PAIDIAN PLAYFUL INTERACTION IN NON-GAME USER INTERFACES

by

MATTHEW LAKIER

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EXAMINING COMMITEE MEMBERSHIP

The following served on the Examining Committee for this thesis. The decision of the Examining Committee is by majority vote.

External Examiner	Regan Mandryk Professor, Department of Computer Science, University of Victoria
Supervisor	Daniel Vogel Professor, Cheriton School of Computer Science, University of Waterloo
Internal Members	Dan Brown Professor, Cheriton School of Computer Science, University of Waterloo
	Edith Law Associate Professor, Cheriton School of Computer Science, University of Waterloo
Internal-external Member	Aimée Morrison Associate Professor, Department of English Language and Literature, University of Waterloo

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1 https://authors.acm.org/author-resources/author-rights. Accessed January 2025.

ABSTRACT

I investigate "paidian" play in the context of non-game software user interfaces. Paidian play means activities that are open-ended, exploratory, and free-form. In an initial investigation, I characterize 16 types of playful experiences, 7 characteristics of play in software, and guidelines for the role of play in user interfaces, based on a qualitative analysis of a series of surveys and a brainstorming session with experts. As a case study of inspiring design with paidian play, a second investigation focuses on Easter eggs (hidden features in software applications), an interface feature associated with one of the playful experience types. I analyze source code repositories of open-source software containing Easter eggs, scrape online Easter egg databases, and interview developers of well-known software containing Easter eggs, to characterize 14 different Easter eggs purposes. Results show that Easter eggs provide significant value to developers and users, for example, by enabling recruitment of new developers and teaching users transferable knowledge and skills. I also propose implications for how Easter eggs could be applied in new ways, such as providing educational value. In a third investigation, as a design case study for paidian play, I define and implement "digital knick-knacks" as a form of playful digital possession (e.g., virtual pet). I deploy three exemplar designs in a diary study, in which participants customize and install a digital knick-knack on a personal device. The investigation reveals implications for how playful digital knick-knacks can bring joy and even support mental health. Taken together, the investigations show how user interfaces can be designed to provide social and emotional value to users through paidian play, including in workplace contexts.

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TABLE OF CONTENTS

List of Figures ix
List of Tables x
1 Introduction 1
2 Background and Related Work 4
2.1 Definitions of Play 4
2.2 Early Empirical Studies Characterizing Play 5
2.3 "Play" Versus "Playfulness" 6
2.4 Ludic Design 6
2.5 Situated and Emergent Play 6
2.6 "Fun" User Experience 7
2.7 Games, Gamification and Gamefulness 7
2.8 Curiosity 9
2.9 Design-Focused Playful Artifacts 9
3 Investigation of Playful Experiences in User Interfaces 10
3.1 Methods 11
3.2 Descriptive Results 20
3.3 Playful Experience Types 22
3.4 Play Perspectives 30
3.5 General Discussion 37
3.6 Conclusion 42
4 Purposes, Processes, and Directions for User Interface Easter Eggs 44
4.1 Background and Related Work 45
4.2 Method 47
4.3 Purposes of Easter eggs 50
4.4 Processes Impacting Developers and Users 60
4.5 Future design directions for software application Easter eggs 64
4.6 Conclusion 68
5 Digital Knick-Knacks: Standalone Audiovisual Digital Possessions or Embellishments in Digital Environments 69
5.1 Background and Related Work 70
5.2 Digital Knick-Knack Taxonomy 73
5.3 Exemplar Digital Knick-Knack Design Templates 77
5.4 Diary Study: Effects of Digital Knick-Knacks 78
5.5 Qualitative Analysis of Diary Entries and Interviews 81
5.6 Discussion and Implications 86
5.7 Conclusion 91
6 Conclusion 92
6.1 Play as a Resource for Design 92
6.2 The Uniqueness of a Paidian Play Approach in HCI 93
6.3 The Relationship Between Play and Distraction 94
6.4 Limitations and Future Work 95
6.5 Call for Playfulness in User Interfaces 98

Bibliography 99

Appendices

A Playful Experiences: Supplemental Details 123
A.1 Study 1: Survey Details 123
A.2 Study 1: Supplemental Descriptive Results 123
A.3 Brainstorming Session: Expert-generated Playful Experience Examples 126
B Easter Eggs: Supplemental Tables 128
C Brainstorming Session Digital Knick-Knack Types and Examples 130

LIST OF FIGURES

Figure 1.1 Research overview. Arrows show dependencies between chapters. 2

Figure 3.1 Screenshots from a subset of videos shown to respondents. (a) 2/*Dog Picture Scrolling*, (b) 9/*Barrel Roll Easter Egg*, (c) N2/*Swap Mode* 16

Figure 3.2 Histogram of SAM valence results across all respondents (lower score corresponds to higher valence). 20

Figure 3.3 Relative proportions of respondents who selected each experience example as "playful". 20

Figure 3.4 Histograms of SAM valence results for anti-archetypal examples (*Anti*) and archetypal plus expert brainstorm examples (*Play*), across all respondents and shown examples (lower score corresponds to higher valence level). 21

Figure 3.5 Proportion of HEMA eudaimonic ratings for each of the archetypal and expert brainstorm examples, across all respondents. 22

Figure 4.1 Images steganographically hidden in Matlab's 'default image'. © Image courtesy of The MathWorks, Inc. 53

Figure 4.2 Dinosaur game in Google Chrome, accessible by navigating to "about:dino". Image courtesy of Google LLC. 54

Figure 5.1 Example renditions of the three exemplar DKK design templates. 78

LIST OF TABLES

Table 3.1 Demographic information of brainstorming session participants. 13

Table 3.2 The 36 experience examples presented to respondents in Study 2. Experience IDs without a prefix are the archetypal examples from Study 1, IDs with a prefix of "E" (existing) or "N" (novel) are the expert brainstorm examples, and IDs with a prefix of "A" (anti) are the anti-archetypal examples. 16

Table 3.3 The 16 playful experience types, the studies they are based on, and examples. 22

Table 3.4 The 7 play perspectives and the studies they are based on. 31

Table 3.5 Comparison of our playful experience types with Webster's 1988 pilot study [225] and Arrasvuori et al.'s revised PLEX framework [12]. 39

Table 4.1 Summary of Easter egg purposes and associated publications. 41 Easter eggs were investigated in total. Counts sum to more than this total because Easter eggs can have multiple purposes. 51

Table 5.1 Selected theory categories and dimensions, including an example design generated from each theory. 74

Table 5.2 DKK types and descriptions, with an example of each from the brainstorming session. 76

Table 6.1 Connections between playful experience types and perspectives from Chapter 3 and concepts from the case study chapters (Chapters 4 and 5). 93

Table A.1 Counts of different types of features used by respondents as part of their reported playful experiences. 124

Table A.2 The 14 playful experience types with software user interfaces. Counts do not sum to 63 because some respondents' experiences belong to multiple types. Subtypes have counts dedented. 125

Table A.3 Ranked playful experience examples generated from the expert brainstorming session. 126

Table B.1 Examples of places in which Easter eggs are hidden. 128

Table B.2 Examples of user interaction methods to trigger Easter eggs. 129

Table C.1 Summary of participant examples from the brainstorming session. 130

1 INTRODUCTION

Some early desktop user interfaces were different than the ones we use today. Consider Microsoft Bob, which was a graphical interface for Windows in the 1990s, intended to make computers easier for new users [197]. It playfully represented programs as objects in a digital 2D environment. For example, one environment featured a living room with furniture and a fireplace. Bob also encouraged playful interactions, like exploring and interacting with the objects in the environment, and decorating the virtual rooms with objects of the user's choice. A friendly agent (e.g., in the form of a dog) would guide users through different aspects of the interface. Despite Bob's unique, playful take on computing, it was a commercial failure. In the HCI textbook *Interaction Design: Beyond Human-Computer Interaction* [197], Sharp et al. take Microsoft Bob as a case study for "Frustrating Interfaces and Negative Emotions":

> *"Contrary to the designer's expectations, many people did not like the idea of Bob at all, finding the interface too cute and childish. [...] Interfaces, if designed poorly, can make people look stupid, feel insulted or threatened."*

Were the very things that made Bob playful also the reason for its failure?

The style of user interfaces today might make it seem to be the case. User interfaces in serious contexts for productivity have largely moved away from the playful aesthetics and interactions of software like Bob, instead being designed to be sleek and minimalistic. Yet, people repurpose serious user interfaces in playful ways, like creating humorous custom emoji in corporate messaging apps. There are also examples where playfulness has been successfully integrated into less-serious contexts, like video or photo filters that make people look like animals. Examples like these can provide emotional value through aspects like humour, and social value, such as feelings of social connectedness. Can we capture and apply these qualities to a broader range of user interfaces and usage contexts?

We may consider turning to games for inspiration, using a method like gamification [59], because games are specifically designed for the purpose of playing. However, there are two limitations with this approach. First, while practically all games are designed solely for entertainment, the majority of non-game software applications are not. This means that non-game software features have differing design goals and criteria for success. Second, games generally operate in a context removed from their surroundings [189], whereas non-game software applications are usually part of a broader activity, like doing calculations, creating art, or communicating with others. Outside of games, play "needs to respect the purpose of the activity it is applied to" [200]. In other words, trying to incorporate playfulness into non-game software cannot ignore the broader context in which the software is being used. Considering the value of play and the limitations associated with borrowing from games, we need a different approach for understanding play in non-game contexts. *User interface researchers and designers are missing general principles or approaches for incorporating play into non-game user interfaces.*

Before we can investigate play, we need to establish a definition of play as something that people experience. Borrowing from Caillois' notion of *paidia* [34] and Gaver's notion of *ludic activities* [77], we define *paidian play* as an "open", "exploratory", and "free-form" experience, such as an experience associated with "curiosity", "diversion", "exploration", "invention", and "wonder". By *experience*, we mean an encounter with a feature or app, rather than a place or attraction like a theme park. This definition is intended to be broad and general, because we want to avoid applying preconceived notions of what different types of experiences might be considered playful.

This thesis investigates and argues for the value of paidian play in the context of non-game software user interfaces. It aims to understand the types of paidian play that exist in current software user interfaces, the benefits that paidian play can provide in this context, and ways to design features that support paidian play. We address these aspects through empirical investigations using qualitative analyses of surveys, interviews, and internet media to characterize different types of play and suggest user interface design directions. We also conduct design research to create digital systems that support play. Our findings demonstrate social and emotional benefits of play in software user interfaces, such as supporting social connection, creativity, mental health, and learning about how to use systems. We also show how user interfaces can be designed to provide social and emotional value to users through paidian play.

Figure 1.1 shows an overview of the thesis. We provide a high-level outline of each of these aspects below.

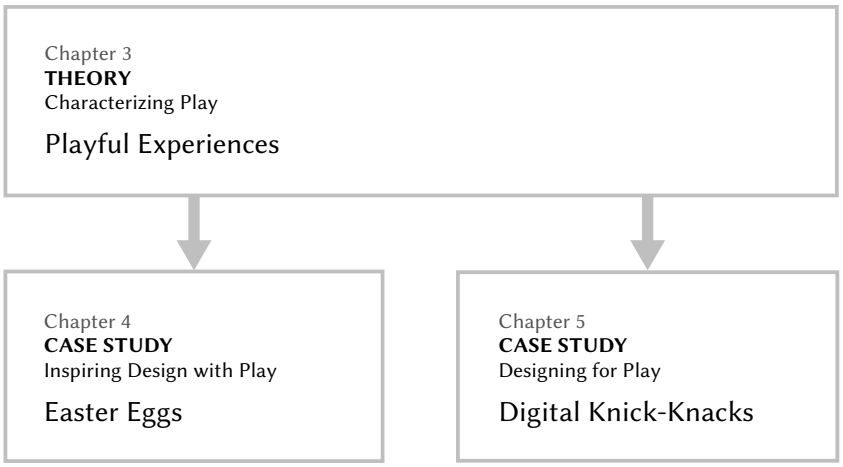

Figure 1.1: Research overview. Arrows show dependencies between chapters.

Chapter 3, *Playful Experiences* (Figure 1.1, top), investigates the ways that users experience playfulness in software user interfaces, to develop a theory of playful experience types. This is achieved through a primarily qualitative analysis based on online surveys. In the first survey (n=63), respondents reflect and report on a "playful" experience with a non-game app of their choice, and answer a set of questions about their thoughts and feelings. In the second survey (n=61), respondents reflect on a set of specific playful and non-playful experiences,

answering similar questions. Responses are analyzed to characterize categories of playful experience types, and themes representing perspectives on play. We also reflect on the types in relation to past theoretical works on play.

Chapter 4, *Easter Eggs* (Figure 1.1, bottom-left), is an in-depth exploration of the phenomenon of *Easter eggs* in software applications. One of the playful experience types characterized in Chapter 3 is called *Discovering Unexpected Feature*, which refers to the surprise of finding a previously unknown feature or a feature that others might not know about. *Easter eggs* are features hidden inside software, and can serve as a basis for *Discovering Unexpected Feature* playful experiences. While Easter eggs have seen some investigation in the context of games, their nature within non-game software applications is less clear, despite their prevalence. We perform a qualitative, investigative analysis of Easter eggs in non-game software applications, using primarily archival research including discussion forums, social media posts, and user-created online databases, along with select developer interviews. We uncover the stories behind, motivations for creating, and intended perceptions of Easter eggs, which we present as categories of purposes with illustrative examples. Our analysis also informs a categorization and discussion of processes that Easter eggs undergo concerning the social and emotional circumstances of their developers and users. This investigation serves as a case study for how investigating specific types of play can serve to inspire designs for future interactive systems.

Chapter 5, *Digital Knick-Knacks* (Figure 1.1, bottom-right), moves beyond Chapter 3 and Chapter 4's goals of investigating existing playful experiences, to focus on designing new playful experiences. It serves as a case study for the design of digital systems that support play through non-utilitarian digital possessions or embellishments we call "digital knick-knacks". We draw from our knowledge gained about play in software user interfaces. We propose a taxonomy to define and generate digital knick-knacks based on key publications on consumer behaviour and personal possessions, augmented by results of a brainstorming session with 9 HCI researchers. Using the taxonomy, we prototype three classes of digital knick-knack exemplars: an ambient noise machine, a virtual pet, and a virtual picture frame. In a 10-day diary study, 10 participants design their own variants of the prototypes, and report on their experience using them on a personal device. We analyze the diary entries and interviews with participants to show how digital knick-knacks can bring value to users, and we suggest implications for designing playful digital embellishments.

This thesis is structured as follows: Chapter 2 reviews past theories about play and related empirical and design work in the context of play. Chapters 3 through Chapter 5 detail the main research studies of the thesis, as outlined above. Chapter 6 concludes by highlighting common findings and ideas across the preceding chapters, situating our work more broadly in the play literature, and discussing limitations and future work.

2

BACKGROUND AND RELATED WORK

Play has been investigated in a diverse range of contexts, including psychology, game studies, product design, and user experiences. We review relevant work below.

2.1 DEFINITIONS OF PLAY

The terms "play" and "playfulness" are not easily defined. Many different attempts have been made to define and characterize play over the past century (e.g., [34, 86, 101, 206, 216]), each taking different approaches. For example, play has been investigated as evolutionary [86], in relation to games [34], in relation to rituals and rites of passage [216], and as an important aspect of culture [101]. More recently, frameworks have also been created to address specific contexts of play (e.g., social play among children [190]). We discuss several key conceptualizations and categorizations of play here.

Caillois, in his book "Man, Play, and Games" [34], uses the terms *paidia* and *ludus* to refer to different types of activities. *Paidia* refers to play that is "free" and "spontaneous", whereas *ludus* refers to activities associated with "arbitrary... conventions" (e.g., rules) that enable "diversion and amusement". Variants of this *paidia-ludus* distinction have been adopted by the games research community [58, 120]. Caillois' notion of paidia is central to our definition of play.

Csikszentmihalyi is also well-known for investigating play as part of his broader research on flow theory [48]. He argues that *flow*, a sensation of total involvement during activities performed with an optimal balance of skill and challenge, is present during play. He describes such experiences as "autotelic", meaning that such activities are motivated "primarily by the experience itself".

Apter's reversal theory [11] is a psychological theory associated with motivation and emotion. Apter claims that play "cannot be defined externally by reference to objective criteria; it is a phenomenological state". In other words, to define play or to understand if an activity is playful, we must understand the state of mind and context of the person engaged in the activity. Apter uses the term *paratelic* to refer to a playful state of mind, involving doing something "for its own sake", and *telic* to refer to a serious state of mind. Inspired by Apter, Hassenzahl [94] proposes two different "usage modes" for interacting with computers, "goal mode" and "action mode", which correspond to telic and paratelic states of mind, respectively. Because we define play in reference to Caillois' notion of paidia, many of the forms of play we focus on are performed with a paratelic or "action mode" mindset.

Sutton-Smith [206] reviews past works on play from a wide range of contexts, and groups them into seven "systems of value" that he refers to as "rhetoric[s] of play". Examples include "Rhetorics of Child Play", "Rhetorics of Power", and "Rhetorics of Self". Sutton-Smith argues that works like those of Csikszentmihalyi and Apter follow a "rhetoric of the self" because they focus on individual concerns such as motivation and emotions, and they typically characterize play as

intrinsically motivated, focused on "means rather than ends", "nonproductive", and associated with "freedom". Our exploration of play follows this rhetoric of the self, because we focus on more free-form types of play. However, unlike some works following a rhetoric of the self, we do not claim that this is representative of all forms of play.

Motivations for playing have also been investigated. One highly-referenced theory in Game Studies is Self-Determination Theory (SDT). SDT describes *extrinsic* motivation as related to "Compliance, [and] External Rewards and Punishments" and *intrinsic* motivation as related to "Interest, Enjoyment, [and] Inherent Satisfaction" [188]. It associates play with intrinsic motivation [54] and also borrows the term "autotelic" from Csikszentmihalyi to describe play. Huta and Ryan developed a scale to characterize motives for taking part in different types of activities [102]. They describe two kinds of motives, *hedonic* motives, associated with "the pursuit of pleasure, enjoyment, and comfort", and *eudaimonic* motives, associated with "seeking to use and develop the best in oneself". They relate different types of play to these two motives. For example, they describe playing video games as hedonic, but playing a sport as both hedonic and eudaimonic. Because software user interfaces are a core part of many people's daily work and leisure routines, we recognize that in addition to hedonic value, play also has the potential to provide eudaimonic value.

Rather than attempt to define play or motives for play in general, our work focuses on play that is open-ended, exploratory, and free-form, in the context of software user interfaces.

2.2 EARLY EMPIRICAL STUDIES CHARACTERIZING PLAY

Work during the 1980s investigated how the notion of "playfulness" applies to computer interfaces. Webster [225] synthesized a list of "characteristics of playful activities" based on a review of theoretical works from Malone, Csikszentmihalyi, and Sandelands et al. She also conducted a pilot study with 15 participants, to "highlight" this review. Participants were asked to describe "situations in which computers seem like play". In response, they described activities such as "figuring out new features" and "producing graphs or charts" as playful. This work was from a time when desktop graphical user interfaces were novel; much of what was considered playful then, such as undo commands and help modes, may no longer be considered playful. Furthermore, this work conflates the more modern concepts of gamefulness and playfulness as used by the games community, because it was published over a decade before the concept of gamification was formalized. As a result, many of the proposed "playful" features were actually what we might now call "gameful". We describe games and gamefulness further in Section 2.7. Malone [136] conducted a series of experiments to understand how to make user interfaces more enjoyable, developing three categories of heuristics for designing such interfaces: "Challenge", "Fantasy", and "Curiosity". In contrast with our work, the experiments evaluated the appeal of games, rather than non-game software, and the participants were primarily young schoolchildren.

In the more than 30 years since these works, other forms of user interfaces have proliferated, such as touch screen tablets and phones, and virtual and augmented reality interfaces. Our study designs enable us to gain insight into perspectives on play for modern user interfaces.

