).

Enjoyment Levels Relative to Those with Traditional toys

Questionnaire responses revealed no significant difference in participant enjoyment between the baseline and the application condition (p = .094; see Fig. 6). This implies that the humans found both interaction styles entertaining. The interview data support that conclusion, in that, while participants noted that their engagement approach differed between use of the application and of traditional toys, they did not communicate an overall preference for either. Café visitors believed that using MewTube altered their general way of interacting with the cats. For example, P16 commented that using the application 'adds a different dimension to' the interactions. Some participants stated that the app helped them have more appropriate engagement with the cats, with P26 commenting on a sense that 'the cat was more engaged with me than if I went up and started bothering it with a toy'. Additionally, some participants identified the application's use as eliciting more desirable responses from cats, such as responding more with 'a cute body language' (P17).

No significant differences between conditions were visible in responses about the likelihood of returning to the café either (p = .436; see Fig. 7). Therefore, the interaction tools that visitors employed to engage with the cats seemed to have no impact on their overall experience at the café. The absence of a significant difference appearing in the enjoyment of the visit reported by the two sets of participants echoes this finding (p = .730; see Fig. 8).

Application's Impact on the Human–Cat Relationship

Where the questionnaire illuminated a highly significant difference in the sense of connection with the cats – participants favoured the baseline condition in this regard, with p = .001 (see Fig. 9) – the interviews added nuance to the picture. Several stated that the app fostered a more personal or relaxed form of engagement, expressed by P17 in musings that MewTube excels for letting people 'entice the cats to come and sit beside them and snuggle'. At the same time, lack of feline response could leave a user feeling uncomfortable or unsure, as with P25's nagging sense that 'I felt like I was annoying [the cats] when they didn't react'.

Such concerns notwithstanding, the data showed no significant difference in the overall connection to the cats reported after participants' visit (p = .730; see Fig. 10). This suggests that, though the choice of interaction method shaped individual moments of connection, it did not define the relationship between the visitors and the cats.

Differences in Visitor Perspectives

The value seen in the application differed with participants' earlier experiences with cats. First-time visitors found MewTube to be a non-intimidating way of initiating interactions, while those already familiar with cats tended not to find as much use in it. The contrast is captured in the comments 'I've never played with cats or cat toys before, so I was more comfortable with the tablet' (P26) and 'I'm more comfortable with the traditional toys, because I've always been around cats' (P25). However, even those with prior experience acknowledged the application's value for less experienced visitors. For instance, P22 stated: 'It would probably help people who are more nervous around cats.'

Theme	Codes
Feline engagement and interaction with the application	• Impact of playback speed • Impact of cats' preferences • Impact of cats' state of mind
Visitor enjoyment of the application, relative to traditional toys	• Differences linked to visitor perceptions of feline behaviour • Differences in perceived interaction with cats
Effects of the application on the human–cat relationship from the human perspective	• Impact of cat disengagement • The impact of application use on interactions with cats
Differences in visitor perspectives	• Previous experiences with cats • Identification of target users for the application

Table 4: Themes and codes identified from post-interaction interview transcripts from the visitor perspective

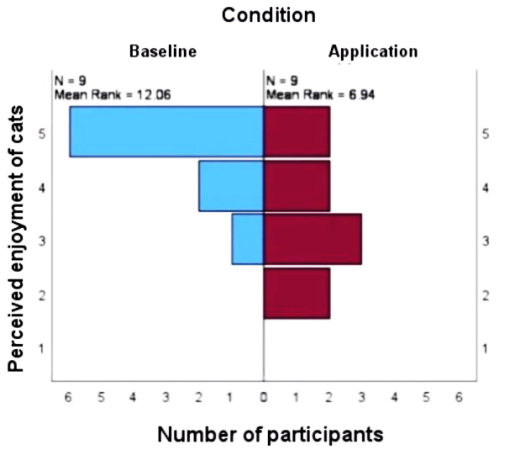

Figure 5: Visitor perceptions of the cats' enjoyment of the toys (the baseline condition) vs. the MewTube video application (our intervention).