2.3 "PLAY" VERSUS "PLAYFULNESS"

Sicart [200] defines playfulness as "the capacity to use play outside the context of play". This implies a dichotomy between "play activities" and "nonplay activities" based on whether the objects used in the activity are designed for play. Sutton-Smith [206] proposes a different dichotomy, suggesting using play to refer to "expected" forms of play, and playfulness to refer to "disruptive" or "meta" forms of play. Rather than using "play" and "playfulness" in a dichotomous sense, we use "playfulness" to refer to an attribute or state associated with play, independent of the design intent of the objects involved.

"Playfulness" has also been used to describe personality traits and attitudes to computing. Webster and Martocchio [226] developed a personality measure for how playful people behave when using computers, based on traits such as "spontaneous" and "creative". They defined playfulness as "an individual's tendency to interact spontaneously, inventively and imaginatively with [computers]". Moon and Kim [156] define "perceived playfulness" as the extent to which someone perceives themself as "focused on the interaction", "curious during the interaction", and "find[ing] the interaction intrinsically enjoyable or interesting". In contrast to developing a measure of personality or attitude, we explore the aspects and contexts of interface use that people find playful.

2.4 LUDIC DESIGN

Gaver [77] challenges the workplace-centric values of "clarity, efficiency and productivity" as central to computer technology in people's lives. He suggests that people are "playful creatures" and characterizes *ludic activities* by "our curiosity, our love of diversion, our explorations, inventions and wonder". Gaver borrows the term *ludic* from Huizinga's work that argues for the importance of play in civilization [101], but Gaver uses the term to refer to more open-ended, exploratory play, rather than the more competitive forms of play suggested by Huizinga. This usage is closer in meaning to Caillois' concept of *paidia*, whereas other works use *ludic* more in line with Caillois' concept of *ludus* (e.g., [154]). The Drift Table by Gaver et al. [77, 79] is a case study embodying these values. It was a table with an embedded screen that displayed a map that moved based on the placement and weight of items on top of the table. The design was intentionally left ambiguous, enabling domestic users to playfully engage with and explore the Drift Table over a six-week period. We explicitly incorporate Gaver's notion of *ludic* into our definition of play to account for forms of play that lead people to reflect, learn, and seek personal growth.

Ludic design is part of a much larger space of critical design work focused on challenging efficiency- and technology-driven lifestyles. Some examples are reflective design [195], slow technology [88], and calm technology [228]. Many of these also incorporate ideas of ambiguity and playfulness, for example, through intentionally ambiguous information art [185].

2.5 SITUATED AND EMERGENT PLAY

The term *emergent play* has seen interest in the HCI and Game Studies communities. Montola uses *emergent play* to refer to positive accidental encounters in

pervasive games, which are games that "blur the boundary of game and ordinary life" [153]. In the context of interactive art, Costello and Edmonds discuss how play can can "emerge through the creative activities" of the audience [45]. Altarriba et al. [4] develop a "bridging concept" that combines this concept of emergent play with the concept of *situated play*. They define emergent as "emerg[ing] organically as people playfully re-ambiguate mundane situations", and situated as "tak[ing] place in non-play contexts and intertwined with non-play activity". The bridging concept draws from past examples from the literature on game studies, psychology, and other disciplines. The bridging concept highlights three experiential qualities: "brings joy", "affords agency", and "social connection". It was developed to help designers create technologies that encourage play behaviours in everyday situations. Through the examples they cover, they hope to "escape the productivity hype", arguing that situated and emergent play provides socio-emotional value, beyond values of performance or productivity. This work motivates the value of our exploration into play.

2.6 "FUN" USER EXPERIENCE

Primarily within the context of UX (user experience) and product design, there is a large body of work on designing "fun" user experiences. *Fun* is a concept related to play. There are conflicting definitions of "fun". Sharp and Thomas [198] define it as "when a person playfully engages with a situation or object". In contrast, Sicart [200] argues that while all play is "pleasurable", not all play is fun, because it can be hurtful, challenging, addictive, or destructive. The study of fun interfaces has also been referred to as "Funology" [25]. This encompasses a variety of types of works such as designing specific fun products (e.g. [229]) and exploring specific approaches to create fun experiences (e.g. [18]). Hassenzahl et al. [93] developed a semantic differential scale breaking down the qualities of software systems into those that are pragmatic (e.g., "simple", "controllable") and hedonic (e.g., "exciting", "interesting"). Through a controlled experiment in which participants evaluated various versions of an industrial pump-control interface, they found that hedonic and pragmatic qualities almost equally inform people's judgment of how "appealing" a software system is. Unlike this past work on fun design, we focus on understanding playful experience types in various contexts of software use, rather than designing specialized playful devices or tools for evaluating holistic user experiences.

2.7 GAMES, GAMIFICATION AND GAMEFULNESS

In the games research community, while many scholars distinguish between play and games [59, 120], play is sometimes taken to be synonymous with games. For example, Juul has described "playful thinking" as "new ways of thinking about games and new ways of using games to think about the rest of the world" [200]. To form a distinction, Salen and Zimmerman [189] describe the relationship between games and play as, "[p]lay is an element of games" and "[g]ames are a subset of play", which clarifies that play can occur in non-game contexts. Our work focuses on such non-game forms of play.

Costello and Edmonds [46] synthesize a "pleasure framework" for interactive art, based on psychological, philosophical, and game-design theories of play,

generating categories like "Creation" and "Exploration". They demonstrate how the framework can be applied by using it as a questionnaire to evaluate three interactive artworks. Korhonen et al. [120] extended the pleasure framework to create the Playful Experience ("PLEX") framework, by incorporating additional theoretical works mostly focused on game design and evaluation. The framework was revised the following year based on an additional validation study [12]. Although the PLEX framework was initially evaluated in the context of games, it has been applied in other contexts like products [119] and applications and services [26]. For example, Boberg et al. [26] conducted a survey related to our first survey, asking respondents to recall a recent "pleasurable, enjoyable or fun experience". However, the survey was specifically focused on evaluating the PLEXQ, a questionnaire based directly on the PLEX framework categories. Responses were only mapped to the preconceived PLEX categories, and the survey focused on a small set of specific application types such as "MP3 Players", "social media", and "gaming". Similar to this line of work, we borrow from theory to define the scope of play. However, in contrast to a top-down approach of applying theoretical preconceptions of play to create conceptual categories, we follow a bottom-up approach of empirically exploring how people experience play in software user interfaces today. This enables us to gain nuanced, context-specific insights about forms of play in software applications, and what users themselves consider to be playful in this context.

Drawing from Caillois' *paidia-ludus* distinction, Deterding et al. [59] form a continuum by positioning "open, exploratory, [and] free-form play" at one end (associated with *paidia*), and "rule-bound, goal-oriented play" or *gaming* at the other end (associated with *ludus*). An orthogonal dimension of "whole" and "parts" is presented, with games and toys as "wholes", and gameful design (gamification) and playful design as "parts". They define gamification as "the use of game design elements in non-game contexts". In more recent work [58], Deterding associates *paidia* directly with toys, where "toyification" is the playful analogue of "gamification".

Nicholson [163] argues that "reward-based gamification" is reliant on extrinsic motivation, but that gamification can also be used to foster intrinsic motivation using a series of elements based on game design. One of these elements is play. He describes how museum exhibits provide attendees with the ability to choose among "so many things to engage with". He uses the term "playification" to describe "play-based gamification". This contrasts with previous work Deterding et al.'s definition, which places "playful design" and "gamification" at opposite ends of a scale [59]. The term "playification" has also been used in other contexts. With the PhySeEar project [141], Márquez Segura et al. employed a research-through-design approach [242] to apply "playification" in the context of rehabilitative therapy. They used a NAO robot (a type of programmable humanoid robot) as part of the therapy, which facilitated social and playful behaviours between the therapist and patient.

Juicy game design, as proposed by Hicks et al. [98, 112] relates to our conceptualization of play. Juicy game design investigates how augmenting in-game feedback with "visual embellishments" can lead to improved player experience. Our work investigates forms of play beyond visual embellishments, and outside the context of games and player experience.

2.8 CURIOSITY

Curiosity refers to "a desire to know, to see, or to experience that motivates exploratory behaviour directed towards the acquisition of new information" [130], which can also include seeking out novel stimuli [20]. Curiosity is sometimes considered a fundamental aspect of play [54, 65, 120], and its relation to exploration, learning, and novelty makes it relevant to certain types of play we explore.

Several works have focused specifically on designing for curiosity. Tieben et al. [213] synthesize five "principles for evoking curiosity". Using an interactive prototype deployed in a hallway, they played sounds in response to motion of passersby and observed their reactions. Hobye et al. [100] present three case studies of interactive artworks that piqued the audience's curiosity and invited them to to engage in social ways. They drew considerable inspiration from Gaver's notion of ambiguity, by considering how ambiguity can create excuses for exploration. There is also similar work in research examining crowdsourcing. An experiment conducted by Law et al. [125] inserted breaks into a transcription task, during which a scrambled image would be increasingly unscrambled as tasks were completed. Crowdworkers were motivated by curiosity to see what the image would unscramble to, and completed more tasks. Dai et al. [51] delivered short games and comics as breaks to crowdworkers, also with a focus on worker retention. In the case of these works, the motivational interventions occur during breaks and act as gameful rewards denoting progress. Our work addresses forms of play motivated by various factors, one of which is curiosity.

2.9 DESIGN-FOCUSED PLAYFUL ARTIFACTS

There is a variety of work focused on designing holistic playful systems and digital artifacts. For example, Mueller and others (e.g., [159]) created artifacts that support playful experiences associated with the human body, like an augmented bike with amplified motion. Olsson et al. [174] had students in a postgraduate seminar course use "PLEX cards" associated with the PLEX framework, to create design artifacts with the goal of supporting a subset of PLEX's playful experiences. As an example, one student group developed the concept of a smart jacket to support outdoor walking journeys. Nijholt's collections of "Playful User Interfaces" [164, 165] and Altarriba et al.'s [4] bridging concept for situated and emergent play discuss many more examples of playful digital artifacts, from games to interactive toys. Unlike this past work on playful artifacts, we focus on the context of software user interfaces rather than physical devices.

3

INVESTIGATION OF PLAYFUL EXPERIENCES IN USER INTERFACES

Before we can understand design criteria or develop systems to support paidian play, we first need to understand the manifestation of paidian play in current, real software user interfaces. We describe how we conducted a series of studies to produce categories of playful experience types and themes representing perspectives on play, based on reflections from software users.

Past work investigating playful experiences in HCI has primarily been in a game context, including developing play frameworks and definitions based on theoretical work from other fields like psychology, sociology, and philosophy (e.g. [4, 46, 120]). There are also design-focused works that aim to create playful experiences outside the context of software user interfaces (e.g. [75, 79]). However, there is a limited understanding of non-game play in software applications based on empirical knowledge, and we question the applicability of games-focused research to interfaces frequently used in professional contexts. Because of these concerns, we follow a bottom-up approach of empirically exploring types of play in user interfaces, to provide a contextually deep and relevant understanding. The most similar related work is from the 1980s, in which Webster [225] developed a list of "characteristics of playful activities", in part based on a small pilot study asking office workers to relate computers to play. Also in the 1980s, Malone [136] generated a set of guidelines for creating enjoyable interfaces based on a series of studies of mostly schoolchildren playing computer games. Both over 30 years old, these lines of work are from a time when desktop graphical user interfaces (e.g., mouse pointers) were new, and they only focus on stationary desktop form-factors. For example, features like "undo" were considered playful because of their novelty at the time. Our work focuses on play of adult users in the context of modern non-game user interfaces found in apps on devices such as mobile phones, tablets, and desktop computers. We aim to develop a big-picture understanding of play in this context, rather than focusing on specific aspects of play or user interfaces.

This work is primarily exploratory, and focuses on investigating the following questions:

1. What specific types of play exist in real non-game software user interfaces, and what are their defining features?

2. How does the concept of play factor into users' perceptions of non-game software user interfaces?

We conduct an initial survey study with 63 respondents ("Study 1"), in which they recall and reflect on a time that they did something playful in a non-game app. We construct themes based on respondent submissions, resulting in an initial categorization of 14 playful experience types.

To develop a deeper understanding, we compile a collection of three sets of examples of various experiences with user interfaces (36 examples in total). The first set comprises archetypal examples of playful experiences based on Study 1.

The second set comprises "anti-archetypal" examples by removing, hindering, or reversing playful aspects from the archetypal examples. For the third set, we conduct a brainstorming session with three experts on play, to generate a set of supplementary examples of playful experiences.

Using these experience examples, we conduct a second study with 61 respondents ("Study 2"), to understand perceptions of the experience examples from the three sets. We revise and expand on our initial playful experience types, resulting in a total of 16 types. We also construct additional "play perspective" themes, in which we discuss broader ideas about playfulness in software user interfaces. In the discussion, we reflect on the two studies, and discuss our playful experience types in relation to existing works on play.

Our main contribution is an analysis of play in real non-game software user interfaces, based on a bottom-up understanding of what users consider playful. This includes a reflection on the applicability of past characterizations of play (e.g., [12, 225]) to the context of non-game software user interfaces.

3.1 METHODS

We describe the protocol for the first survey study, the expert brainstorming session, and the second survey study they informed.

3.1.1 *Study 1: Recalling a Past Playful Experience*

The goal of this study is to understand what users consider "playful" in the context of software application user interfaces. Respondents recalled and reflected on a time that they did something "playful" in an application. We also asked respondents about the context and motivation for the interactions. We explicitly designed the study to be open, to support this exploratory goal.

We distributed the survey using university mailing lists and word-of-mouth. Respondents could complete the survey on any personal device of their choice, such as a laptop or smartphone, and the survey took a median time of about 13 minutes to complete. Respondents were entered into a draw to win 1 of 7 gift cards valued at $40[1] in appreciation for their time. The survey was hosted using Qualtrics, and was made available for three weeks. Our study protocol was approved by our institution's research ethics board.

Survey Structure

In the survey, we provided respondents with a definition of "playful" based on prominent understandings of non-game play: Deterding et al.'s description [59] of Caillois' notion of *paidia* [34], in which play is "open, exploratory, [and] free-form", and Gaver's notion of *ludic activities*, characterized by "our curiosity, our love of diversion, our explorations, inventions and wonder". We then asked respondents to recall a specific time that they experienced a playful encounter with a user interface. (See Appendix A.1 for details on the prompt.)

Based on the experience that respondents recalled, they responded to a series of multiple choice and short answer questions about it, specifically, describing the

1 All reported remuneration values have been converted to USD for consistency, because our studies used different currencies as payment methods.

software, the context of use, and the "playful" experience. We included additional scales as secondary measures, asking about respondents' affect, measured using the valence and arousal scales of the Self-Assessment Manikin (SAM) [27].

Data Analysis

For qualitative analysis of playful experience types and additional themes, we used a Template Analysis [114] style of thematic analysis to develop themes from the respondent descriptions of their recalled playful experiences. Unlike Braun and Clarke's approach of *reflexive thematic analysis* [28], Template Analysis develops initial themes (the "template") earlier in the process, has a focus on iteratively developing and "trying out" the template during coding [30], and does not make as strong of a distinction between "codes" and "themes" [29]. In line with a constructivist paradigm, our analysis of play recognizes knowledge as socially constructed. Our experience as researchers and the context of our study shape the way we make meaning from the data. For example, the way we think about play with respect to concepts like experience and motivation, and our preconceptions as to what forms a 'type' of play, are influenced by our past experiences and other works in HCI, psychology, and games studies. We are also familiar with theories and concepts related to play and games, which may have implicitly informed the analysis.

We refer to our approach as inductive or "bottom-up" because we started the analytic process with the data rather than with existing theories. However, we acknowledge that we have theoretical assumptions and that thematic analysis cannot be done in a "theoretical vacuum" [29]. Our use of a Template Analysis approach enabled us to incorporate the theoretical assumption that playful experiences can be meaningfully categorized into representative "types". We see this as a form of "qualitative pragmatism" [29], in that it helps make our analysis actionable to researchers and designers and provides a way to break down and further analyze play in software applications.

I independently performed the analysis over several iterations. I first became familiar with the data (approximately 5100 words in total) by reading over the descriptions of playful experiences and justifications provided by respondents. Given the diversity of reported experiences, I performed preliminary coding over the entire dataset to generate an initial template. In two subsequent iterations, I revised the template, grouping similar themes and refining them.

Respondents

We received 74 responses. We excluded 11 respondents due to data quality issues: 3 for describing a video game when explicitly instructed not to, 2 for describing hardware devices rather than software, 1 for describing a television series, and 5 for spam responses (e.g., putting "no" for all text fields and filling in all scale items randomly). This left a total of 63 respondents for analysis. We refer to individual respondents as A1–A63.

Respondent ages were 21 to 75 (mean 34, median 27, SD 16). 23 respondents identified as women, 39 men, and 1 transmasculine. Most respondents resided in North America (49), but respondents came from a variety of geographical locations: 3 each from India and Japan, 2 each from China and Iran, and 1 each from Germany, Israel, Singapore, and Turkey. A wide variety of occupations

were represented, including 4 teachers, 4 engineers, 3 artists, a bookkeeper, a dog walker, a therapist, a sound editor, among other occupations. 30 respondents were students. In terms of familiarity with technology, 30 respondents reported being extremely familiar, 21 very familiar, 10 moderately familiar, 2 slightly familiar, and 0 not familiar at all. In terms of time spent with technology each day, 41 respondents reported more than 8 hours, 12 reported 6–7 hours, 6 reported 4–5 hours, 2 reported 2–3 hours, and 2 reported 1 hour or less. 42 respondents considered themselves to be video gamers. 53 respondents reported on a playful experience encountered at home, 9 reported on an experience at work, and 1 reported on an experience in transit.

3.1.2 *Brainstorming Session with Experts*

We conducted a brainstorming session to supplement the playful experiences reported by respondents in Study 1 with a broader range of examples to include in Study 2 (Section 3.1.3). We draw on the knowledge of three experts on play to generate examples that laypeople might not initially consider playful and that may have been missed in Study 1. The experts were asked to generate examples of play, rather than theoretical classifications. This enabled Study 2 respondents to assess for themselves whether experience examples seemed playful, in line with our bottom-up approach. Conducting the session with play experts enabled us to generate playful experiences in a more rigorous way than attempting to fill in what we felt might be missing from the playful experience types ourselves.

Protocol

For participants, we sought individuals with two or more years of experience working in the domain of play with user interfaces, such as games and play researchers, game designers, or UX designers. We recruited participants via word-of-mouth through connections with colleagues. The session took place via videoconferencing, and lasted approximately 100 minutes. We used a Miro digital whiteboard to facilitate the session, and participants used the sticky note feature to write ideas on the board. Each participant was remunerated with a gift card valued at $160. Our study protocol was approved by our institution's research ethics board. Table 3.1 provides an overview of participant demographic information, including occupation, expertise, and number of years experience.

Table 3.1: Demographic information of brainstorming session participants.

ID	Age	Gender	Occupation	Expertise	Yrs. Exp.
1	39	Man	Software Engineer	PhD thesis on gamification; currently does gamification consulting	6
2	30	Man	Postdoctoral Researcher	PhD thesis on gamification	6
3	33	Woman	UX Designer	uses game elements in designed systems	8

After a brief round of introductions, the brainstorming tasks were introduced. Participants were given the same definition of "playful" that we gave to the Study 1 respondents, and requested to keep this definition in mind while developing experience examples, but were allowed to deviate from it if desired. Participants were provided with non-comprehensive lists of application categories (e.g., "Finance", "Shopping") taken from app store listings, and user interface features (e.g., "Context Menus", "Voice Input/Output") taken from UI toolkit documentation, to help trigger ideas and encourage responses applicable to a diverse range of contexts.