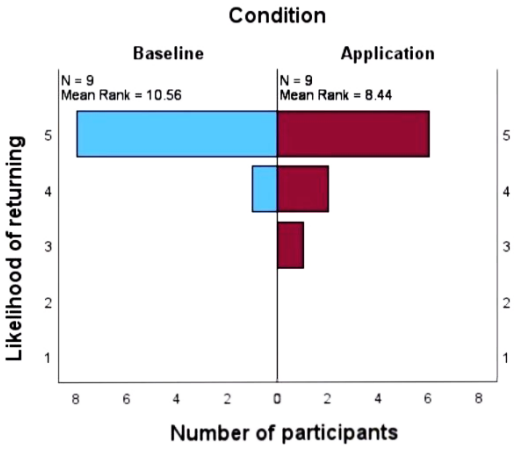

Figure 7: Visitors' estimates for their likelihood of returning, for cat café activities using traditional toys vs. our application (MewTube videos).

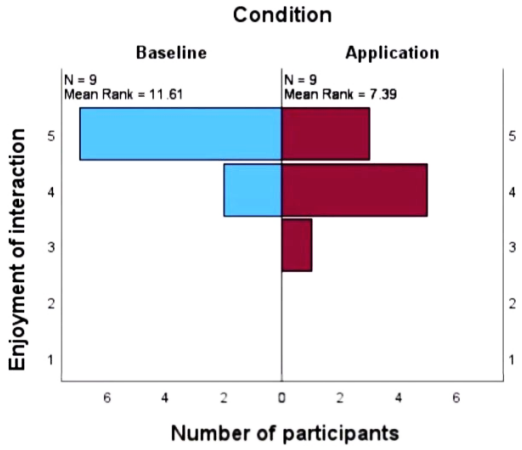

Figure 6: How much visitors enjoyed their interaction with the cats when using traditional toys and MewTube videos (in the baseline and intervention condition, respectively).

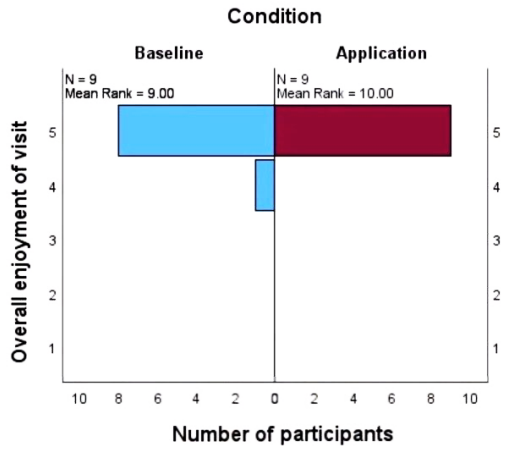

Figure 8: Visitors' overall enjoyment of their visit in settings with toys (the baseline condition) and MewTube videos (our application).

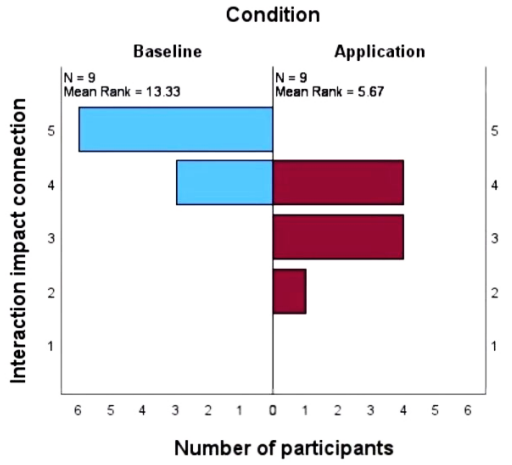

Figure 9: Visitors' perceived connectedness to the cats they played with when using toys (baseline) and the MewTube videos (our intervention).