The main part of the session was divided into three phases. Participants were first asked to recall existing examples of playful experiences with software user interfaces, then design novel kinds of playful experiences, and then take all the experiences considered so far and rank them by "playfulness" based on their interpretation of the definition we provided.

EXISTING EXAMPLE IDEATION PHASE Participants recalled existing playful experiences that they were familiar with from commercial apps, proof of concepts, research works, and so on. This phase followed two rounds of individual ideation for 3 minutes each, followed by one round of group ideation for 5 minutes. Participants shared their ideas with each other between each round. 26 examples were generated.

NOVEL EXAMPLE IDEATION PHASE This phase followed an approach similar to "brainwriting", in which participants could build off each others' ideas in each round. There were three rounds in total, 5 minutes each. In the first round, participants generated new kinds of playful experience examples that they had not personally seen before. In the following rounds, participants could continue to generate new examples, or could expand or make a variant of an example from an earlier round. At the end of this phase, participants were asked to share their favourite or most interesting ideas. 36 additional examples were generated.

RANKING PHASE Participants first worked together to group all 62 generated examples into Likert-type buckets from "Very Not Playful" to "Very Playful". To simplify the process, duplicate or similar ideas were merged, resulting in 39 examples. All ideas that participants agreed were at least "Somewhat Playful" were then carried forward, and participants did a forced ranking to generate a single list of 30 playful experiences, ranked from most to least playful.

During the session, a wide range of examples were generated, including fitness-related experiences, choose-your-own-adventure ("CYOA") features or use of features, applying playful decorations to interfaces, and so on. Some examples resemble features more than experiences, but nonetheless lend themselves to being described as part of playful experiences. (The full ranking of expert-generated examples is reported in Appendix A.3.)

3.1.3 *Study 2: Reflecting on Demonstrated Experiences*

The goal of this final study is to further investigate whether different people share opinions about what kinds of experiences are playful, and expand and refine our

playful experience types. Respondents provided their feelings and opinions on a set of video examples of playful and non-playful experiences based on Study 1 and the expert brainstorming session.

Study 2 was hosted using Qualtrics and distributed using the Prolific crowdsourcing platform. Respondents were required to be fluent in English, have a minimum approval rate of 98%, and at least 20 previous submissions. The survey took respondents a median time of about 37 minutes to complete, and respondents were remunerated $6.50. The study protocol was approved by our institution's research ethics board.

Experience Example Selection

In support of our goal to refine and expand on the playful experience types from Study 1, we wanted to select experiences representative of the study, as well as examples from the expert brainstorming session. Here, we describe our process for generating the experiences included in the survey.

We generated 3 sets of examples. The first set are archetypal experience examples representing all 14 playful experience types characterized in Study 1. These were taken directly from responses, focusing on examples that came up more often. However, we adjusted some experiences to improve the likelihood of familiarity, and where possible, we used examples that exist in real apps, rather than implementing our own apps from scratch. The second set are the top ten most playful experience examples from the expert brainstorming session (N1–N4 and E1–E6 in Table A.3). Some of these resembled features rather than experiences, in which case we situated such features within broader experiences. For the third set, we generated 14 "anti-archetypal" examples based on the 14 archetypal examples. These intentionally removed, hindered, or reversed what we felt made the corresponding archetypal experience playful. We included these to enable comparisons between what is considered playful and not playful, and potentially improve our understanding of contexts that can make certain experiences seem playful. We also expected that responses for the anti-archetypal examples could help us characterize individual playful experience types by understanding what they are *not*.

Two examples overlapped between the archetypal set and the expert brainstorm set, so we treated them each as one. This left a total of $14 + 10 - 2 + 14 = 36$ experience examples in Study 2. The descriptions of the experience examples as shown to respondents are listed in Table 3.2.

We created the experience example videos (Figure 3.1) using a combination of royalty-free stock footage, our own recorded footage of people using software, and screen captures of software in use. For two of the novel experiences from the expert brainstorming session (*VR Chemistry* and *Swap Mode*), we implemented custom user interfaces to facilitate creation of screen capture footage. The descriptions that go alongside the videos are intended to be as neutral as possible. We intentionally did not include descriptions of the actors' state of mind unless it was critical to the experience.

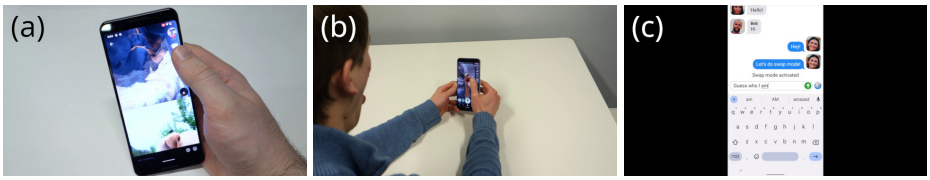

Figure 3.1: Screenshots from a subset of videos shown to respondents. (a) 2/*Dog Picture Scrolling*, (b) 9/*Barrel Roll Easter Egg*, (c) N2/*Swap Mode*

Table 3.2: The 36 experience examples presented to respondents in Study 2. Experience IDs without a prefix are the archetypal examples from Study 1, IDs with a prefix of "E" (existing) or "N" (novel) are the expert brainstorm examples, and IDs with a prefix of "A" (anti) are the anti-archetypal examples.

ID	Category	Short Name	Description
Archetypal Examples			
1	Experimenting	Drawing App Parameter Tinkering	"Someone experiments with the different paintbrush options in a drawing app."
2	Exploring Content	Dog Picture Scrolling	"Someone scrolls through dog pictures on a video-sharing app. As they scroll, the app shows new content it thinks the user will like."
3	Learning	Star Map	"Someone uses an augmented reality star map app to learn about constellations."
4	Creating Content	Photo Effects	"Someone creates artwork by applying visual effects to a photograph in a photo editing app."
5	Engaging with the Real-World	Plant Identification	"Someone goes to an outdoor garden and uses a plant-identification app to learn about a new kind of local flower."
6	Forming a Challenge	Gamified Walking	"While walking, someone uses an app that converts the steps they take into a virtual currency that can be spent on goods and services."
7	Using Feature in Unintended Way	Playing the Wiki Game	"Someone plays the "Wikipedia Game" in their web browser. They are trying to get from a random Wikipedia article to the article for 'Human' in as few clicks as possible."
8	Body Appearance Play	Selfie Filters	"Someone uses an app to change the appearance of their face with various photo filters and 'lenses'."
9 (E5)	Discovering Unexpected Feature	Barrel Roll Easter Egg	"Someone searches 'do a barrel roll' in the Google search engine, and discovers that it causes the page to spin around."
10	Customizing and Personalizing	Messaging App Background Theming	"Someone customizes the background image of their chat screen in their messaging app to a background of their choice."

ID	Category	Short Name	Description
11	Improving Workflows	Email Filters	"In an email app, someone creates an email filter to automatically categorize emails from certain senders, which will save them the time of having to organize these emails manually."
12	Reflecting on System Operation	Selfie Suggestions	"Someone notices that the camera app on their phone makes suggestions for improving the photo (e.g., 'Try Portrait Mode'). They become interested in understanding how this functionality works."
13	Appreciating Computer Graphics	Animated Message Effects	"In a messaging app, someone receives a chat message with an animated confetti effect to go along with it."
14 (E6)	Playing Game within System	Chrome Dino Game	"Someone navigates to 'about:dino' in the Google Chrome web browser, and is taken to game where they have to make a dinosaur jump over obstacles."
Expert Brainstorm Examples			
E1	(Forming a Challenge)	Themed Fitness	"Someone uses a fitness app as they go for a run: As they run, they listen to audio-based, interactive zombie-themed stories, which the app presents through their headphones."
E2	(Using Feature in Unintended Way)	Twitter CYOA	"Someone goes through a 'choose your own adventure' story made up of posts on the Twitter social media platform. For each stage of the story, they click on their preferred choice in the replies, and are taken to the next stage of the story."
E3	(Exploring Content)	Interactive TV	"Someone uses a video streaming app to watch an interactive TV show in which they click on options during the show to change the outcome."
E4	(Forming a Challenge + Socializing)	Fitness Comparison	"Using a social fitness app, two people compare their fitness performance for when they raced against each other."
N1	(Learning + Seeking Novelty)	VR Chemistry	"Someone uses an interactive learning app that lets them engage in simulated experiences about the learning topic (e.g., chemistry)."
N2	(Playing Game within System + Socializing)	Swap Mode	"Three friends use the 'Swap Mode' in a group messaging app. This mode causes their profile pictures to get swapped randomly, and they take turns quizzing each other to guess who they really are."
N3	(Customizing and Personalizing + Socializing)	Profile Decorating	"Someone decorates their profile page in a messaging app, and is helped by their friend."
N4	(Learning)	Virtual Yoga	"Someone uses a virtual yoga coaching app to help improve their yoga poses."
Anti-Archetypal Examples			
A1	Experimenting	Drawing App Page Size Setting	"Someone changes the size of the page in a drawing app."

ID	Category	Short Name	Description
A2	Exploring Content	No Search Results	"Someone searches for something in a social media app, but the app can't find any relevant content."
A3	Learning	Mandatory Tutorial	"Someone installed a photo editing app they already know how to use on their phone. When they open the app, they need to spend time scrolling through a tutorial, even though they already know how to use it."
A4	Creating Content	Spreadsheet Transcription	"Someone uses a spreadsheet app to transcribe data into a spreadsheet."
A5	Engaging with the Real-World	Inventory Scanning	"Someone uses a barcode scanning app to do inventory at a warehouse."
A6	Forming a Challenge	Fitness App Neglected	"Someone briefly remembers that they had installed a fitness tracking app on their phone, but never used it. They continue to not remember to use it."
A7	Using Feature in Unintended Way	Wiki Page Navigation	"Someone navigates to the Wikipedia article for 'Human' in their web browser so they can find specific information."
A8	Body Appearance Play	ID Photo	"Someone uses an app to take an ID card photo for their workplace."
A9	Discovering Unexpected Feature	Not Noticing Easter Egg	"Someone searches for 'recursion' on Google, but doesn't notice the 'Did you mean: recursion' suggestion."
A10	Customizing and Personalizing	Factory Reset	"Someone 'factory resets' their phone to remove all customizations and personal data."
A11	Improving Workflows	Manual Email Organization	"In an email app, someone spends time manually going through their emails and categorizes them based on who they're from."
A12	Reflecting on System Operation	Error Message	"Someone clicks on a post in a social news website, but they are taken to an error page that says: 'Oops! Something went wrong.' "
A13	Appreciating Computer Graphics	IRC Chat	"Someone uses a text-based messaging app to send a text message."
A14	Playing Game within System	Navigating to Google	"Someone navigates to 'google.com' in the Google Chrome web browser."

Survey Structure

Respondents were shown 5 different videos of examples of experiences along with descriptions. The examples were randomly selected from 36 experience examples described above. Respondents were asked to focus their responses on the specific experience examples described, rather than their own past experiences or on generalizations.

Two short answer questions asked the respondent to explain whether they would like to engage in the experience themselves, and what needs or desires

they feel are satisfied by the person engaging in the experience. Response excerpts from these questions were used in the thematic analysis.

We also asked supplementary multiple choice and short answer questions asking whether the respondent has personally engaged in the experience, describing appropriate or acceptable contexts for the experience, and ways that the experience could provide utilitarian value. Response excerpts from the acceptable contexts and utilitarian value short answer questions were also used within the thematic analysis. As with Study 1, we also included additional scales as secondary measures, including:

- *affect*, measured by the valence and arousal scales of the SAM; and
- *perceived motivation*, measured by a 2-item reduced version of the "Hedonic and Eudaimonic Motives for Activities" (HEMA) questionnaire [102], which measures the extent to which motives for doing an activity are hedonic (associated with pleasure and comfort) or eudaimonic (associated with using and developing the best in oneself).

After respondents had reflected on all five experience examples, they were asked to select checkboxes corresponding to the experiences that they felt were playful, and explain why they made each selection. To minimize demand characteristics, the survey did not use the term "playful" until this point.

Data Analysis

For the qualitative analysis of short answer responses, we used the same overall analysis approach as Study 1. Our use of Template Analysis combined an inductive and deductive approach, by using the playful experience types from Study 1 as an initial template for the analysis of Study 2. This approach is similar to other works in HCI that use a combined inductive and deductive approach [113, 124]. For all excerpts (approximately 24 000 words in total), coding was inductive, asking what the data means, as well as deductive, asking what the data conveys about the experience being responded to. I performed four iterations over the entire dataset to revise and extend the template. I engaged in regular discussions with another researcher to challenge assumptions and discuss the value and structure of the codes and themes.

3.1.4 *Respondents*

We received 63 responses. We excluded 2 respondents due to data quality issues: 1 for providing responses of only a few words, and 1 for providing off-topic responses (e.g., discussing making coffee). We refer to individual respondents as B1–B61. Since each respondent saw 5 examples, this resulted in 8–9 respondents per example for all 36 examples.

Respondent ages were 18 to 66 (mean 31, median 38, SD 12). 32 respondents identified as women, 28 men, and 1 non-binary. Most respondents resided in the USA (14) or the UK (12), but there were at least 3 respondents each from Germany, Italy, Mexico, Poland, Portugal, South Africa, and Spain, and at least 1 each from Australia, Canada, Greece, and Hungary. In terms of familiarity with technology, all respondents reported being at least moderately familiar, with 24 very familiar and 31 extremely familiar. In terms of time spent with technology each day, 41

respondents reported more than 8 hours, 9 reported 6–7 hours, 10 reported 4–5 hours, and 1 reported 2–3 hours. 39 respondents considered themselves to be video gamers.

3.2 DESCRIPTIVE RESULTS

Here, we present descriptive results from the two survey studies, concerning affect and motivation. These results help to provide an understanding of the context and sample. Supplemental descriptive results can be found in Appendix A.2.

3.2.1 *Study 1: Affect*

Respondent valence was very high overall as indicated by SAM valence scores (mean 2.1, SD 1.1; scale from 1–9, lower score values mean higher valence; Figure 3.2). All scores were at most 5, meaning that the recalled playful experiences were associated with positive feelings. Arousal was moderate-to-high as measured by the SAM (mean 4.2, SD 1.7; lower score values mean higher arousal).

Figure 3.2: Histogram of SAM valence results across all respondents (lower score corresponds to higher valence).

3.2.2 *Study 2: Shared Definitions of Playfulness*

Figure 3.3 shows the relative proportion of respondents who considered each of the 36 examples to be playful. In general, the playful experience examples (archetypal or expert brainstorm examples) were moderately or mostly considered playful, whereas the anti-archetypal examples were not considered playful.

One clear exception is that example 11 (*Email Filters*) was not considered playful by any respondents. This highlights the importance of *process* to playful experiences, which we elaborate on in the *Improving Workflows* and *Playing as a Process*

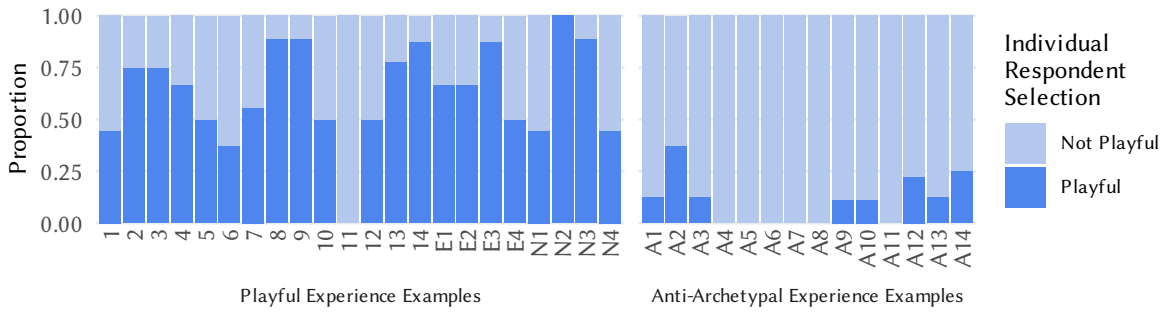

Figure 3.3: Relative proportions of respondents who selected each experience example as "playful".

in the Present sections below. The *Individuality of Play Preferences* section below elaborates on the overall level of variability apparent in the playful examples.

Some respondents labelled certain anti-archetypal examples as playful. Such cases mainly arose because respondents were considering a playful equivalent to the anti-archetypal example. For example, A2 (*No Search Results*) and A12 (*Error Message*) were considered playful by a few respondents because browsing social media was considered playful independent of search results or error messages. The remaining cases were from respondents who had particularly eager conceptualizations of play (e.g., considering *Navigating to Google* as playful because one can learn new things) or more uncommon definitions of play (e.g., considering *Factory Reset* as playful because it is "useful").

Overall, the strong correspondence between our playful experience examples and what respondents considered playful helps to validate our characterization of playful experience types.

3.2.3 *Study 2: Motivation and Affect*

We grouped the SAM responses based on whether they were for playful examples (archetypal or expert brainstorm examples) or anti-archetypal examples. We do not compare directly with the Study 1 questionnaire results, because the Study 1 results describe what people consider playful first-hand, whereas the Study 2 results describe what people generally think about experiences that *can* be playful. For the playful experiences, SAM valence scores were skewed towards low values, meaning a more positive valence (mean 3.4, SD 2.0; Figure 3.4), suggesting that respondents generally considered the playful examples to be strongly associated with positive affect. For the anti-archetypal examples, valence was more uniform (mean 4.9, SD 2.3). Arousal was also more uniform for the playful (mean 5.3, SD 2.3) and anti-archetypal examples (mean 5.9 SD 2.3), reflective of the variety of both exciting and relaxing playful experience examples.

The HEMA eudaimonic scores (Figure 3.5) indicate that different playful experience examples correspond to varying levels of eudaimonic motivation. For example, E4/*Fitness Comparison* and N4/*Fitness Comparison* were strongly associated with developing the best in oneself, whereas 13/*Animated Message Effects* was clearly more associated with immediate gratification. Our *Playing to Improve Well-being* perspective below addresses this potential for eudaimonic outcomes from playful experiences in more detail.

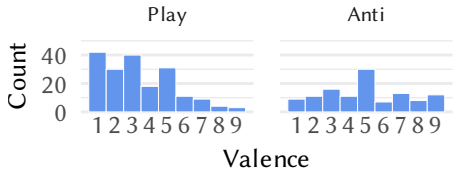

Figure 3.4: Histograms of SAM valence results for anti-archetypal examples (*Anti*) and archetypal plus expert brainstorm examples (*Play*), across all respondents and shown examples (lower score corresponds to higher valence level).

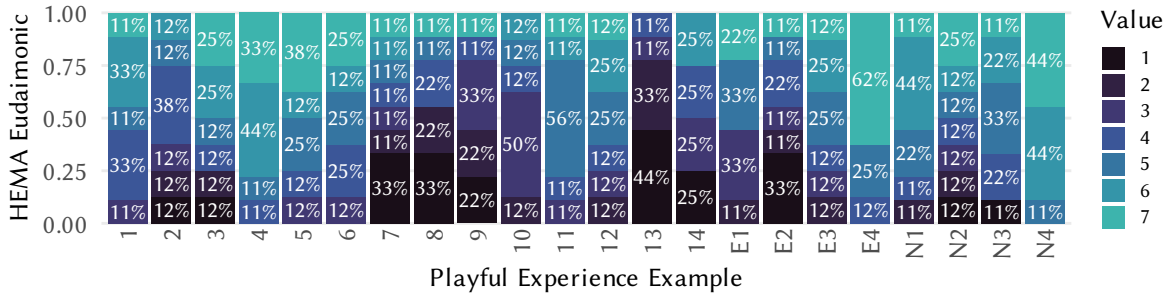

Figure 3.5: Proportion of HEMA eudaimonic ratings for each of the archetypal and expert brainstorm examples, across all respondents.

3.3 PLAYFUL EXPERIENCE TYPES

We present our analysis in which we develop 16 categories of playful experience types with software user interfaces (Table 3.3). The first 14 types were developed in Study 1 (see Appendix A.2.2 for counts of experiences). These were then refined based on Study 2, and the last two types are new based on Study 2. To improve readability, we have corrected spelling errors in respondent quotes that we report, but no other changes have been made. Unless otherwise specified, we use "play" to refer to open and free-form play in the context of non-game software user interfaces.

Table 3.3: The 16 playful experience types, the studies they are based on, and examples.

Type	Studies	Examples
1. Experimenting	1 & 2	1/*Drawing App Parameter Tinkering*
2. Exploring Content	1 & 2	2/*Dog Picture Scrolling*, E3/*Interactive TV*
3. Learning	1 & 2	3/*Star Map*, N1/*VR Chemistry*, N4/*Virtual Yoga*
4. Creating Content	1 & 2	4/*Photo Effects*
5. Engaging with the Real-World	1 & 2	5/*Plant Identification*
6. Forming a Challenge	1 & 2	6/*Gamified Walking*, E1/*Themed Fitness*, E4/*Fitness Comparison*
7. Using Feature in Unintended Way	1 & 2	7/*Playing the Wiki Game*, E2/*Twitter CYOA*
8. Body Appearance Play	1 & 2	8/*Selfie Filters*
9. Discovering Unexpected Feature	1 & 2	9/*Barrel Roll Easter Egg*
10. Customizing and Personalizing	1 & 2	10/*Messaging App Background Theming*, N3/*Profile Decorating*
11. Improving Workflows	1 & 2	11/*Email Filters*
12. Reflecting on System Operation	1 & 2	12/*Selfie Suggestions*
13. Appreciating Computer Graphics	1 & 2	13/*Animated Message Effects*
14. Playing Game Within System	1 & 2	14/*Chrome Dino Game*, N2/*Swap Mode*
15. Socializing	2	E4/*Fitness Comparison*, N2/*Swap Mode*, N3/*Profile Decorating*
16. Seeking Novelty	2	N1/*VR Chemistry*

1. Experimenting. This type involves trying out new things and seeing what functionality is available, through exploration of features. This was the most prominent type in Study 1. This notion was expressed in a variety of ways; for example, "messing" (A1) or "play[ing] around" with features (A13), "Exploration" (A28), "tinkering" (A38), and "Experimenting" (A50). When people experiment with features, they experience a feeling of control over the system and empowerment by its functionality. For example, A13 described trying out various search filters "just to see what happens!", A57 described that experimenting with features "gives me more freedom to create and edit what I want to do". Similarly, when an interface provides clear feedback for user actions, it can help make a playful experience go more smoothly and provide additional enjoyment. For example, A54 described how when using digital art tools, they "enjoyed the immediate gratification of being able to manipulate and change the color".

From a more utilitarian perspective, experimentation is valuable from an educational standpoint, and relates to *Learning* by helping people learn more about their data within an app or features of the app itself. For example, A1 and A38 described how they playfully tinker with visualizations in the context of data analysis, enabling new trends to be identified in the data. A38, a postdoctoral researcher, described the process of reorganizing visualization data as "fun", because it "wound up eliciting potentially new RQs [(research questions)]". When learning about app features, there is a desire to "mak[e] the most of [an app's] features" (B42), "try out new ways of doing things" (B54), and "know how what you are using works" (B59). Part of the freedom and educational value afforded by experimentation comes from "Lots of opportunities for trying and failing and pivoting in a low risk way" (A36). This type also relates to *Seeking Novelty*, in that novel functionalities open opportunities for exploration. For example, VR functionality "would show me the possibilities of interacting with technological interfaces" (B57) and enable one to "try the possibilities of VR" (B52).

Creative Experimenting – This subtype focuses on the process of experimenting with different digital creativity tools with the goal to "develop" (B32) or "express" (B40) creative output. For example, A10, A12, and A35 described exploring how features can be used and combined to create different visual outputs. A28, an artist, discussed how they tried out new creative ideas like "tool combinations" and "colour schemes" as reference for new art pieces. One can also inject creativity into less creative tasks, like decorating electronic messages at the workplace (A36), or applying creative liberty over visual effects on a 3D model for work (A59). *Creating Content* experiences can involve creative experimentation as part of the process.

Process is fundamental to this subtype. As A28 and A35 described, it is the act of experimenting with different visual outputs, more than creating a single playful visual output, that makes the experience playful. The creative process is playful because it can feel "very empowering and freeing, like a kid in a playground" (A12) and like "an open virtual space that stretche[s] endlessly" (A59).

Testing System Limits and Capabilities – In this subtype, people experiment with various inputs to a system to push at its boundaries and express judgment over the system's capabilities based on its output. This was reflected in Study 1 through examples like A2, who described engaging with a recommendation system: "People want to know whether [the recommendation system] can provide correct content". Similarly, A5 described this as "Try[ing] different things and

how the app would respond". In Study 2, there was limited additional evidence of respondents having a desire to break a system or push at its boundaries.

2. Exploring Content. This is another common type in Study 1, focused on using interfaces to interact with internet content like videos and pictures. Most features for exploring content are associated with browsing and searching features in web-based apps; for example, recommendation system-based unlimited scrolling (A2), or browsing videos, photos, pages, music, or recipes (e.g., A17).

The playfulness of such experiences comes from the feeling of discovering and consuming new content. In describing content recommendation systems, A2 said that a social media app "will continue providing videos you probably like to watch", and A46 mentioned that "it's fun and exhilarating" to have new content recommended in a music streaming app. A31 described how the ability to search in a social media app using tags helped them find "lots of new interesting pages to look at". Using apps to find and watch funny videos helps A48 "change my mode" and "make me happy". Sometimes, people also explore content for educational reasons, like A19, who found videos in order to "explor[e] in the world of music and choreography", A62, who used the 'following' feature on social media to help them find "new methods and products to use" for household cleaning, and A63, who found the ingredient-search functionality of a recipe app helped them find "innovative offering options I would not have thought of".

Based on Study 2, content recommendation, when a system "caters content towards you based on your interests" (B22), is a way that apps can facilitate playful exploration of content. The expectation that "I can always find the specific media I'm trying to look for on the internet" (B37) was a focus of respondents, and when a system indicates it is not able to perform, by returning no search results or when content is temporarily unavailable, this hinders the ability to explore content.

3. Learning. This type concerns the satisfaction with the experience of learning and having learned something new. Play can support "A desire to learn and improve" (B23), for example, by learning survival skills (e.g., "to find a plant that had nutritional value", B49) or becoming familiar with tools (e.g., to "[familiarize] the person with the different tools and aesthetic options", B23).

As with *Exploring Content*, apps associated with *Learning* were often made for this specific purpose. As examples of playful learning experiences, A6 and A24 downloaded AR star map apps to learn about "what stars are visible" (A6), A44 learned how to use photo enhancement software by following online tutorials and replicating the steps in the user interface, and A45 and A60 described apps for identifying local plants they wanted to learn more about. Engaging in a novel learning experience can make the experience more fun and interesting. For example, learning through a software app can make learning more engaging than traditional ways of learning like "just reading" (B57) from textbooks.

Playful learning experiences may be driven by curiosity; for example, A60 described that the ability to explore with the nature app's features "stimulated curiosity towards the natural world". In Study 2, such experiences were apparent in a number of examples, including *Star Map* ("A desire for curiosity and getting to know the world around us", B9), *VR Chemistry* ("learning chemistry in an interactive VR environment sounds interesting", B52), and *Playing the Wiki Game* ("curiosity mainly, to see if it requires few pages or many", B58). However, notably, *Wiki Page Navigation* was not considered playful by any respondents in Study 2,

despite curiosity being described as a fundamental part of this experience (e.g., "the curiosity to inquire", B25). This indicates that the presence of curiosity does not necessarily imply playfulness.

Experiences that facilitate learning in software also can be used when teaching others, for example, using an app to "teach my children about good and bad plants" (B49). As highlighted by *VR Chemistry*, playful educational experiences could help improve the breadth or availability of learning resources, for example, by providing a VR demonstration of a chemistry concept "if a real life demonstration was not possible" (B54).

4. Creating Content. This type describes using software as a creative outlet to create content (e.g., art), which is considered a "fun" and "playful" (B47) process. It contrasts with *Exploring Content* because it focuses on play centred around *creating* content like documents, pictures, and videos, rather than *exploring* such content. Also, unlike *Creative Experimenting*, which focuses on the process of experimenting with tools during a creative task, *Creating Content* focuses on the content creation itself.

Software enables one to be expressive when making creative output, by "Getting [one's] creative juices going" (B56). For example, A26 explained that they were "engaging in creativity" when using word processing software to "writ[e] an article for fun", A30 found it "fun and exciting" to make art using digital painting software, and when creating videos, A42 was able to use "visual effects [that] are interesting". Creating content also enables one to "show off who I am" (B22), similar to how *Customizing and Personalizing* play can support self-expression.

When created *content* is playful, it can lead to the perception that the experience of creating it is also playful. For example, A8 described a birthday card they were designing with graphics software as: "It needs to look playful", and A61 was "making something fun" with photo editing software. These experiences were associated with playfulness and positive affect.

In some cases, there is pleasure from the process of "aimlessly doodling" (B21), even with no end goal in mind, and independent of the quality of the content created. B12 doodles "if I'm thinking about something else and I want to move my hands", suggesting value in doodling while doing other primary tasks. B58 doodles because it is a "relaxing" process. In contrast, when a creative end goal is the focus, lower skill levels can hurt the experience. For example, B23 said they "find these [drawing apps] frustrating to use" because they don't have the skill level to "produce something good quality".

5. Engaging with the Real-World. Apps can support playful experiences external to the app itself, encouraging going out in the world and doing something playful. For example, when making sound loops, A3 discussed how they made "weird noises with my mouth and slapping my cheeks" to create interesting sounds, and A9 discussed how they took the output images from photo filters they were playing with and had them printed on mugs as gifts for friends. A32 discussed how the messaging feature on an online classified advertisements website enabled them to schedule a meet-up with another person to do a musical gear exchange. They felt that the ability to interact with strangers online to set up spontaneous meet-ups was playful and they "Got a new instrument I never would have tried". As mentioned earlier, A45 and A60 described apps for identifying local plants. Using the identification feature of these apps encouraged them to go by gardens or into nature to spend time learning about plants and sharing their findings.

Remembering Memories – This subtype describes experiences in which using features can "bring up happy memories" (B30), enabling people to recall or reminisce about positive past events in the real-world. For example, A13 described a board game collection-tracking app. When using search filters, they would "remember the fun experiences I had playing games" out in the real world with others. In Study 2, B30 gave an example of setting a wallpaper to a personal photo that the user "will see [...] all the time and this could bring up happy memories".

6. Forming a Challenge. App features can be used to create personal challenges, for example, by trying something new within an app, or using gamified or game-like apps. Doing something out of one's comfort zone is one form of challenge. A47 described the excitement of posting a video they created to social media as: "I have never done something so public on social media where I put out an opinion in video format". A23 described automating the processing of an online form as "a fun challenge". (This is also an example of *Improving Workflows*.)

Gamified or game-like apps that offer virtual (or real) rewards can push one to form a challenge, whether competitive with another person (e.g., "you want to be better than them", B52), or setting a personal goal (e.g., "push myself harder on my fitness journey", B1). For example, A40 described a gamified fitness app that awarded exercise with a virtual currency, suggesting that it might help people who "might not always have the motivation [...] to [be] physically active". Similarly, A51 felt their use of a health tracking app was playful because it helped with "Understanding my performance/improvement over different periods of times". One form of playful challenge is adding a playful "twist" to a normally "boring" activity (B21) to make it more interesting. For example, study 2 respondents felt that *Themed Fitness* would help one be more "inclined to work out" (B44) and provide a good level of "stimulation" (B23) to help avoid boredom.

Such apps intended to change behaviour are strongly associated with extrinsic motivation. For example, for *Gamified Walking*, respondents indicated they would engage only to "be rewarded for it" (B46) and to "receive things (money etc.)" (B52). For some, there is a desire for a certain level of monetary compensation, suggesting that virtual rewards may provide insufficient motivation for use. For example, B44 said, "it will not be worth trying" because apps like these typically "offer low rewards", and B46 would only engage "if it paid well enough".

There is a desire to "develop a habit" of engaging with a challenge so that one is "more likely to continue" (B49), and to "change [one's] lifestyle" (B1). Not successfully following through with a challenge can lead one to feel like they have "let themselves down" (B53) and that they are "not fulfilling their desire[s]" (B46).

7. Using Feature in Unintended Way.

This type covers repurposing a feature by using it in an unconventional or unintended way. The new use of the feature can be playful, like turning it into a game, or the act of repurposing could itself also be considered playful. For example, A52 described manipulating dates using a text editor as playful because "It's not necessarily what the software was intended for".

This type relates to *Discovering Unexpected Feature* below, in that when people discover an unexpected feature, they may have the impression that they are using the app in an unintended way. A53 experienced this when they discovered that certain icons in a health tracking app could be tapped, and described this as: "I

didn't think these were clickable icons and felt like I was doing something a little bit 'illegal', like climbing over a fence with a 'no trespassing' sign on it".

Using features in unintended ways can be also playful by enabling one to gain a new perspective on the interface or content of an app. For example, *Playing the Wiki Game* "allows [one] to see one website in another way" (B59) and elicits "Engagement, critical thinking and intellectual thought" (B60) in a way that the app would not normally do. Social features can also be used in unintended ways for humorous ends; for example, *Twitter CYOA*, which is similar to Easter eggs in that it is unexpected content, but it is user-generated.

Turning Features into Game – One way that features can be used in an unintended way is by having users decide on a set of independent rules that turn a feature into a game. A canonical example is how, when using Wikipedia, A14 tries to navigate from one topic page to another only by clicking through hyperlinks in the page. (This is commonly known by names like "Wikiracing" or "The Wiki Game" [230].) Similarly, A55 described how a specific social media community turned the act of replying to a conversation thread into a game.

8. Body Appearance Play. This type refers to using technology to manipulate or explore one's appearance for entertaining or humorous results. Examples include using "augmented reality filter 'lenses' that overlay features on users faces" (A7) and turning pictures of one's face into cartoons (A9). The experience of using AR filters was described as "funny" (A7), and "fun and made me look different" (A33).

Body appearance play experiences can also be beneficial for self-confidence. When one plays with their appearance, it provides the opportunity to "be funny or feel confident" (B20), "to feel more cute and beautiful" and "remove negativity of how they feel about themselves" (B61), and can make one feel they are "knowing they look their best" (B42).

In a social context, one consideration is how people make choices about whether or how to play to "portray themselves" (B20) to others; for example, as a "serious" (B11) or "funny" (B20) person. Playful experiences can serve as an opportunity to support "social approval and the need to feel accepted" (B26), for example, by sharing photos with filters applied. However, others may see this in a negative light as "attention seeking behaviour" (B11). Body appearance play experiences can also be a precursor to *Socializing* play experiences, when people engage in shared experiences or share the resulting images.

9. Discovering Unexpected Feature. The surprise of finding a previously unknown feature, or a feature that others might not know about, can be considered playful. A feature could be unexpected in that the user simply did not know about it before. For example, A41 discovered that an app had a menu (hamburger) button, and A53 was "surprise[d]" when they discovered that certain in-app icons could be tapped to open different views.

Alternatively, a feature could be unexpected in that it is inherently unique, like *Easter eggs* (features hidden inside software), which are often humorous and form a "joke" or "trick" (B30). For example, A27 described finding an Easter egg in a search engine as, "you do not expect a search engine to do such things". They described the experience as playful because "you discovered something mysterious that not many people know, making it special". Experiences prompted by Easter eggs can be "fun" (B60) and "amusing or entertaining" (B30), and can

provide value by making one feel part of an in-group. For example, B60 described *Barrel Roll Easter Egg* as: "It feels more like a friend playing a light joke on me and we're in on it together". However, such features can be misunderstood by people who do not understand their intention. For example, an Easter egg may be interpreted as a malfunction (e.g., "sometimes Google Chrome glitches out", B38), or as if the user is not in control of the software (e.g., "I would not be happy to be taken directly into a [...] game if I had been looking for information", B57).

10. Customizing and Personalizing. This type relates to *Experimenting*, but with the aim of tweaking the appearance or interface of the app to make it more suitable for one's personal "tastes" (B25) or "state of mind" (B14). Examples include A4, who described "trying to find the different themes (backdrops)" in an instant messaging app, and A39, who wanted to "find a [smartwatch] face that I would like to use". A39 described the importance of the experience as "trying to see what [...] I liked best as this is something I use all day every day". Customizations like changing one's "profile image" (B61) or "background" (B15), enable self-expression by supporting a desire to "show off who I am" (P22), express one's "actual state of mind" (P14), and "be completely unique" (P30). For example, A39 also explained how customization enables them to express their personal identity by showing the pride flag as part of their watch face.

Customization can also make default user interface configurations more or less playful, for example, if "the standard wallpapers are boring" (B30) or "If a device came with an over fussy or inappropriate wallpaper" (B11). Customizations accumulated over a period of time may come to feel cluttered. *Factory Reset* can feel like "a relief" (B14) and "like you're removing a heavy weight of stress off your back" (B22). However, the extent to which this applies to customizations beyond personal data is unclear.

11. Improving Workflows. Making an effort to improve workflows through automation, in business and personal contexts, can be a satisfying achievement and a playful experience. This is separate from *Forming a Challenge*, because only some workflow improvements involve challenging oneself (e.g., to learn to program something). As an example, A18 described how they used chat bots and public web APIs to automate checking for COVID-19 vaccination time slots, which saved them the effort of "checking [for availabilities] again and again" through a tedious manual process. Similarly, but in a work context, A23 described how they were able to automate the processing of an online form, a process they described as "full of surprises", and they "kept realizing more and more options to incorporate".

Organizing digital content is a potential type workflow improvement experience, for example, by sorting "which emails are to be attended first" (B61). There is an inherent "need to be organised" (B42), to give people the feeling of having "my life [...] in control" (B28), or "mak[ing] it appear [to others] that one has more control over their professional [...] affairs" (B19). However, in Study 2, no respondents directly mentioned the process of improving workflows or indicated that this process is playful. *Playing as a Process in the Present* (below) elaborates on this in more detail.

12. Reflecting on System Operation. Contemplating how an app or feature works during or after use can form a playful experience. For example, A16's camera app made automatic suggestions for how to improve the picture. They became

"really interested in knowing how this worked", and searched online to better understand this "playful idea". Similarly, A20 was "thinking about how dating apps have personalized search", and was "curious" about "what kind of features they analyze and how does that lead to relevant [search] results". In contrast, in Study 2, respondents did not comment on the act of reflection, instead focusing on the utility of features (e.g., "learn about using the camera", B17) and the exploration of features.

13. Appreciating Computer Graphics. Entertaining or technically sophisticated graphics produced by software can lead to playful experiences centred around amusement or wonder. For example, A15 pointed to how some instant messaging apps have animated particle effects when certain messages are sent, which they described as "add[ing] to the wonder effect". Similarly, A34 used a new computer graphics fluid simulation, describing the experience as playful because it was "fun to use" and "extremely responsive".

From a social standpoint, sharing positive forms of computer graphics can serve as a way to spread joy (*Socializing*). For example, *Animated Message Effects* enables "sending cheer" (B45), and is "intended at bringing joy" (B56) and "brighten[ing] up someone's day" (B57). The graphics can convey a certain mood, for example, "to convey [...] excitement" (B49) or to "[set] the tone for a possibly exciting conversation" (B20).