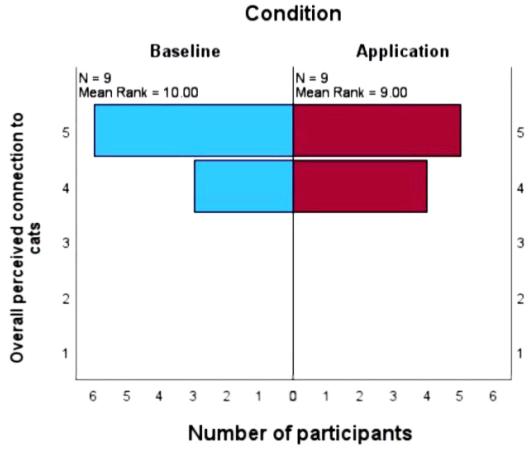

Figure 10: Our application compared to the baseline – overall perceived connection to cats when visitors used toys vs. MewTube videos.

9 REFLECTIONS ON KEY FINDINGS

Integration of digital engagement tools into multispecies settings has garnered increasing attention, centred particularly on such environments as animal cafés and zoos, where human–animal interactions constitute the core of the visitor experience [18, 54, 56]. That provided one motive for building on prior work exploring tablet-based systems' possible part in facilitating more appropriate human–cat interactions by examining both how cats engage with tablets and how using one to mediate interactions with the animals affects visitors' perceptions. Below, we reflect on unravelling the complexities of designing technologies that accommodate both feline welfare and human expectations within a shared space.

9.1 Interpreting Feline Responses to Digital Interactions

A major theme emerging from the data is the importance of reciprocal engagement in shaping humans' perceptions of the quality of their interactions with animals. Traditional toys elicit immediate physical responses sparked by cats' instincts. These chasing, pouncing, and batting actions give instant feedback to humans even if the behaviours' meaning might not be obvious. This may explain why participants reported a stronger sense of connection to the cats in the baseline setting (as Fig. 9 shows): their actions directly exerted influence on the animals' visible behaviour. Interactions with the tablet-based app, on the other hand, often had a more passive and observation-oriented nature, with cats engaging at their own discretion. As several participants exposed to the application condition reported instances of cats being intrigued by the video but not actively interacting (e.g., P12's 'They like to watch it, but weren't very interactive'), uncertainty lingered: was the interaction meaningful for the cats and the humans both?

This result implies that, for digital engagement tools to enhance human–cat bonding, they should maximise feedback to the visitors. However, we would question such an approach to reciprocity, because it might impose anthropocentric expectations on cats. The human pattern of anthropomorphising non-human agents, assigning our own meanings to their observable behaviours [11], may prompt us to seek out interactions that mesh with our human understanding – e.g., with physical responses of tapping or swiping. Our research suggests that felines in cat café environments might demonstrate their engagement with screen-based devices by showing attentiveness rather than via active physical motions. Perhaps, then, instead of designing technologies to elicit human-desired behaviours from cats, we should concentrate on educating visitors in interpreting natural feline responses and fostering appreciation for them. This proposal is consistent with a conclusion from research into designing digital systems for animal end users: animals must be respected as legitimate stakeholders [30], and the designs should accommodate their needs [42]. We harbour no illusions that shifting from anthropocentric to cat centred design is a challenge-free undertaking. Many nuances of human–animal interaction technologies hold relevance. Perhaps most prominently, entirely prioritising animals' preferences over human expectations in commercial environments such as cat cafés could undermine visitor satisfaction and, ultimately, the venue's sustainability. The problem lies in arriving at design approaches that respect feline agency while still providing meaningful experiences for visitors, a balance that requires considering both species' needs carefully, without compromising either.

> **Recommendation 1:** So that human visitors to cat cafés can more fully understand the cats they engage with, computer systems for the cats' use should support insight into feline behaviour.

9.2 Uncertainty Surrounding What Cats Might Be Enjoying

The significant difference in perceived enjoyment by cats suggests that participants felt less confident in the felines' enjoyment of interacting with the app relative to the baseline artefacts.

Again, the divergence likely arises from the tablet-based engagement's lack of clear behavioural cues (what even is a 'good' cat–tablet interaction?), which renders it more difficult for the visitor to judge whether the interaction was positive, meaningful, etc. for the cats. Many participants' struggles to interpret cat–tablet behaviour manifested themselves in uncertainty and, in some cases, discomfort. One participant (P25) even wondered whether use of the application was intrusive or disruptive for the cats. This observation is consistent with prior studies identifying a critical challenge of ACI research: our inability to understand animals' experiences and therefore design systems that meet their unique needs [2, 30, 42].

The issue of uncertainty points to a broader consideration in digital systems designed for animals – inherent reliance on human interpretations of engagement. A mismatch clearly can exist between these and the behaviour interpreted. While traditional toys naturally initiate a well-known cycle of action and response, screen-based interactions do not always yield clear, immediate, or expected feedback. This raises important questions about evidence. How can humans craft interactive systems that facilitate genuine feline engagement and simultaneously grant users a clearer window to understanding how – and to what extent – the cats are engaging?

Recommendation 2: Those developing applications for cat cafés should concentrate on creating systems that clearly communicate to human users how cats are engaging – not least by considering signs from the negative and positive behaviours possible.

9.3 Digital Interaction's Role As a Mediator for New Visitors

The contrasts visible in our results illuminate not just the above-mentioned challenges in interpreting feline responses but also differences in visitor needs, alongside how digital systems can address factors such as experience level. Because participants familiar with feline behaviour tended to favour traditional toys while first-time visitors and others less confident around cats found the tablet to be a non-intimidating way of getting eased into interaction, we recognised that digital systems designed for animal use hold promise as an entry point for people uncomfortable with interacting directly with animals. In marked contrast against the traditional toys, which require close physical interaction, the application offered a lower-pressure, observation-anchored way of interacting. This held particular appeal for those with less experience or more uncertainty in the realm of feline behaviour, giving them a valuable way to engage without fear of mishandling or overwhelming the cats.

Rather than take the place of traditional forms of play, digital tools of MewTube's sort could be strategically positioned as a bridge guiding first-time cat café visitors toward more direct interaction. By assisting users to engage in a passive, observation-based interaction before transitioning to physical play, the application could reduce anxiety and build confidence in those unfamiliar with feline behaviour.

Moreover, this structured approach to interaction could greatly benefit cat café settings at large. Many of these venues face challenges from younger visitors, who may struggle to understand cats' boundaries and sometimes engage via actions that stress or overwhelm the animals, such as chasing them [3]. In captive settings especially, such applications could serve as an alternative interaction method for children, whereby they can interact without posing a risk of unwanted physical contact. If combined with embedded educational content, such as guidance on reading feline body language, the tools could strongly support more mindful, appropriate visitor–cat interaction across the board.

Recommendation 3: Computer systems for interactive use in cat cafés can significantly assist first-time and less experiences cat café visitors by providing structure for non-physical interactions with cats.

9.4 The Impact of Interaction Timing

Another pivotal factor emerging in engagement with the application is the timing of interactions, particularly in relation to the cats' natural activity cycles. Participants frequently reported that MewTube elicited engagement less effectively when the cats were sleepy or in a state of relaxation (P12 and P16 are cases in point). While some cats displayed curiosity and passively observed the on-screen stimulus, others ignored it entirely, so participants ended up questioning whether the application is a meaningful tool for interaction.

That uncertainty, introduced above, underscores another challenge unique to designing digital experiences for non-human users, that engagement is not solely a function of the technology itself. It gets shaped also by external, context-dependent factors. Whereas visitors can derive entertainment from traditional toys regardless of feline responsiveness, the application required some level of participation from the cats. When this was not forthcoming, some visitors experienced frustration or disengagement. For example, P25 suggested that the effectiveness of the tool was contingent on the cats' readiness to interact, rather than on its inherent design.

Hence, our findings suggest that the application should be treated not as a universally applicable tool for engagement but, rather more, as one that is best utilised at optimal times: during the cats' peak activity periods, when they are naturally more active and receptive to interaction efforts. In a cat café setting, where visitor expectations are shaped by a desire for playful, reciprocal interactions, providing the application during spans of feline inactivity might lead to disengagement or disappointment. Instead of positioning the technology as a stand-alone alternative to traditional toys, a better strategy could involve applying it as a supplementary option at the peak of cats' activity cycle.