14. Playing Game Within System. We explicitly excluded games from our scope of app types, but a few respondents discussed games that are *embedded* in otherwise non-game software, such as in the form of Easter eggs. For example, A11 found it "fun" to play the side-scrolling action "dino" game in Google Chrome, a feature displayed when there is no active internet connection. A56 described a case in which a promotion advertisement in a food delivery app took the form of a game. They felt "extremely entertained", explaining that "it was quite unexpected and one-time". Games like these are essentially separate from the main functionality of the app, and can serve as a time-filler or distraction while waiting for content in the app or during another task. For example, B59 would play with with *Chrome Dino Game* "if the internet was down" because it is "engaging", and B58 describes playing with this feature as "something I can do when I'm waiting for Wi-Fi to return" because it is "fun".

15. Socializing. Playful socializing experiences are an additional type characterized based on Study 2. Experiences with software that support maintaining contact with friends and family, facilitate conversations and new kinds of social activities, or enable sharing content, are some examples that are considered playful.

Playful social experiences can help maintain close "connection" (B22) with friends and family; for example, to "feel closer to ['the person you are talking with']" (B23), "connect with friends and family in a playful way" (B22), and "stimulate my relationship with a friend" (B38). To some, social experiences may be inherently playful. For example, B17 described *Fitness Comparison* as playful simply because it is experienced "with someone else". Some playful experiences can take social activities and modify them in enjoyable, playful ways. For example, *Swap Mode* is "a fun time in a group with your friends" (B41).

Social play can involve sharing knowledge, jokes, or content; for example, "sending [a] selfie to friends" (B6), "tell[ing] people about [*Barrel Roll Easter Egg*]

so they can try it themselves" (B42), sharing videos on social media with "someone they love so the other person can feel better" (B37), and "draw[ing] something to send to a friend" (B54). Playful experiences with software can also serve as a form of conversation-starter. For example, for *Plant Identification*, B52 suggested that "If you walk past some flowers and you have a discussion with someone [about] what they're called". Similarly, *Animated Message Effects* "sets the tone for a [...] conversation" (B20) and "convey[s] [...] excitement and pleasure greeting someone" (B49). The resulting graphical effects "spread joy and good vibes" (B57) and "[make] people smile" (B49).

Other playful experience types can form the basis of a social playful experience, and features designed for individuals can also lead to social playful experiences. As examples: *Profile Decorating* (*Customizing and Personalizing*) "helps socialise with my friend and learn new things [about them]" (B61); *Barrel Roll Easter Egg* (*Discovering Unexpected Feature*) supports social sharing of humour (e.g., "to show a friend a joke or trick", B30) and feeling socially connected due to understanding the joke (e.g., "It would make me laugh and feel like an insider", B60); *Selfie Filters* (*Body Appearance Play*) supports sharing a selfie with friends, as well as being "a good way to bond" (B23) when "fool[ing] around a bit with our friends" by making silly faces (B15); and *Fitness Comparison* and *Gamified Walking* (*Forming a Challenge*) are both activities that "I can do with friends or family, that way the experience would be a lot more nice and fun" (B1).

16. Seeking Novelty. Novelty-seeking playful experiences are another additional type characterized based on Study 2. This type describes engaging in experiences simply because one has never used something before (e.g., B28), the technology is new (e.g., being able to "interact with the latest technologies", B40), or one has become tired of the status quo and wants change (e.g., "sometimes you get bored of just looking at the same lock screen all the time", B27). B27's comment is notable because it shows how *Customizing and Personalizing* can make the experience of using an app novel again. Specific examples of novelty-seeking experiences include *VR Chemistry*, which enables one to "try the possibilities of VR" (B52), *Star Map*, which "would be [a] really interesting and a new/fun way to learn" (B21), and *Themed Fitness*, which "makes running a little new" (B55).

Novel features or experiences can also trigger curiosity. For example, B42 said that if suggestions for improving their selfie were displayed on-screen, they "would be intrigued". "Surprising" (B32) and "unexpected" (B60) features like Easter eggs (*Discovering Unexpected Feature*) are a novelty when experienced for the first time. However, novelty-based playful experiences can become boring over time. For example, B58 describes an Easter egg as: "funny only once, afterwards it's meh", and B21 describes *Swap Mode* as: "it would easily get boring".

3.4 PLAY PERSPECTIVES

Through our inductive analysis approach, we also generated seven themes pertaining to play (Table 3.4). We use the phrase "play perspectives" to describe these themes because they represent ways that one can think about play, and pertain to multiple, but not necessarily all types of play. The first is based on Study 1, the second is based on both studies, and the remaining five are based on Study 2. We describe these themes, and use them to discuss connections between certain aspects and past work from other contexts.

Table 3.4: The 7 play perspectives and the studies they are based on.

Perspective	Studies
Play as Fundamental to Some Forms of Productivity	1
Balancing Between Diversion and Dependence	1 & 2
Playing as a Process in the Present	2
Play as Consciously Chosen	2
Individuality of Play Preferences	2
Play as Frivolous and Disconnected from Daily Life	2
Playing to Improve Well-being	2

3.4.1 *Play as Fundamental to Some Forms of Productivity*

Play can be beneficial for, or even fundamental to different types of creative work. For example, A59 uses 3D graphics software to create objects and animations for their job, but describes their work as a playful experience because although they have specific job requirements, they can choose their own path to achieve the outcome and have some creative liberty over the visual effects. User interfaces are beneficial to supporting creativity by enabling freedom of how tasks can be completed. This relates to A36's suggestion that a playful experience can support iteration by "trying and failing and pivoting in a low risk way". A28, a professional artist, uses digital graphics software to explore visual art styles as reference for physical artwork. They describe their work as fundamentally playful, arguing that "visual art is of necessity a playful creative process". User interfaces that enable creative exploration help to nurture this creative process.

In addition to supporting creativity, the value of play can extend to productive outcomes in other key ways. For example, playful experiences with software user interfaces can support people challenging themselves to improve their abilities, like *Improving Workflows*. A23's comment that described automating the processing of an online form as "a fun challenge" exemplifies this, because it provided them with experience troubleshooting unexpected problems and a sense of accomplishment in "perfect[ing]" the automation.

Another way play benefits productivity is by expanding one's knowledge of and appreciation for concepts and tools applicable to professional work. For example, A20 was reflecting on the operation of personalized search functionalities, and made connections between their reflection and their student research on neural-networks. "Hoping to get a productivity boost", A49 experimented with a new piece of software and learned to use it in a way that would help them organize their work schedule. Another example is A38's comment that described how playfully experimenting with visualizations led to potential new research questions, giving them new insight. Playful attitudes towards or engagement with user interfaces can stimulate ideas about how work can be completed or applied in different ways.

3.4.2 *Balancing Between Diversion and Dependence*

There is a tension between play that supports taking breaks, relaxation, and productivity, and play that becomes distracting or addictive.

One can engage in play during "free time" (e.g., B7) or "for a hobby" (B56). Play activities also can serve as a "remedy against boredom" (B25) by "kill[ing] time" (B44), for example, while waiting for "dinner to cook" (B59). One can choose to play to distract attention from a less pleasurable background task. For example, *Themed Fitness* enables one to "be distracted from the physical activity they are taking part in" (B54). This is like how *Forming a Challenge* can help to make a boring task more interesting. Playful experiences can serve as a temporary escape from reality when "somebody is very worried" (B7) about "day to day life" (B50). For example, watching funny or interactive videos can enable one to "forget the trouble" (A37) and "disconnect" from "day to day worries" (B7). Some playful experiences do not need much time to engage in and enable a quick diversion from everyday life. For example, for *Gamified Walking*, "you just have to walk like you always do and get rewards for that" (B52), and for *Barrel Roll Easter Egg*, it just "takes a second" (B43). Such diversions can "help you feel better" (B37), "be entertained" (B48), or provide personal value in other ways. Further, unlike tasks that require "your full attention" (B28), playful experiences may demand less mental energy, facilitating easier integration into life. For example, *Chrome Dino Game* enables one to "be entertained without needing to think a lot" (B48), and B21's comment about "aimlessly doodling" shows how this process helps them practice drawing in a "no-stress way" (B21). Engaging in playful experiences can also help calm, which we elaborate on in *Playing to Improve Well-being* (below).

However, playful experiences can be effective at grabbing and holding on to one's attention. An example is how A56's attention was grabbed by an "extremely entertain[ing]" in-app interactive advertisement in the form of a game. Similarly, B60 said that *Playing the Wiki Game* can "suck that time into a black hole of fun and challenge". To the extreme, this can result in impact on other parts of one's life, such as leading to "procrastination" (B11), internet "addict[tion]" (B4 in reference to unlimited scrolling) or having "attention stolen" from important tasks (B60). There is also some tension between distraction and play that supports productivity. For example, A23 described how their playful experience of automating tasks "snowballed" and that they "kept finding additional features for automation", which could have taken away time from other important work-related tasks.

Playful experiences may be perceived as positive even when potentially harmful. For example, in Study 1, several respondents described playful experiences that could be considered a form of distraction, yet all these descriptions were presented in a positive light. Further, we did not receive any responses describing experiences as hurtful, addictive, or destructive, categories suggested by Sicart [200].

3.4.3 *Playing as a Process in the Present*

The process of doing an activity, as opposed to achieving a predefined end goal, is a key aspect of what was considered to make an experience playful. For example, playful experiences were described as "enjoying" or "living the moment" (B13, B12). Similarly, in line with past work in other contexts [34, 200], respondents associated playful experiences with terminology around freedom; for example, being able to try out "hundreds of thousands of possibilities" (B22) while "not [being] limited" (B30). For example, engaging with *Interactive TV* provides a

feeling of freedom, since users are "getting a say in a storyline" (B42) and a feeling of "having an influence" on the outcome (B4).

Moving one's body can also evoke pleasure. For example, *Virtual Yoga* is playful "Because you move your body as if you were playing a sport" (B5), *Photo Effects* is playful because it "is very comfortable to work with paints" (B26), and for *VR Chemistry*, B57 "would feel happy to actively engage in the task instead of just reading about it". A specific example of movement-related play is doodling, from *Creating Content*; for example, how B12 mentioned doodling "if I'm thinking about something else and I want to move my hands". This indicates that doodling is not primarily in support of an end goal, but rather, is an enjoyable process that itself forms a playful experience. This subset of play is similar to Shneiderman's notion of "fun-in-doing" [199], which describes "Joyful sensations" from activities like dancing.

When focusing on an end goal rather than the process, the playfulness of the experience can easily be missed, interpreted in a utilitarian way, or seen as a poor use of time. *Email Filters* exemplifies how playfulness can be missed. With this experience, there is not a clear distinction between perceptions of having emails automatically filtered versus manually organizing emails (*Manual Email Organization*), aside from how filters are more efficient. No respondents in Study 2 discussed the actual process of improving workflows, instead focusing on how the *resulting* workflow process is better (e.g., "saves me time and effort in the future", B23), and possible productivity gains (e.g., "simplifying the task" BP28). Examples of playfulness being interpreted as utilitarian include how B20 would use a fitness tracking app to "obtain information regarding my health and performance" rather than compete (concerning *Fitness Comparison*), and how B54 feels that one may "need to see a demonstration in order to understand the theory behind [a concept]", independent of the novelty of VR (concerning *VR Chemistry*). *Playing the Wiki Game* is an example of seeing playfulness as a poor use of time. This experience only differs from *Wiki Page Navigation* by means of process: playing a game instead of directly navigating to the target page. When focused on obtaining information from the target page, one may feel that "the process [of playing the Wiki game] is useless" (B36), a "waste" (B43), or a "Poor use of resources" (B11), because "it would take me more time to find what I am looking for" (B36). Similar comments were made for other experiences. For example, B10 said, "I want to use my time wisely" by not playing *Playing the Wiki Game*, and B16 said that "In general [*Twitter CYOA* is] a waste of time". Unless playing is the intention, there is a desire to complete tasks "in the least amount of time possible but with the most accurate results" (B28) "to get [them] done and over with" (B7).

These considerations relate to Apter's notion of "paratelic" and "telic" states [10] in psychology. In the telic state, one has a tendency to "complete the activity as rapidly as possible in order to accomplish the goal", which is similar to our finding that efficiency is a key concern when there is not an explicit intention to play, where it can be perceived as "annoying and a waste of time" (B29). In contrast, in the paratelic state, one has a tendency to "prolong the ongoing activity", which is similar to how play was perceived as process-focused. However, the paratelic and telic states do not correspond exactly to playful and non-playful experiences, because boredom can be experienced in a paratelic state but is not strongly associated with play.

3.4.4 *Play as Consciously Chosen*

In line with other works describing play as voluntary (e.g., [101]), respondents perceived engaging with a variety of playful experiences as a "consciously chosen" (B21) and "deliberate" (B52) choice. Seeking leisure is one reason for choosing to engage in play. For a wide variety of playful experience types, respondents engaged when seeking "entertainment" (e.g., B6), "fun" (e.g., B34), and "pleasure" (e.g., B29). In line with past work in other contexts [206], respondents were "judg[ing] their play by whether it is fun or boring" (e.g., describing playing as "fun", B21), even when they felt they would not engage in a particular experience themselves.

The appearance of an interface can affect the perceived potential for play. For example, B26 "would like to engage with [*Barrel Roll Easter Egg*] because it looks funny", and B36 would "like to engage [in *Interactive TV*] because the show has an excellent graphical interface". Experiences may also be dismissed as less playful or not playful when one judges the perceived quality of a feature to be poor, relative to past personal experiences with similar features. For example, B41 said for *Star Map*, "the illustration is not attractive to [be able to] learn about constellations", B58 said for *VR Chemistry*, "if the [app] was more realistic [...] it would be fun", and B60 described *Twitter CYOA* as too "contrived" compared to other CYOA experiences.

Playful experiences are also consciously chosen in that *features* cannot be guaranteed to be playful. Put differently, it can be difficult to draw the line between emergent play and designed play. Some design elements can set the "stage" [200] or serve as cues for a possible playful experience, but do not guarantee that it will be experienced in a playful way. This is evidenced based on three key points from the analysis. First, "playful" features may be ignored in light of utilitarian goals (*Playing as a Process in the Present*). Second, "playful" features may be dismissed as being "stupid and a waste of time" (B16; *Play as Frivolous and Disconnected from Daily Life*). Third, as highlighted by other work (e.g., [200]), people appropriate features for play, even those not intended to be playful. This is most evident for *Using Feature in Unintended Way*, but is also demonstrated by *Discovering Unexpected Feature* when people find a feature they did not know about before, *Improving Workflows* when people experience a fun process of making something, and *Reflecting on System Operation* when curiosity about an application's implementation drives the playful experience.

3.4.5 *Individuality of Play Preferences*

In line with past work from other contexts arguing that "individuals show great variation [...] in their kinds of play and in the amount of play" [206], our respondents' opinions varied significantly in terms of whether a given experience was considered playful. There were varying preferences for theme and style of play. Examples include how B54 is "not interested in zombie themed stories" (*Themed Fitness*), B20 is "big into fitness" (*Fitness Comparison*), B31 "would prefer to sit and relax to watch something rather than have to engage and actively participate" in a CYOA TV show, and B9 would "prefer to ride a bike" than do yoga. This relates to what Apter [10] calls "displacement", when "a paratelic activity, if it does not provide pleasure, can often be terminated and another more pleasant

paratelic activity substituted". This also relates to work in games and gameful design focusing on the notion of player types, such as the Hexad gamification user types model [138, 214], which attempts to characterize personality types of users of gamified systems. Developing user typologies for non-game play may also be useful for the design of user interfaces with tailored forms of play.

3.4.6 *Play as Frivolous and Disconnected from Daily Life*

Play can sometimes be perceived as an unnecessary or peripheral concern in daily life. Certain playful experiences were dismissed by several respondents as not having a "point" (e.g., B18), "need" (B17), or any "value" (e.g., B30). This relates to *Individuality of Play Preferences*, because people who dislike a particular style of play may be critical of it, and *Playing as a Process in the Present*, because people focused on goal achievement may dismiss the value of activities that do not aim for efficiency. This also relates to Sutton-Smith's [206] suggestions that people may see "play" in contrast with "work", and that proponents of different rhetorics of play may dismiss others' forms of play as "frivolous". The subsections below outline a number of specific ways that play is considered frivolous.

PLAY AS PERIPHERAL Play can be considered peripheral when it is perceived as an "unnecessary" concern (e.g., B37), as having limited or no meaningful impact on one's life (e.g., "it doesn't change anything in the long run", B25), or that there are "more important things to do" (B16). For example, B59 said, "I would have to be pretty bored and uninspired" to start *Playing the Wiki Game*. In apps that provide utilitarian functionality in addition to playful aspects, the latter may be considered fundamentally unimportant to the use of the app. For example, B23 said, "without [*Themed Fitness*,] they could still run, it just adds entertainment", and B10 said, "I would not [engage in *Profile Decorating*] as I care more about the purpose of apps like that, which [is] the communication itself". In contrast, many forms of play are inherent to their underlying tasks and therefore cannot be separated into elements; for example, A28's comment about how professional art "is of necessity a playful creative process". We feel it is a mischaracterization to assume that all play is supplementary and can simply sprinkled on top of other tasks. This relates Deterding's [57] argument in gamification research, that we need to think about how effects of an experience emerge from the total system, rather than through some sort of "additive-deterministic" application of game design elements.

PLAY AS UNPROFESSIONAL The workplace can be seen as a "serious" place (B38) in which "unprofessionalism" (B22) is not tolerated. In this context, playful experiences can be considered "silly" (B54), "unproductive" (B11), "distract[ing]" (B15), and "destr[uctive]" (B22). Some types of play are "meant to be fun and quirky, and work is not the place for fun or quirkiness" (B22). Unserious features such as playful graphics (*Animated Message Effects*), may be described as "over the top" (B57), "childish" (B23), and "cheesy" (B49). People who see themselves as "a serious person" (B11) may form judgments about others who play. For example, B10 said, "the people around me who engage in [*Selfie Filters*] a lot don't always have a seriousness towards important goals".

Play can also be considered unprofessional from a social standpoint. For example, it may come off as "rude or inappropriate" (B58) or show that one is "uninterested" (B21). Playing could disrupt others in public situations, for example, by "disturb[ing] the other passengers" on public transport (B6). They could also could pose danger if in safety-critical situations, such as "while driving or doing hazardous tasks" (B46). Further, people in the environment may have their privacy violated when in range of a playful experience. For example, if a playful experience involves taking photos (e.g., *Selfie Filters*), bystanders in a busy place "may not want to be in your photo" (B30). Some playful experiences may use features or resources in a way that could be considered wasteful or disrespectful. For example, B11 said that *Playing the Wiki Game* "seems to trivialise all the work to build the resource", disrespecting the efforts of Wikipedia contributors by turning its pages into a game.

3.4.7 *Playing to Improve Well-being*

Engaging in playful experiences can support one's well-being by serving as a form of self-care. This is enabled by a variety of playful experience types. For example, digitally-mediated mindfulness activities such as *Virtual Yoga* can serve as "a form of mental rest" (B9) and "peaceful[ness]" (B37), supporting mental well-being (B49) and health (B25). Digitally-mediated fitness activities such as *Gamified Walking* can serve as a way for one to "to get some exercise" (B29), ultimately resulting in a "health[ier] lifestyle" (e.g., B1). Also, activities like *Plant Identification* can get people into situations that help "take care of [their] mental health", for example, "by being out in nature" (B11). Many playful experiences can also bring joy and improvements in mood by presenting funny or cheerful content or interactions in a context that would otherwise not have this. For example, *Barrel Roll Easter Egg* "would give [one] something to smile about" (B60) and "cheer you up a little bit" (B43), *Selfie Filters* "calms when a person is not emotionally well" (B61), and *Dog Picture Scrolling* can help one "improve their mood while watching cute dogs" (B9).

Similarly, people often engage in a wide range of playful experiences because they can help "relax" (e.g., B9) and "eliminate stress" (B45). For example, B60 said that *Barrel Roll Easter Egg* could 'provide a nice small respite from the drudgery of my day". This relates to *Balancing Between Diversion and Dependence* (above), in that some people may feel a need to escape from reality in order to relieve stress; for example, "in case somebody is very worried about something, and needs to disconnect in order to relax" (B7). This also relates to Shneiderman's notion of "fun-in-not-doing" [199], which describes activities "about relaxing". Interestingly, B61 described *Manual Email Organization* as "calming" and "relaxing", despite not considering this playful. This suggests that the process of manually going through the motions of doing something that can be automated may provide meditative value, even if not broadly considered playful.

Some playful experiences can support self-improvement, in that doing or learning something personally meaningful through a playful experience can make one better off in the future. For example, *Drawing App Parameter Tinkering* can help expand artistic knowledge by "learning what each brush does for future use" (B51), and for *Fitness Comparison*, introducing competition can help

"people [...] improve themselves" (B37) and enable one to "view opportunities for improvement" (B20).

3.5 GENERAL DISCUSSION

We discuss how our playful experience types and perspectives compare across the two studies, contextualize them in relation to past work, and discuss limitations and future work.

3.5.1 *Reflecting on the Combination of Studies 1 and 2*

Study 2 serves to validate and elaborate on Study 1, taking into account the additional experience examples developed in the expert brainstorming session, and the variety of perspectives of additional respondents. Here, we reflect on key additions based on Study 2 and the differences between the studies.

From Study 2, we characterized two additional playful experience types, *Socializing* and *Seeking Novelty*, as well as five additional play perspective themes generated based on inductive coding as we refined the types. We also developed a more nuanced understanding of types initially characterized in Study 1. Examples include how curiosity is an element of *Learning* experiences yet it does not necessarily imply playfulness, how play in experience types like *Using Feature in Unintended Way* can be perceived negatively (e.g., as unprofessional or a waste of time), and how there are unique play preferences in non-game user interfaces affected by subjective judgments about aesthetics. Study 2 did not significantly expand our characterization of three playful experience types (*Engaging with the Real-World*, *Improving Workflows*, and *Reflecting on System Operation*); however, when Study 2 shared similar data to Study 1, it helped validate these types or provide additional connections (e.g., the relation of *Improving Workflows* to *Playing as a Process in the Present*).

The strongest difference between the studies was that *Improving Workflows* was not judged as playful by any Study 2 respondents. In terms of playfulness, we found there was not a clear distinction between having emails automatically filtered (*Email Filters*) versus manually organizing emails (*Manual Email Organization*). Instead, respondents focused on the resulting workflow process and potential productivity gains. This productivity-oriented mindset was also manifest to a lesser extent in other experiences, such as *Selfie Suggestions*, in which respondents focused on the utility of the feature rather than on reflecting about how it works. Experiences types like *Improving Workflows* are noteworthy in that in addition to having playful value, they also can provide significant productivity-related or utilitarian value. Similar to how some respondents felt negatively about experiences that did not provide utilitarian value, they may have prioritized utilitarian value of certain experiences, overshadowing playful aspects.

In Study 1, we noticed a surprising scarcity of examples of social play. A number of experiences were socially motivated, but the experiences were not social themselves. For example, A9 applied photo filters to the faces of their friends, A43 and A47 created content to post on social media, and A8 and A36 created documents to be shared with other people. It is possible that social forms of play are not the first that come to mind when reflecting about software

applications. In any case, through the expert brainstorming session, we developed examples of social playful experiences (*Fitness Comparison*, *Swap Mode*, and *Profile Decorating*). These examples enabled Study 2 to provide additional insight into social play in non-game user interfaces, leading to the new *Socializing* type and connecting it with other types. For example, teaching others can form a *Learning* experience, *Body Appearance Play* has significant social meaning in terms of people's self-presentation, sharing Easter eggs can make one feel like part of an in-group (*Discovering Unexpected Feature*), and computer graphics can be shared to spread positivity or moods with others (*Appreciating Computer Graphics*).

There are also differences in our play perspective themes. In Study 1, we characterized play in relation to productivity. However, because the expert brainstorming session did not introduce additional productivity-related experiences, and Study 2 respondents did not make many comments pertaining to productivity within the playful experiences from Study 1, we did not expand our characterization of play for productivity in Study 2. However, we developed a more nuanced understanding of how play can support eudaimonic motives (*Playing to Improve Well-being*), which relates to productivity through concepts like self-improvement. In Study 1, we also characterized how play can be distracting, but in Study 2, we characterized play in relation to attention more broadly, including aspects like why playful experiences serve as an escape from reality, how they integrate into one's life, and the role of playing in different contexts and environments.

3.5.2 *Relating to Past Play Categorizations*

We wanted to understand how our playful experience types compare to Webster's "play-like situations" from her 1988 pilot study [225], to see how play in software has changed in the more than 30 years since. We also wanted to understand how our categories relate to those of Arrasvuori et al.'s revised version [12] of Korhonen et al.'s PLEX framework [120], which is well-known in the context of games research. While some categories inherently overlap, like *Forming a Challenge* and the PLEX *Challenge* category, other mappings required a level of interpretation. Further, although we are able to draw connections between our categories and those in the other works, in the two subsections below, we discuss how our categories provide significant additional insight into modern non-game user interfaces.

Table 3.5 shows our mapping of the categories. We grouped Webster's "seeing results" situation under our *Experimenting* type, since it refers to immediate feedback. We grouped the PLEX framework's *Cruelty* category with our *Experimenting* type because *Testing System Limits and Capabilities* could be considered a form of "exerting power over others" [120], its *Fantasy* category with our *Body Appearance Play* type, because although *Fantasy* is broader, features like AR filters have some element of "make-believe", and its *Nurture* category with our *Socializing* type, because sharing digital content with friends can support this.

Webster's "Play-like Situations" and Ever-changing Forms of Play

Our playful experience types form a superset of Webster's "play-like situations" [225]. Webster focused specifically on office workers, which is a narrower scope than ours. Also, social use of computers, computer graphics, computer art,

Table 3.5: Comparison of our playful experience types with Webster's 1988 pilot study [225] and Arrasvuori et al.'s revised PLEX framework [12].

Ours	Webster	PLEX
1. Experimenting	asking 'what if' questions; massaging data; investigating the possibilities available; seeing results; figuring out new functions/features	Control; Cruelty; Exploration; Expression; Relaxation
2. Exploring Content	*N/A*	Exploration; Relaxation
3. Learning	learning new functions or programs or systems; receiving positive feedback from tutorials; figuring out new functions/features	Challenge
4. Creating Content	producing graphs or charts; designing new systems	Expression
6. Forming a Challenge	*N/A*	Challenge; Competition
7. Using Feature in Unintended Way	*N/A*	Subversion
8. Body Appearance Play	*N/A*	Fantasy; Humor
9. Discovering Unexpected Feature	*N/A*	Discovery; Humor
10. Customizing and Personalizing	*N/A*	Expression
11. Improving Workflows	designing new systems; devising ways to make the systems work more efficiently	*N/A*
13. Appreciating Computer Graphics	*N/A*	Sensation
5. Engaging with the Real-World; 12. Reflecting on System Operation; 14. Playing Game Within System; 16. Seeking Novelty	*N/A*	*N/A*
15. Socializing	*N/A*	Fellowship; Nurture; Sympathy
N/A	*N/A*	Captivation; Completion; Eroticism; Simulation; Submission; Suffering; Thrill

and so on, were not widespread in the 1980s as they are today. The new types of play we identified may come from new forms of modern user interfaces and the proliferation of internet-connected devices. For example, our *Body Appearance Play* type is made possible by the ubiquity of cameras on consumer devices and powerful processors that can do graphical operations, and *Exploring Content* is made possible by widespread use of the internet and social media.

Webster's work categorized features like "undo commands", "help mode", and "icons" as playful. While this classification may seem outdated, our studies clarify how such features could have been considered playful at the time. By interpreting playfulness as a state of mind or activity, rather than as a property of a feature, the features that Webster reported are indicative of characteristics of different forms of play. For example, A36's comment under *Experimenting*, "Lots of opportunities for trying and failing and pivoting in a low risk way", shows that they felt like they were in control, and this sounds remarkably similar to what undo features enable people to do. We also identified that people find some features to be playful because the underlying technology is novel and its capabilities were not previously possible; for example, the prospect of using VR (B52). Similarly, features like undo could have been considered playful in the 1980s because of novelty.

Although forms and specific examples of playfulness will come and go, we believe that our playful experience types will remain relevant as long as computers continue to be used for these kinds of tasks. As computers are used in new ways, there may be new forms of playful experiences that will need to be investigated.

The PLEX Framework and Comparing with Game Play

While it is possible to draw connections between our categories and those of the PLEX framework [120], a number of considerations make the PLEX framework insufficient on its own for understanding play in software user interfaces. The PLEX categories are defined more vaguely, and many describe feelings associated with play rather than types of play. For example, *Captivation*, the "Experience of forgetting one's surroundings", could be said to be true of most types of play. The PLEX categories are also exemplified using games and have been considered mostly in the context of games, which can make them hard to adapt to non-game contexts. Most importantly, our context-specific, bottom-up approach resulted in unique categories and insights that describe the context of playful experiences in software user interfaces more comprehensively than PLEX. Our playful experience types are focused and highlight context-specific aspects of play, such as *Playing Game within System* and *Seeking Novelty*, and our types are nuanced in ways that can assist with understanding and designing for play in this context. Below, we highlight some examples of unique insights about play in software user interfaces based on our analyses, and compare with PLEX.

We designated *Learning* as a key type of playful experience in software applications. In contrast, PLEX treats learning experiences significantly more narrowly by classifying them under the *Challenge* category. Apps are used in serious contexts, and simply experimenting with them or enjoying the process of using them regularly enables one to experience playful learning. PLEX also does not have analogues for *Engaging with the Real-World*, *Improving Workflows*, *Reflecting on System Operation*, and *Playing Game within System*. These types are likely unique to software applications (or possibly also gamified systems), but not games. Of

these types, *Improving Workflows* is noteworthy, because most games do not have serious real-world or performance-related implications.

Non-game forms of play "do not have a distinct boundary", unlike the "magic circle" of games [189]. For example, in A59's playful experience of creatively applying visual effects during work, how might one draw boundaries delineating the start and end of play? This has a number of implications that our studies characterize in the software user interface context. Challenges are often invented by the user rather than imposed by rules. For example, users may appropriate features by turning them into a game (e.g., *Playing the Wiki Game*), or aim to develop habits by repeatedly trying to engage in an activity (e.g., *Fitness Comparison*). Also, apps often deal with personal data, resulting in more deeply-rooted personal or social meaning; for example, B30's comment about how setting a wallpaper to a personal photo could help "bring up happy memories". Another implication is that play should not interfere with work or come off as unprofessional, and our analysis explores the ways that people feel play integrates (or does not integrate) into serious contexts and how play affects attention in these contexts.

There are also a number of categories unique to the PLEX framework. Some may be more strongly associated with games, like *Simulation* and *Suffering*, but these concepts were not suitable for describing our data. Also, some PLEX categories are more connected to our play perspectives than being direct counterparts to our playful experience types; for example, the PLEX *Relaxation* category relates to our *Play as peripheral* perspective, and we consider relaxation to be more a trait of a number of playful experience types than its own type. These unique PLEX categories and other conceptualizations of play in the games literature may be good opportunities for future work to explore how software applications could integrate a wider range of playful experiences, in a gamified manner or otherwise. For example, the gamified smartphone app *Forest*[2] directly integrates the PLEX framework's notion of *Nurture*, by having users plant a virtual tree and watch it grow as they work.

Additional Note Concerning Definitions

Our definition of "play" for Study 1 and the expert brainstorming session followed Caillois' notion of *paidia*, which refers to open and free-form play. This contrasts with games and gameful design work, which primarily pertains to *ludus*, meaning more rule-based or structured play. Our playful experience types demonstrate the diversity of common forms of unstructured play in the software user interface context. *Paidia* and *ludus* do not have a hard boundary, and instead can be thought of as forming poles of a continuum [59]. Despite our focus on *paidia*, some more structured, game-like forms of play were mentioned in Study 1 and the brainstorming session. We categorized these under *Forming a Challenge*, because challenges are often formed by establishing rules. However, this is not to suggest that all forms of game-like play fall under *Forming a Challenge*. Because of our focus only on *paidia*, there may be types of play exclusive to game-like contexts, such as some of the categories in the PLEX framework [12, 120], which we discuss below. Serious games, like *Foldit*,[3] could also be considered a form of gamifying serious tasks, but because these are games, they are outside the scope of our work. Another consideration is that gamification is largely about

2 https://www.forestapp.cc/
3 https://fold.it

behaviour change, in that "The persistent, principled design challenge gamification addresses is motivating users" [57]. In contrast, the playful experiences we studied do not necessarily have the intention or effect of motivating users to change their behaviour.

3.5.3 *Limitations and Future Work*

It is important to understand how conceptualizations of and preferences for play differ across cultures; for example, differences in humour, understandings of the word "play" in reference to one's first language, and different levels of access to technology and leisure time during which one can use technology. Because of the reach of our recruitment methods for Study 1, we were able to obtain some level of diversity in responses, although a large portion of respondents were young and students. Our crowdsourcing approach for Study 2 resulted in wider diversity of respondents and helped us to validate the playful experience types formed based on Study 1, but this does not guarantee the applicability of the categories across cultures. Further, the North American context of our university and background will have influenced our analysis. It would be valuable for future work to conduct variations of our study in translations to other languages and in other cultural contexts, to investigate the potential variations of types of play.

For our definition of play in the prompts for Study 1 and the expert brainstorming session, we tried to be as inclusive as possible, and did not indicate types of interaction (screen, sound, etc.) to avoid limiting the scope of possible interactions with the presented devices. Despite this, visual, screen-based interfaces were predominant in our responses. Future work could focus on understanding experiences of play for less prevalent input and output user interface modalities, such as auditory or tactile interfaces.

We chose to present the experiences in Study 2 vicariously, in that respondents were watching and reading about each experience rather than experiencing it for themselves. This approach made it feasible to obtain a wide range of perspectives about particular playful experiences, and supplemented the exclusively first-person perspectives gathered from Study 1. Future work could devise controlled experiments that deploy features aimed at eliciting playful experiences. This would help better understand specifically how *features* can lead to playful experiences, and could capture additional performance or physiological measurements during playful experiences.

3.6 CONCLUSION

To better understand the ways that non-game software user interfaces are used in playful ways, we conducted two survey studies. Study 1 asked 63 respondents to recall and reflect on a recent playful experience with software, from which we created an initial characterization of 14 playful experience types. Study 2 asked 61 respondents to reflect on examples of both playful and non-playful experiences, drawn from our playful experience types and a brainstorming session with three experts on play. Our analysis of responses enabled us to refine and extend our playful experience types, resulting in 16 types in total, as well as seven play perspectives that span across multiple playful experience types. By comparing

our playful experience types with past works on play, we were able to highlight the nuances and unique aspects of playful experiences in software user interfaces.

Given the ubiquity of software user interfaces and the extent to which commercial interfaces already contain what could be considered playful features, it is valuable to have an understanding of play in this context. Our results provide an understanding of how 'in the wild' interfaces are currently using play, which can serve as a point of comparison across different contexts (e.g., games) or within specific subcontexts (e.g., social media). Our 16 playful experience types and examples from the expert brainstorming session could serve as inspiration and starting points for the design and evaluation of features that encourage play in software user interfaces. Our playful experience types and perspectives could also be developed into questionnaires for assessing the playfulness of experiences with software user interfaces, or could highlight how existing questionnaires might be modified to adapt to this context. We hope that this work helps to advance the creation and investigation of playful interfaces that provide social and emotional value in non-game contexts.

4

PURPOSES, PROCESSES, AND DIRECTIONS FOR USER INTERFACE EASTER EGGS

Linguists of emerging language for 1996 defined *Easter eggs* as an "[u]nexpected operation programmed into commercial software as a joke and activated by a secret command" [2]. In fact, they had been included in software for decades, and have become an international phenomenon. Video games frequently include them; for example, developer Warren Robinett famously added a hidden room to the Atari game Adventure as a signature for his work because Atari would not credit the game's authors [152]. Easter eggs have even been referred to as a new kind of gameplay [44]; for example, hidden cheat codes can be hunted for, potentially leading to increased replayability and sales of a game [44, 236]. Easter egg "hunters" have active social communities, and online databases of Easter eggs inside computer and other media have been created (e.g., "eeggs.com").

Easter eggs are also prevalent in the user interfaces of non-game software applications, which we will refer to simply as "software applications". Yet, Easter eggs in this context have received limited study, with the exception of a popular press book from 1997 [161] and a few online blog posts and news reports [82, 184]. Examples of software application Easter eggs include the puzzle game hidden in the Android operating system, and the sheep sound hidden in Adobe After Effects. Although Easter eggs in software applications share commonalities with those in games, there are notable differences, such as cheat codes being unique to games, and considerations that are unique to software applications, such as Easter eggs distracting users from work.

We define software Easter eggs as hidden features in software applications that are activated either at certain times or through specific user interactions, and whose functionality is undocumented. This definition expands the mostly game-oriented definitions of Easter eggs used in previous work by refining and relaxing certain criteria, to better represent the range of hidden features in software applications. Specifically, Easter eggs do not have to be exclusive to commercial software, as open-source software also includes what developers have called Easter eggs. Easter eggs can be created by actors other than the original programmer; for example, users may inject hidden media into applications through remixing or customization, and then share this for others to discover. Not all Easter eggs must be strictly reproducible; "hidden" features can be designed so they may only be found at certain times (e.g., in association with a calendar event), and Easter egg hunting experiences can even be the result of fictitious Easter eggs that are not implemented at all. Finally, Easter eggs can provide value beyond entertainment, such as education and social awareness.

The goal of our research is to better understand these types of Easter egg phenomena in non-game software application user interfaces. This includes the stories behind their development, why developers make them and for whom, and how users have perceived and are intended to perceive them. We use the term "purpose" to encompass this set of ideas succinctly. In addition, through the process of our analysis, we identify processes related to Easter eggs, specifically those

regarding their social and emotional benefits and challenges. The study of Easter eggs is important to developers, users, HCI researchers, and designers, for several reasons. First, the study of interfaces that are not only productivity-boosting, but also "playful" and provide emotional value, has seen recent interest in HCI [4]. Easter eggs are one potential way for HCI researchers and UX designers to create interfaces that provide emotional value. We can gain insights about this from studying how Easter eggs are designed to provide emotional value in the wild. Easter eggs may also have the potential to support the *hedonic quality* [95] of user interfaces, such as heightening user perceptions of originality and excitement, which can make software applications more appealing in commercial settings. Second, as we discuss in Section 4.5, Easter eggs can serve as design exemplars for important concepts such as microbreaks [97], emotional support using conversational agents [40], emergent help features, and remote collaboration icebreaker activities, which could be further researched as ways to improve task efficiency and workplace health and well-being with computer interfaces. Third, Easter eggs give rise to a number of social phenomena like digital communities of Easter egg hunters (e.g., "eeggs.com") and Easter egg remixers (e.g., Scratch users who have remixed the Google Chrome dinosaur game[1]). Understanding the purposes of Easter eggs and how they impact developers and users can form a starting point for future work to learn about these digital communities.

We developed a conceptual categorization of Easter egg purposes through an approach centred around archival research, using a selection of tools and principles from constructivist grounded theory [38]. The primary data source was Internet media discussing Easter eggs. To gain more insight into specific well-known Easter eggs, we conducted interviews with four developers. Through the process of constructing this categorization of purposes, we also identify and categorize a set of processes that Easter eggs undergo, concerning developers and users. We illustrate our conceptual categories using a variety of examples. We also propose design directions for applying ideas from Easter eggs to user interfaces in new ways, such as providing a structure for users to be more expressive and gain educational value from their interactions with software.

4.1 BACKGROUND AND RELATED WORK

We briefly summarize past work on Easter eggs in games, before examining past definitions and classifications of Easter eggs in software applications. In the context of software applications, few formal publications exist.