Recommendation 4: Future interactive computer systems for cat cafés should be designed to account for cats' natural activity cycles, ensuring that timing interactions for when the cats interactions occur when the cats are at their most receptive.

9.5 The Role of Toys in the Cat Café Experience

Irrespective of differences in how visitors interacted with the cats, the method of interacting – via traditional toys or the application – did not seem to have significant effects on their overall enjoyment of the visit or their likelihood of returning, as noted above. This implies that factors beyond the specific interaction tools (such as the cats themselves, the café's atmosphere, and the social environment) play a larger role in shaping visitor satisfaction. Likewise, from a design perspective, the individual engagement tools, whether digital or physical, appear secondary to the broader experience of the human at a cat café. While visitors may favour some types of interaction above others, these preferences do not strongly influence their overall perception of

the experience. In short, the choice of tools seems less important than the fundamental appeal of the visit itself. This conclusion dovetails with scholarly reports that cats in Shanghai cat cafés, working alongside human staff, constituted the primary attractant for visitors [59].

Interestingly, this stands in contrast against findings from zoo environments, where researchers have documented technology's significant enhancement of visitor enjoyment [53]. The discrepancy might reflect the fundamental difference in interaction style – zoo visitors primarily observe animals from a distance, whereas cat café patrons engage in direct tactile contact. This suggests that technology's positive effect on enjoyment may be most pronounced when direct physical interaction is unavailable; i.e., it might serve as a supplementary engagement mechanism rather than a competitor to hands-on experiences. This distinction indicates that digital systems for cat cafés probably should be designed differently from zoo technologies, to prioritise subtle enhancement over direct-engagement mechanisms.

The findings presented above highlight a vital consideration for future digital systems developed for cat cafés: their engagement tools should complement and align with, rather than function to replace, the holistic café experience. In venues that facilitate direct animal–human contact, the greatest value stems from the direct human–animal interactions, with technology operating as an enhancement, not a substitute. This conclusion too articulates the objective at the heart of multispecies design: digital systems must balance the needs of multiple stakeholders, accommodating both animal-welfare requirements and visitors' engagement expectations.

Recommendation 5: Interactive computing systems at cat cafés should serve as supplementary engagement tools, rounding out the existing café experience.

10 LIMITATIONS AND PATHS FOR FUTURE WORK

The project's findings represent a first step within specific contexts of time and place. Further progress requires working with more (feline and human) participants, over longer spans of time, for fuller exploration of how interactive computer systems can facilitate human–cat interactions in cat cafés. Likewise, further enquiry that considers multiple café environments, background cultures, and target species at cafés would expand our knowledge from that provided by this study, as would addressing seasonal and other temporal factors.

A substantial limitation in our study arose from the variability in cats' responsiveness to taking part in the study, or in how (and how much) they engaged with the human and/or tablet. Namely, this imposed uneven effects on user experiences. Visitors encountering an aloof/disengaged cat faced a highly limited opportunity to interact with MewTube so could not fully assess how using it might influence their connection with the animal. The study also faced challenges linked with the setting's scope, involving a business environment. Held during the cat café's operation as usual, the research sessions were subject to interruptions from non-participating visitors and from café staff. In a similar vein, encouraging participants to engage freely with the cats produced variations in how the application was used. While improving ecological validity, this autonomy might have introduced inconsistencies in the source data. Another limitation identified was rooted in the cats' natural activity cycles; as noted above, these influenced engagement with the application and in some cases reduced the chances of the cat showing interest in interacting with visitors. Several factors affected responsiveness, from the time of day (including whether the session coincided with the cat's rest period or feeding time) to the interval between interactions or the individual's temperament. All of these limitations, which are part and parcel of a cat café environment, underscore the complexities of designing and evaluating digital systems for human–animal interaction in real-world contexts.