4.1.1 *Easter eggs in games*

Easter eggs have been mainly explored in the context of video games, for which they have been conceptualized in different ways. Consalvo [44] argues that Easter eggs are a new kind of gameplay and may lead to increased sales for this reason. She breaks them down into three types: "ornamental", affecting the display of the game, "functional", adding behaviour such as game cheat codes, and Easter eggs that "attempt to make a larger statement", for example, by critiquing the status quo. Bailey [13] highlights how Easter eggs have been used to circumvent organizational restrictions, have accidentally emerged out of last-minute scrapped

1 https://scratch.mit.edu/projects/189057541/remixes/

video game content, and have been hidden for marketing reasons. Consalvo [44] and Gazzard [80] both relate Easter eggs to the concept of cheating. An example of cheating in games is using hidden cheat codes, which give players advantages like bonus lives or weapons. Gazzard argues that exploring or exploiting hidden or unintended features of games can lead to flow-inducing player experiences, and social aspects around sharing game hacks and Easter eggs can lead to an increased sense of community among gamers.

Easter eggs can also be conceptualized through the lenses of intertextuality and paratextuality. Intertextuality can be described as a "textual strategy" involving *parodic allusion*, *creative inclusion* of other texts, or *self-reflexive reference* [177]. For example, searching "the answer to life the universe and everything" in Google Search produces "42" as a result, a parodic allusion to *The Hitchhiker's Guide to the Galaxy*. Broadening this idea from text to media more generally, some Easter eggs in games have been described intertextually, as allusions to other media [217]. Paratext refers to "the materials and discourses that surround [a] narrative object" [181]. Consalvo [44] argues that Easter eggs in games "set the stage for a paratextual industry" for texts such as game magazines and strategy guides. She relates this to what she terms "gaming capital": "how being a member of game culture is about more than playing games or even playing them well". In the following sections, we illustrate how Easter eggs in software applications could be understood similarly, for example, by encouraging discussion about Easter eggs on social media.

In the context of software applications, the nature of Easter eggs is necessarily different from Easter eggs in games. In particular, the idea of hidden cheat code Easter eggs in games does not have a direct analogue in software applications. Further, software application Easter eggs have received much more negative attention concerning security and developer productivity problems, because software applications are often used in mission-critical contexts. Because Easter eggs are hidden and undocumented code, they have similarities to dangerous code such as backdoors and logic bombs [172]. For example, historical versions of the PHP scripting language contained an image-based Easter egg that would render in output webpages. The images changed in each version, making it easier for hackers to identify the PHP version the server was using. This could facilitate exploitation of bugs and vulnerabilities in old versions [3]. For reasons like these, some companies like Apple and Microsoft have prohibited developers from including Easter eggs in their software [61, 176].

4.1.2 *Definitions and characteristics in software applications*

Nagy-Farkas' 1997 popular press book "Easter Eggs: Software Surprises" [161] is one of the most thorough, albeit informal, descriptions of game and software application Easter eggs. Nagy-Farkas defines Easter eggs as features that are undocumented, written by the original programmer, reproducible, harmless, and entertaining [161]. Our expanded definition of Easter eggs, provided in the Introduction, refines and relaxes these criteria, including user-made Easter egg remixes and customizations, and non-reproducible and non-entertaining Easter eggs.

In software applications, some characteristics of Easter eggs have been discussed in specific contexts, such as with conversational agents, and in informal

publications like blog posts. Work by Luger and Sellen [132] demonstrates that people will often look for Easter eggs when first interacting with conversational agents, to gauge what the agent is capable of in a playful way. Weinel et al. [227] argue that Easter eggs serve two "purposes": providing enjoyment to their creators, and adding aesthetic value to the resulting artifact (whether it be software, a video game, music, etc.). However, despite discussing software, Weinel et al.'s categorization is mainly focused on Easter eggs in musical media (e.g., images hidden in music spectrograms). Outside of academia, in a New York Times article [184], Pogue uses several examples to describe how software and hardware Easter eggs can be used for recognition, to "establish software as an art form", as a 'thank-you' notice, and to encourage prospective company employees. In a blog post, Gkogka [82] discusses how Easter eggs can lead to "delightful" user experiences that "act as special rewards", entertain users and "break the monotony", give "personality" to a product, "attract people back to [a] product", and "serve as a distraction". She also describes how Easter eggs can be "context focused", "enlightening", "artistic", and capable of "add[ing] extra functionality" or "teasing." Nagy-Farkas [161] claims software Easter eggs are created for four reasons: "recognition", "nostalgia", "humor", and "revenge". However, this classification is mostly unsubstantiated and may be less relevant today, because of new computing platforms, interface designs, and reduced concern about computer resource usage. Inspired by these classifications of Easter eggs, we develop a more complete and modern classification of Easter egg purposes.

The term "Easter egg" has also been used to describe software watermarks, historically used to discourage software intellectual property theft by hiding ownership information [43]. For example, if a certain sequence of keys is pressed, the developers of an application could be revealed as evidence of ownership. This is similar to Easter eggs where developers have discreetly signed their work, like the Atari Adventure game example.

4.1.3 *Gamification and Play*

Easter eggs can be considered in relation to research on playfulness in user interfaces and gamification. Costello and Edmonds' pleasure framework [46], in the context of interactive art, categorizes thirteen "pleasures of play". It formed the basis of the PLEX framework [131], which is used in the design of games and playful experiences more generally. Boberg et al. [26] place Easter eggs within the PLEX category of "Discovery", in which the discovery is "associated with a degree of surprise". In gamification research, Easter eggs are considered to be a gamification element, described by Marczewski as "a fun way to reward and surprise people for just having a look around" [139]. Our investigation reveals that software Easter eggs are not necessarily playful, and can have more purposes than this more limited view of enabling discoveries or acting as rewards or surprises.

4.2 METHOD

The primary motivation of this investigation is to better understand, in the context of software application user interfaces, the purposes of and processes involving Easter eggs.

We focused on Easter eggs that people experience in user interfaces in the wild, rather than investigating them purely from a standpoint of developer-centric practices. Because Easter eggs are by definition hidden phenomena, this approach poses the challenge of identifying the provenance of specific Easter eggs, whichis not usually possible without inside knowledge. Further, as we learned through our investigation, the original developers of specific Easter eggs may become forgotten over time. While there are online communities of Easter egg "hunters", active engagement with these communities can only provide limited insight into Easter egg developers' intention and affect, because developers are usually not involved in these communities and users can only speculate as to Easter egg purposes.

Recognizing these constraints around possible data sources, we chose to use an approach centred around archival research, in which we performed a qualitative, investigative analysis of Internet media discussing Easter eggs. Some previous works have characterized this approach as "passive netnography" [47], a set of research practices in which data is collected through the Internet [121], itself related to a subset of methods used in digital ethnography. We also conducted interviews with four developers to gain insight into specific well-known Easter eggs. We used a selection of tools and methodological principles from constructivist grounded theory as described by Charmaz [38], which focuses on constructing conceptual categories that emerge from the data, as opposed to borrowing or applying external or pre-existing theories to analyze the data. Specifically, we conducted data collection and analysis simultaneously and iteratively, made constant comparisons across different segments of data, and drew on the data to develop conceptual categories. We focused on developing a set of Easter egg purposes and conceptual categories that have strong explanatory power and a close fit with the data, rather than aiming to develop a formal theory. This is in line with Charmaz's suggestion that grounded theory guidelines can "solve varied problems... whether or not you aim for theory development". In contrast with other qualitative approaches that separate data collection and analysis, such as thematic analysis [28], we found the need to continually return to the data to seek more types of information. Our methodology enabled us to refine our research questions throughout the process of analyzing the data [38], uncovering potential benefits and challenges associated with Easter eggs, in addition to their purposes.We describe our approach in more detail below.

Rather than provide a history of Easter eggs, we primarily focus on recent examples because they are more relevant to contemporary computing platforms, applications, and interface designs. However, throughout the investigation, some historical Easter eggs were included to highlight specific properties of different Easter egg purposes.

The results of this investigation (Sections 4.3–4.4) form conceptual categorizations, and further enable us to provide insights for design practice inspired by Easter eggs through a discussion of future directions (Section 4.5).

ARCHIVAL RESEARCH To scope out the space of software application Easter eggs, we performed initial sampling using the popular, community-maintained Easter egg database website "eeggs.com". The website contains categorized lists of links to pages about Easter eggs. The categories correspond to the source of the Easter egg, such as "Application Software" and "Movie". Each Easter egg page

contains user-contributed instructions and possibly images for the associated Easter egg.

There are several other database websites and forums for sharing Easter eggs online. However, we found these to be more outdated, contain only a few software application Easter eggs, or lack clear separation between software Easter eggs and a larger mix of other types, such as those in movies. "eeggs.com" is itself rather outdated; only 58 of the 1656 submitted software Easter eggs were added since 2010. However, a considerable number of older Easter eggs remain in current versions of the same software. We also observed the fact that companies that have produced Easter eggs in the past are known for continuing to produce new Easter eggs (e.g., Google [184]). To ensure recent Easter eggs were represented, we scraped "eeggs.com" to collect the most common keywords in Easter egg application names, identifying top organization and application names associated with recent software (e.g., "Adobe", "Windows", rather than "Macromedia", "Lotus"). We used these as keywords in Easter egg searches, combined with search terms "Easter egg" and "hidden/secret/undocumented feature", in online discussion forums and blog posts. We also went through social media feeds associated with these organization and application names, which helped us identify non-conventional Easter eggs like Google Doodles and a fictitious "=CAKE" function in Microsoft Excel. For Easter eggs belonging to open source software, we searched through commit messages and bug reports to collect additional information. Using theoretical sampling [38], we further investigated emerging categories and discovered variations.

INTERVIEWS During the archival research investigation, we identified a small number of specifically well-known Easter eggs that had little information available about them. For a subset of these, we were able to identify contact information for potential developers with inside knowledge. We conducted email-based interviews with software developers who created Easter eggs themselves, or were in close contact with developers who did. Our interview protocol was approved by our institution's research ethics board, and requires we preserve the anonymity of our participants.

We used a structured interview approach, defined in the same sense as Dimond et al. [62]: a fixed set of questions were provided to the developers by email and responded to via email. We used this direct, email-based approach because we were 'cold emailing' developers associated with well-known Easter eggs, and wanted to make our contact as effortless for them as possible to encourage a response. The questions asked were:

1. "What was the motivation to create this Easter egg? Is there a story behind it?"
2. "Who was this Easter egg targeted at? (For example, a particular person or population.)"
3. "From what you've seen, how have others (developers, users, etc.) responded to this Easter egg? What comments have others made to you about it?"

We received responses from four developers. We describe their companies and software in a way that preserves their anonymity, and we refer to them using the generic labels, *D1–D4*. *D1* is a developer for a popular open-source multimedia application for Android, *D2* is a senior engineer at a large, commercial software

company, *D3* is a front-end developer at a different, large, commercial software company, and *D4* is the lead developer of an internationally renowned open source software application. *D1*, *D3*, and *D4* discussed one Easter egg each, whereas *D2* discussed six separate Easter eggs. We followed up with two of the developers to clarify ambiguities in their initial replies and to collect more information about gaps in properties of categories uniquely associated with their Easter eggs.

Purpose categories were constructed by coding the data in an iterative process moving between data and analysis. Initial (open) coding was line-by-line. Focused coding and theoretical sampling were used to consolidate more abstract categories and identify variations in the data. We stopped collecting Easter egg examples and associated information once we reached saturation; that is, new data was not revealing new theoretical insights or properties of Easter egg purposes [38]. During the process of focused coding, we also identified emergent social and emotional process categories, which we developed as a secondary categorization simultaneously with the purpose categories. The data analyzed comprised the developer interview text, as well as the archival research documents, specifically passages written by developers, passages from users that described objective Easter egg functionality, and any textual information contained within the Easter eggs. This process resulted in 14 purpose categories and 6 process categories.

4.3 PURPOSES OF EASTER EGGS

We discuss the 14 Easter egg purposes that emerged from our qualitative analysis, which encompass stories behind, motivations for creating, and intended perceptions of Easter eggs. Where relevant, we also discuss the informal publications about Easter eggs in the context of specific purposes, to highlight the different types of language that can be used to describe Easter eggs. This set of purposes may be incomplete; however, the purposes we identified serve as a way of understanding specific common and interesting aspects of the functions of Easter eggs. Also note that these purposes are not mutually exclusive, as many Easter eggs are applicable to more than one category. The purposes are presented roughly from least to most prevalent in our investigation; however, measuring frequency was not our goal, and in practice, is challenging due to the data collection considerations previously discussed. Table 4.1 summarizes all of the Easter eggs we analyzed and their purposes.

PROVIDING FUNCTIONALITY IN THE SOFTWARE APPLICATION This purpose relates to Easter eggs that Consalvo would describe as "functional", as opposed to "ornamental". However, this distinction is less clear for software applications than games; the meaning of 'providing functionality' is broader, because unlike games, software applications may not have meaningful metrics for progress. Any hidden, undocumented feature that users find useful could be considered an example.

A canonical example is how, since Microsoft Windows 7, creating a folder with a specific, undocumented filename, creates a shortcut to an "All Tasks" view, with all Windows Control Panel items in a single view. Users have colloquially called this functionality "God Mode". It was an implementation detail not intended for use, but people discovered this functionality and found it useful nonetheless [179].

Table 4.1: Summary of Easter egg purposes and associated publications. 41 Easter eggs were investigated in total. Counts sum to more than this total because Easter eggs can have multiple purposes.

Purpose	Easter Egg Examples	Num.	Associated References
Providing functionality in the software application	Windows "All Tasks" view [179]	1	"functional" Easter eggs (Consalvo [44])
Teaching users transferable knowledge and skills	Google Doodles [92], humorous Google Search results [150]	2	
Rewarding users for their actions	WordPress terms of service "treat" [184], *D2* Easter egg	2	"act as special rewards" (Gkogka [82])
Mocking or seeking revenge	"about:mozilla" page in Internet Explorer [42], *D2* Easter egg	2	"revenge" (Nagy-Farkas [161])
Showcasing developer skills or new technology	Excel 97 flight simulator [243], Matlab's "image" [66]	2	
Occupying users while waiting	Chrome dinosaur game [84, 106], uTorrent's Tetris [245]	2	"serve as a distraction" (Gkogka)
Sharing a personal message from the developer	Matlab's "reshape" [151], Amazon Risher tribute [21]	2	'thank-you' (Pogue [184])
Recruiting developers	recruitment via web browser developer tools, Google Foobar [180, 204]	2	encouraging prospective company employees (Pogue)
Giving credit to the individual developers	Excel 97 flight simulator, "about" pages/Firefox's "about:mozilla", After Effects credits [6], *D2* Easter egg	4	"recognition" (Nagy-Farkas)
Creating hype	Android version [91], After Effects credits, Matlab's "spy" [202], Matlab's "image", Excel's "=CAKE" function [147], *D3* Easter egg, *D4* Easter egg	7	
Encouraging development or remixing	Android version, GIMP's "Goat-exercise" [162, 221], *D1* Easter egg, *D2* Easter egg, *D3* Easter egg	5	
Sharing something dear to the developer	Android version, Matlab's "image", PHP version [173], Matlab's "spy", *D2* Easter egg	5	"break the monotony" (Gkogka)
Boosting moods with simple jokes or references	VLC Santa hat [111], VS Code Santa hat [60], Ant Design holiday theme [129], GIMP's "Goat-exercise", humorous Google Search results, *apt-get* "moo" [87], "about:mozilla" page in Internet Explorer, *man* Easter egg [211, 224], After Effects sheep sound [203], After Effects' "Mask Embiggen" [41], Chrome dinosaur game, AutoCAD's "CAD-PAC" (fictitious) [9], Microsoft Office Clippy background [146], PHP version, Matlab's "f***" [110], Matlab's "reshape", 4 *D2* Easter eggs	20	"humor" (Nagy-Farkas), "nostalgia" (Nagy-Farkas), "break the monotony" (Gkogka), "serve as a distraction" (Gkogka)
Acting as a creative, expressive outlet for developers	Google Doodles, humorous Google Search results, After Effects sheep sound, "about" pages/Firefox's "about:mozilla", Firefox's "about:robots" [192], *D2* Easter egg	6	"establish[ing] software as an art form" (Pogue), "personality" (Gkogka)

TEACHING USERS TRANSFERABLE KNOWLEDGE AND SKILLS Some Easter eggs create educational value for users by providing knowledge or the means to access knowledge, or showing the user how to do something that might be useful in other contexts.

For example, Google Doodles, the temporary commemorative modifications to the Google homepage logo, often educate about important historical figures. "We really want to, like, kind of tickle different parts of the users' brains; you know like one day it's about dance, one day it's about science; one day it's about pop culture; like another day it's a national holiday", said Ryan Germick, a Google Doodle designer [92]. Not only can Easter eggs themselves educate users, but they can also motivate users to seek more information, for example, by clicking on the Google Doodle image to search for more sources related to a topic. To achieve this, Google Doodles are designed to "inspire curiosity" [92]. Google Search itself also has similar educational Easter eggs, such as Conway's Game of Life, which Google engineer Peter Dolan describes as: "introduc[ing] people to the Game of Life. It's often seen when you're just starting to learn programming" [150]. These Easter eggs are associated with search engines, which are often used to gain knowledge about a topic, independent of any Easter eggs. In Section 4.5, we describe other ways that future Easter eggs could be designed to provide educational value.

REWARDING USERS FOR THEIR ACTIONS This purpose is similar to Gkogka's "act as special rewards" characterization. While Gkoka refers to Easter eggs that encourage user "exploration" and brand "loyalty" [82], we focus on Easter eggs that reward users for specific beneficial actions they take within the software application.

An example is the "treat" hidden inside the WordPress terms of service. The text "If you're actually reading this, here's a treat." is hidden midway through the terms. Clicking this opens a webpage with a photo of a meal at a restaurant. This "treat" has been unintentionally copied to other websites that based their terms of service off WordPress' [184]. *D2* provided another example, explaining that, historically, an image-based Easter egg in one of their software applications was "designed by prominent users / beta testers". In the case of beta testers, this meant that as a reward for using a specific version of the software application, they could showcase their design skills in an Easter egg.

MOCKING OR SEEKING REVENGE This purpose is related to that of sharing a personal message, with the difference of having a specific focus of 'poking fun' at another person, group of people, organization, or piece of software. It could be understood as a superset of Nagy-Farkas' "revenge" category.

An example is an Easter egg in Internet Explorer that was a response to a similar Easter egg in Mozilla Firefox (which we also discuss later). When navigating to "about:mozilla" in old versions of Internet Explorer,[2] a blue screen is displayed. Users have suggested that this Easter egg was designed to look like the Blue Screen of Death, in reference to the instability of Netscape at the time; however, some have instead related it to Microsoft branding colours [42]. As another example, *D2* described an Easter egg in one of their applications: "Initially, [it was] just a humorous placeholder name for a new, as-yet-unnamed command

2 Relocated to "res://mshtml.dll/about.moz" in recent versions.

in [the application], when shipped in a beta build, it annoyed a manager as unprofessional, and he ordered its removal. The programmer responded by putting in a more appropriate name for the new command, but sometimes randomly replacing other [UI controls] with [humorous text], rarely enough so that you'd wonder if you actually saw it or just imagined it – just to tweak the manager."

SHOWCASING DEVELOPER SKILLS OR NEW TECHNOLOGY This purpose was particularly relevant historically, when developers would push the graphical capabilities of early computer systems to the limits. An example is the Microsoft Excel 97 flight simulator. In this Easter egg, selecting a specific range of cells in the spreadsheet, then entering a sequence of specific keyboard and mouse commands, would trigger a fullscreen flight simulator to be displayed. YouTube commenter "hank804" claims to have been an intern when this Easter egg was being developed, and adds: "Imagine how cool this was back then, when 3D engines were relatively new" [243]. The developers were able to show off their skill with 3D programming, as well as what contemporary computer hardware at the time was capable of.