We speculate that the results could have been affected also by the individual's temperament – i.e., each cat's distinct personality. Building on this awareness, the app's provision of information on cats could encompass not only generic information on felines as our implementation did but also a more personalised approach. Education about specific cats' personality, preferences, and behaviour patterns might represent an interesting line of research. Café visitors might value an additional layer of information, especially if less familiar with feline behaviour and more reliant on the app.

Our design drew from recent work around how to shape more appropriate human–animal interactions in public spaces, but plenty of room remains as we look toward the future. Regarding cats in particular, we see animal shelters as a strong candidate for future research, as cats housed at shelters often experience acute stress and fear [15, 57]. App-based facilitation could exhibit special value for the wellbeing of stressed shelter cats, animals often exhibiting withdrawal behaviours that, by complicating traditional assessment, potentially prolong the animal's stay and reduce adoption rates [15, 57]. A tool similar to ours could enrich the life of cats at shelters while simultaneously opening an avenue for potential adopters to interact with them in a less intrusive, perhaps less stress-inducing manner. Research probing the outcomes could even exploit feline biomarkers (e.g., cortisol levels) and ethograms to delve more deeply into the cats' experience of interactive technologies and inform the guidance to visitors. Importantly, such measurements might enable assessing the application from the cats' perspective directly. Alongside physiological metrics, researchers conducting future work should establish ethics protocols specifically tuned for ACI studies. Ethics guidance, both for designers and for the human users of the human–animal devices, should incorporate solid, standardised welfare-assessment criteria, to be applied for engaging with the device initially and ascertaining when to halt or resume the screen-based interaction in light of the animal's actions. Such frameworks promise to hold special value for commercial applications, as a safeguard against economic pressures that might act counter to animal-welfare considerations.

Deployment in other domains possesses potential too. Tablet applications such as the one we developed could furnish ways to engage with pet cats in the home. While some systems have been launched to facilitate interaction between humans and cats in a domestic setting [36, 50, 56], there is little insight into how using such systems affects relations between humans and pets. Future iterations could explore how the application might strengthen existing bonds.

When working to figure out whether interactive computing technologies could be successful in a cat café environment, we tested laptop and tablet computers. While this was a convenient choice – both were portable devices familiar to the visitors and staff we approached – such devices are created with humans as their primary end user. One must bear in mind the anthropocentric bias thereby 'baked into' the resulting application. Exploring

other form factors, such as devices embedded in toys as implemented in some studies with companion animals [30], could uncover routes toward a system better tailored to feline users' physical and cognitive needs.

Lastly, the effectiveness of educational content furnished within the application setting warrants further exploration. While we included a few basic education points by way of introduction to MewTube, its impact on visitor behaviour and cat wellbeing was not directly tested. Future studies should address this factor too: does such content actually bring improvements to visitors' interaction with cats?

11 FINAL THOUGHTS

Our study contributed to investigating tablet-based tools' possible position in the human–animal interaction at cat cafés. Developing the MewTube application to cater for cats and humans alike revealed that an interactive video-player app offers an alternative method of visitor engagement with cats in a café setting. Importantly, the utility of the application remains contingent upon humans' interpretation of feline behaviours. In particular, cats' interaction with the screen-based application was more passive and observational in nature, leading to visitor uncertainty surrounding the cats' level of engagement whereas traditional toys elicited more immediate, observable responses. Coupled with the absence of a significant influence of the interaction-tool type on human satisfaction with the overall café experience, this highlights the importance of considering the experience as a whole. Furthermore, our work illustrates efforts at mindful design aimed at interactive interfaces that mediate human–cat interaction in a manner sensitive to both feline and human needs. This study contributes to the ACI field also by offering recommendations for how digital tools can be integrated for balanced human–animal interaction in public interspecies spaces.

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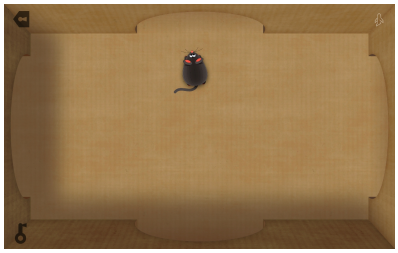

Figure 11: Screenshot of Cat Alone 2 on the mouse setting

Figure 12: Screenshot of Cat Alone 2 on the orb setting

Appendices

A PHASE 1 STIMULI

During Phase 1 of requirement gathering, we explored four different stimuli: the Cat Alone 2 game, a musical baby game, and two videos of animated mice and real birds.

Cat Alone 2 (available at: https://play.google.com/store/apps/details?id=com.galbro.catalone2&hl=en_GB) is a tablet game developed specifically for use by cats, where they can interact with the game by tapping on different items as they travel randomly around the screen. For this phase of testing, we utilised the mouse (Figure 11), orb (Figure 12) and water droplet settings (Figure 13).

In the mouse setting, a mouse travels around the screen, popping in and out of the holes around the edges, with a squeaking noise is played, and the tablet vibrates when the mouse is caught. In the orb setting, an orb bounces around the screen, with a small trail of light following it. Gentle popping noises play whenever it hits the edge of the screen, and when it is 'caught', a high-pitched bubbling sound plays while the tablet vibrates. In the

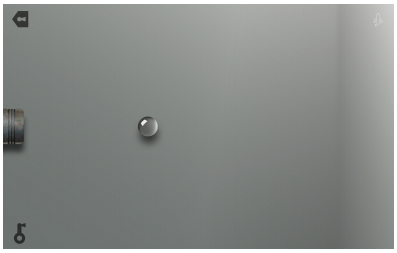

Figure 13: Screenshot of Cat Alone 2 on the water droplet setting

Figure 14: Screenshot of Baby Games on the keyboard setting

water droplet setting, droplets of water fall from a pipe at the top of the screen, with a plopping noise. When the drops are 'caught', a splash noise plays, while the tablet vibrates.

For Baby Games stimuli (available at: https://play.google.com/store/apps/details?id=com.rvappstudios.baby.games.piano.phone.kids&hl=en_GB) We used the music room game mode, which provides users with virtual representations of a piano and keyboard (Figure 14).

The videos used were sourced from YouTube and included an animated mice video (https://youtu.be/qW-KIjHjjHM?si=bSdfCMiuwVDf7gYG), and a real bird video (https://youtu.be/xbs7FT7dXYc?si=rhPw7T1xaVZmbPOK).

B MEWTUBE VIDEOS

- CAT GAMES - Catching Mice! Entertainment Video for Cats to Watch: https://youtu.be/qW-KIjHjjHM?si=xNYvLAMp0dguIfRk
- Disco Fruit Party! - Fun video with music and dancing: https://youtu.be/b65MoVwANq4?si=hxuARaQm_bxzVX7Q
- Footage of Whales & Jellyfish: https://youtu.be/iNrPV5sEoCw?si=c7q_UlYKZiAiJPgS
- Relaxing And Stimulating Bird Videos For Your Kitty: https://youtu.be/rjzWTrt5cd0?si=D4j_rcQA-no7CwSM
- Neon Light Tunnel: https://youtu.be/HZPs57Lp90A?si=gG7MoCwoEbxFtUsZ
- Cat Games - Soccer Ball: https://youtu.be/m9VX0kILTl0?si=Covu3md6hq03i0Ig
- Funny Squirrel Dance: https://youtu.be/iXVKPyFQFFw?si=yvf60ExMrY4TFcFT
- Fish Videos for Cats: https://youtu.be/2xmngxAgKe8?si=4ilPZlRELpJf7TnB
- Mouse Video for Cats: https://youtu.be/8se7AhdLpcU?si=E7zQlBzLktCicwjV
- Black Birds and Squirrels: https://youtu.be/ns0-Au8Brwg?si=v4JUEWIY_SWlFd-E
- Yarn Ball: https://youtu.be/hiBkoRj0Pqc?si=RvVN6Du8gmf5Mzfd
- Spring Birds: https://youtu.be/o-pDL6SbVFI?si=h0stwobhrgFqMfTn