Figure 4.1: Images steganographically hidden in Matlab's 'default image'. © Image courtesy of The MathWorks, Inc.

Matlab, a numerical computing environment, contains another example of Easter eggs that showcase developer skills in the form of an image displayed when the *image* function is called with no parameters (Figure 4.1). The story behind this image is documented in a blog post by the developer, Steve Eddins [66]. The software company, MathWorks, had a charity auction; one of the items was the right to specify the default image for the next version of Matlab. Eddins was a newly-hired image processing specialist at the time, so he had a desire to do this. He chose to make the image steganographic (containing additional hidden data) in response to complaints that Matlab only supported double-precision values at the time. To showcase the capabilities of double-precision values and his skill as a self-proclaimed "image processing guy", he used all of the bits to encode multiple images, each of which were selected by different developers.

OCCUPYING USERS WHILE WAITING Some Easter eggs are hidden in a way that they reveal themselves as a source of entertainment when the user would otherwise be waiting for a job to complete or a resource to become available in the application. Similar to Gkogka's "serve as a distraction" characterization, Easter eggs could be designed to draw users' attention away from limitations or error pages within an application. This notion of distraction was also raised by *D3*, who referred to an Easter egg that they designed as a "short distraction" for users "experienc[ing] a level of frustration".

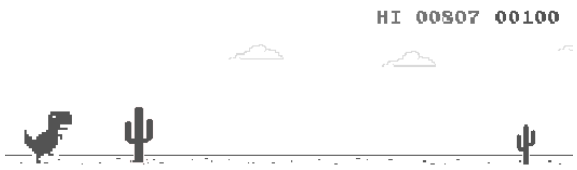

Figure 4.2: Dinosaur game in Google Chrome, accessible by navigating to "about:dino". Image courtesy of Google LLC.

The dinosaur game in Google Chrome is a well-known example. When Chrome is unable to connect to the Internet, a webpage with a dinosaur is shown. Pressing the spacebar starts a minigame in which the user can make the dinosaur jump and duck to avoid obstacles. When Internet connectivity resumes, the page disappears and is replaced with the desired destination page. Another example is the game of Tetris hidden within uTorrent, a BitTorrent client. By pressing "t" on the keyboard in the application "About" window, users can play a bare-bones game of Tetris while waiting for downloads or uploads of files [245]. Interestingly, these examples share the trait that, despite neither being games themselves, the Easter eggs contained within are games.

SHARING A PERSONAL MESSAGE FROM THE DEVELOPER This purpose could be understood as a superset of Pogue's 'thank-you' category, which only refers to messages that express gratitude. We use "personal message" to refer to a written sentiment directed to a particular person or audience. One canonical example is the David Risher tribute Easter egg in Amazon, the online store. By clicking an invisible link at the bottom of the site directory page,[3] a page titled "Thank You, David Risher" is shown in tribute to Risher for his contributions to Amazon as its former senior VP for retail [21]. As another example, in older versions of Matlab, calling the "reshape" function with invalid arguments would result in the humorous and personal error message: "Cleve says you should be doing something more useful." The "Cleve" in this message is Cleve Moler, the developer of that functionality, which "temporarily fixed a bug in earlier versions where negative arguments caused a segmentation violation" [151].

RECRUITING DEVELOPERS This purpose relates to Pogue's category of encouraging prospective company employees. While Pogue describes an Easter egg that uses persuasive language to encourage users to apply [184], we further identify recruitment messages that act more like passive banner advertisements, or assess the user's fitness for the job through the process of interacting with the Easter egg. A common example is how recruitment messages are hidden in websites as a message printed to the developer tools console. Companies that include this type of Easter egg include Reddit, NYTimes, Etsy, and Baidu. These are sometimes decorated with ASCII art (e.g., Reddit, NYTimes), and sometimes with a small entertaining message (e.g., Baidu, in Chinese). Another example is the Google Search recruitment Easter egg, "Google Foobar" [180, 204]. It reveals itself as a secret coding challenge, which Google can use to both attract the attention of possible new employees and gauge their abilities. This Easter egg is far

3 https://www.amazon.com/gp/site-directory

less reproducible than many other Easter eggs, and sometimes can be activated by using programming-related search keywords or is sometimes hidden inside HTML comments [180].

GIVING CREDIT TO THE INDIVIDUAL DEVELOPERS This purpose is similar to Nagy-Farkas' "recognition" category of personal message Easter eggs, but also considers Easter eggs that give credit regardless of the developer's "ability as a programmer" [161]. *D2* describes that Easter eggs can be used to "sign one's work" and that "[o]ther software has sometimes included the creators' names as easter eggs". While less extreme than the Atari Adventure game Easter egg, the flight simulator hidden in Microsoft Excel 97 is an example of this purpose. When the flight simulator is activated, there are scrolling credits on the terrain listing the developers of the application. Notably, these developers are not credited in the official application "About" window. Another example with an interesting story is "about:" pages (e.g., "about:blank"). These were initially added as Easter eggs in Netscape (now Mozilla Firefox) to give credit to the individual developers by showing off their names, and eventually their personal webpages [155, 241]. A modern example is the hidden credits project in Adobe After Effects, activated by holding down specific modifier keys while opening the application "About" window. This opens up a project containing a creative animated video crediting the individuals responsible for that particular version of After Effects [6].

CREATING HYPE Easter eggs can generate hype by attracting social media followers or encouraging users to anticipate or hunt for more. Since version 2.3 "Gingerbread", the Android operating system has contained a new Easter egg in each version, activated by repeatedly tapping the version number text in the Settings app. The Easter eggs are often interactive minigames, like a nonogram puzzle. Dan Sandler, an Android developer, described the intended user reaction as: "I wonder what they did in the next version?" [91]. A recent example is the fictitious "=CAKE" function in Excel, advertised by the Microsoft Excel team on Twitter [147]. Calling the function would purportedly turn the background of the spreadsheet into a colourful cake image (or perhaps even a real cake, as interpreted by some followers). The post was prompted by a viral trend at the time of creating cakes that look like "everyday objects", such as shoes or bags of chips [36].

Many other software companies have used social media to drive hype around Easter eggs in their software products. This may inspire brand "loyalty" [82]. Adobe has used social media to actively give hints about Easter eggs in their software, such as posts from the After Effects team [1, 234]. The Matlab team has posted teaser images to Twitter of what some of Matlab's Easter eggs look like, without giving away how to access them or what they mean [143]. Independent from the companies themselves, reports on Easter eggs by tech journalists also lead to online discussions, in which people reminisce about Easter eggs in software they have used, clarify certain aspects of Easter egg history, and discuss possible safety concerns around including Easter eggs in vehicles like cars and airplanes [61, 184]. The use of social media to present Easter eggs also relates to Consalvo's argument that Easter eggs "set the stage for a paratextual industry" [44], but in this case, the paratext is social media posts rather than magazines and strategy guides about games.

A contrasting way that Easter eggs generate hype is by satiating people's desire for discovery, similar to how "Discovery" is described as a key category of games and playful experiences [120]. Rather than promote Easter eggs publicly like Adobe or Matlab, some developers prefer to avoid exposing Easter eggs, instead relying on the thrill experienced by users when they discover one. *D3* explained that users who do not know about an Easter egg in an application "will hopefully discover it on their own and get that sense of surprise and excitement when you discover a hidden feature". *D4* takes this mindset a step further, suggesting that "It's generally known that easter eggs are not to be exposed widely", so that they "[remain] a secret". They added: "Just like you would not tell where the egg is hidden, the search is part of the fun."

ENCOURAGING DEVELOPMENT OR REMIXING This purpose refers to Easter eggs that encourage two related phenomena, development and 'remixing', by demonstrating functionality of an application or its code, or encouraging users to look at the code for themselves. What ties these together is how users apply their creativity to become part of an Easter egg themselves.

One common context in which Easter eggs have encouraged development is open source software. Easter eggs are included to teach other developers how to implement certain kinds of functionality. An example of this is the "Goat-exercise" feature in GIMP [162], a graphics processing application. The feature is a small demo for developers, showing how to make a plugin for the application using a graphics library called GEGL (Generic Graphics Library). The name is a joke, and comes from a nickname that developers gave GEGL: "Genetically Engineered Goat, Large" [221].

Another example is a hidden icon in *D1*'s Android multimedia application, which animates when tapped. *D1* told us: "At the time we started [the application], no one from the team had any previous experience with the Android OS. We were all learning on the go and we played a lot with the internal features. After a few months of development, before reaching the store for the first time... I accidentally discovered a very simple way to add animations to a visual object and started to play with it as a distraction." This approach for adding animations was something that this developer realized would be useful, so they used this Easter egg as a demonstration for their "fellow [application] teammates". They "had no intention of making an easter egg that would survive the first release of [the application] but it was kept along the years." This motivation of using Easter eggs to learn or teach about development is not unique to open source software. The "engineer wanting an excuse to learn how to [implement code using a new API]" was also mentioned by *D2* as motivation, confirming a similar source of Easter eggs in commercial software.

Because many Easter eggs are artistic in nature, it follows that remixing Easter eggs would be of interest, in line with trends in visual art and music of remixing, sampling, mash-ups, and parodies. An example is the series of Android 'version' Easter eggs, for which developers explicitly encourage remixing: Sandler emphasized that the Android Easter eggs are open source, and that users "can even, like, copy the code and make your own version" [91]. In reference to an Easter egg in a popular application developed by their company, *D3* told us that "The fact that there are many homages and remixes to the [Easter egg] has always astounded

me." This indicates that there are active and creative communities of Easter egg remixers.

SHARING SOMETHING DEAR TO THE DEVELOPER Developers use some Easter eggs as a sort of 'time capsule', by hiding media with personal value to them, often pictures. This purpose relates to Gkogka's "break the monotony" characterization, by giving users something "new and unexpected" to look at [82].

An example is the original Android 'version' Easter egg in Android 2.3 Gingerbread. In an interview [91], Sandler explained that Dianne Hackborn, the head of the Android framework team, was friends with an artist, whom she asked to make a painting containing the Android robot mascot: "[W]hen she got the painting, she thought it was so awesome, that she wanted to hide it in the platform, so that other people could find it". Through this Easter egg, Hackborn was able to share an artwork with personal meaning to her.

The 'default image' Easter egg in Matlab is another example (Figure 4.1). The images hidden inside the default image include pictures of personal importance, such as those of developers, their family members and their pets, and a developer's favourite number. The images also include some mathematically or historically interesting images and photographs. Matlab has other Easter eggs with this same purpose, such as the *spy* function. When called with no arguments, it shows an image of a dog [202], which a MathWorks staff member confirmed to be a lead developer's pet dog [5]. PHP used to contain a similar Easter egg, whereby secret query strings would result in PHP-based websites displaying funny or personal images chosen by the developers, such as photos of the developers' pets. In each version, a new image was used [173].

BOOSTING MOODS WITH SIMPLE JOKES OR REFERENCES This purpose relates to Nagy-Farkas' "humor" category and Gkogka's "break the monotony" characterization, in that an unexpected Easter egg can break up an "ordinary task" with entertainment [82]. It also loosely relates to Gkogka's "serve as a distraction" characterization; for example, 404 "page not found" error pages frequently contain humorous content, such as cartoons (e.g., [7]) or emotional characters (e.g., [63]), which may help reduce user dissatisfaction. We combine the ideas of jokes and references because these two aspects are often found in conjunction.

Sometimes, such Easter eggs may be "motivated first by the need for temporary UI" (*D2*). For example, *D2* explains that in two separate Easter eggs, one of their software applications used humorous icons because the developers "wanted a temporary icon until the real one got designed". The humorous stand-in icons were later included as Easter eggs. Cleve's humorous "reshape" error message in Matlab is another example. It was initially added to fix a bug, but later replaced by a more serious and accurate error message.

More generally, such Easter eggs are often motivated by a developer's "impulse to do something fun and self-expressive when under stress" (*D2*). Sometimes Easter eggs are targeted at users, whereas other times, they are inside jokes among developers (the latter being a common purpose of Easter eggs in historical desktop software).

Targeted at the developers of the application, the After Effects sheep sound effect is an example of this purpose. Shift-clicking on the title pane in After Effects

causes it to play a "baa" sound.[4] At a motion graphics meetup, Dan Wilk, an original developer of Adobe After Effects, passionately described the story behind the Easter egg: "So the sheep sound is... [a developer's] mother making a sheep sound. So I think what it was, it was Monaco or one of the OS9 or OS7 fonts – it actually doesn't look right anymore – one of the fonts that was in the Mac OS system had this odd glyph in one of the upper ASCII [things], [and it was this] sheep, and so as some sort of whimsical moment, [the developer] put sheep in the effects control window, and of course once that happened it got a life of its own" [203]. In other words, the Easter egg was a humorous reference to a sheep glyph in a font at the time (which itself may have been an Easter egg). Users who discover the Easter egg may find it humorous without context, but the story behind it is what makes it connect emotionally with the developers who know about it.

Some examples of Easter eggs focused on making specific references to other media are the "Mask Embiggen" Easter egg in Adobe After effects, which replaces the UI text "Expansion" with "Embiggen", in reference to a particular episode of The Simpsons [41]; and the "moo" command line option for package management application *apt-get*, which causes an ASCII-art cow to be displayed in the console, in reference to an IRC user who would use the greeting "Moo" [87]. In reference to intertextuality, these Easter eggs could be considered examples of *creative inclusion*, a form of commentary on the fragments of media they reproduce.

There have also been more controversial Easter eggs. For example, Santa-themed decorations have been included in various software applications during the winter holiday season (e.g., VLC Media Player [111], VS Code [60], Ant Design [129]), which some users have taken issue with because of the association with Christmas. As another example, old versions of Matlab had the "f***" Easter egg function (the actual swear word), which when entered, Matlab would print the unsavoury reply "Your place or mine?" to the console [110]. The developers likely felt that this was a humorous response [116]. In Section 4.4, we discuss how Santa-themed decorations have caused conflict between developers and users, and in Section 4.5, we suggest how Easter eggs like "f***" in Matlab could inspire the design of Easter eggs that help users emotionally.

There are also many joke and reference-focused Easter eggs targeted at the users of software applications. Until a few years ago, *man*, a documentation reading application for Unix-like systems, displayed "gimme gimme gimme" (in reference to a popular song by 1970s pop group Abba) if *man* was run "after midnight".[5] This reference was suggested on Twitter in 2011 by a user, Marnanel Thurman [211]. The developer, Colin Watson, saw this tweet and actually put the Easter egg in. After removing it in 2017, Watson said, "I'm glad that it made some people smile, which after all was the whole purpose of it." [224] This type of reaction was mirrored by *D2*, who for one of their software applications, said, "[r]eactions I've gotten from [the application] fans have mostly been amusement or delight at discovering an easter egg or recognizing its meaning." Sometimes users have also created blog or social media posts about fabricated Easter eggs, such as for April Fools' Day jokes. For example, a fictitious "CAD-PAC" Easter egg in AutoCAD was described in a blog post [9], which would purportedly start a game of *Pac-Man* in a pop-up window after entering a sequence of fourteen

4 This sound is also used by the application to indicate render errors.
5 The Abba song lyrics are: "Gimme, gimme, gimme a man after midnight".

commands. Prank Easter eggs may entertain their creators when observing others' reactions.

Several examples of joke and reference-focused Easter eggs also contain an element of Nagy-Farkas' "nostalgia" category. For example, when describing the design of the dinosaur game in Google Chrome, the developers wanted to make the game "reminiscent of vintage video games" [84]. Another example is the "Clippy" Easter egg in the background of recent versions of Microsoft Word. If the "Office Background" theme is set to "School Supplies", then a rendering of Clippy, the infamous Microsoft Office user interface agent from historical versions, appears as part of the background [146]. This Easter egg has no dynamic behaviour – it is just a static part of the background image. It is a reminder of how times and software have changed since Clippy was included as a user interface agent in Microsoft Office.

For completeness, previously mentioned Easter eggs that also exemplify the purpose of boosting moods with jokes or references include: the WordPress "treat" Easter egg, the "Goat-exercise" feature in GIMP, the PHP version Easter egg (which specifically used humorous imagery), the Google Chrome dinosaur game (which was a joke that in the "prehistoric age", there was no Wi-Fi [84]), humorous Google Search results in response to "the answer to life the universe and everything" (also to queries such as "recursion", "anagram", "do a barrel roll", and "The Wizard of Oz" [150]), and the "about:mozilla" page in Internet Explorer (which referenced Netscape).

ACTING AS A CREATIVE, EXPRESSIVE OUTLET FOR DEVELOPERS *D2* told us that "Easter eggs are motivated partly by the impulse to do something fun and self-expressive". Several informal Easter egg categorizations [82, 184] have similarly described Easter eggs as having qualities such as "establish[ing] software as an art form", giving "personality" to a product, or other functions associated with creativity and expression. Wilk described the birth of the Adobe After Effects sheep sound Easter egg as a "whimsical moment" [203]. Despite these Easter egg characterizations, our investigation found that Easter eggs are infrequently described as serving this purpose. However, we note that most of the identified Easter egg purposes are not centred around helping developers or users fulfill utilitarian productivity goals. Rather, we suggest that the *expressive* power of Easter eggs has important emotional and social value for their developers and users, defined as "supporting [someone] to build stronger social bonds; feel free, explorative and creative; or simply experience joy and affect" [4]. Easter eggs that we coded as having other purposes may and likely do share this purpose.

As a specific example, "about:mozilla" was one of the "about:" pages described above that has survived to this day, providing cryptic quotes out of a fictitious "Book of Mozilla". These have been updated over time to reflect the history of Firefox in a creative way [158]. Other similar Easter eggs have been in undocumented browser "about:" pages, such as "about:robots" in Firefox, which was created through a bug report in which developers contributed creative ideas for icons and text to use [192]. As another example, while Google Doodles is time based and not considered a conventional Easter egg, it has taken this purpose of Easter eggs to the extreme, frequently presenting animations and minigames about science, culture, and holidays. Germick describes this process as: "how do you share a human moment from behind the screen?" [92]. The humorous Google Search

results are similarly motivated, as Dolan describes: "Some engineer gets some idea and can't stop thinking about it, and they make it happen, and everyone says, 'Oh my god, that's amazing!' And then it goes out" [150].

In summary, there is a broad spectrum of Easter egg purposes, and Easter eggs are not merely "the result of... an individual engineer thinking something essentially random would be funny" (*D2*), but have diverse, focused purposes. Developers have different stances on who Easter eggs are for, some saying "Easter eggs aren't generally targeted at anyone in particular" (*D2*), while others saying "[Easter eggs] are for everyone" (*D3*). Our investigation reveals that it can be both.

4.4 PROCESSES IMPACTING DEVELOPERS AND USERS

To demonstrate potential beneficial processes that Easter eggs engender, and challenges associated with their development and use, we discuss six processes Easter eggs undergo that relate to the social and emotional circumstances of their developers and users. Rather than forming a comprehensive theory, this section provides a descriptive account of some important processes that Easter eggs engender, which emerged during focused coding of Easter egg purposes. We believe these processes can provide insight to developers, users, researchers, and designers about the context around Easter eggs, and inspire further work about Easter eggs.

4.4.1 *Potential Benefits of Easter Eggs*

We highlight positive processes that Easter eggs engender, such as coming to be expected, becoming part of a tradition, and encouraging playful exchanges online.

Coming to be standardized or expected

In contrast with Easter eggs that are removed after some time, sometimes Easter egg behaviour remains long-term, either because it has evolved into core functionality, or users come to expect it of the software application.

One example is the "about:" pages initially included as an Easter egg in Netscape [155]. Because of how browser standards evolved, "about:" pages became *standardized* [157] and implemented across competing software applications (browsers). While still also used for Easter egg purposes (e.g., "about:mozilla"), they implement core functionality in browsers, such as configuration pages and the "blank" page.

Easter eggs can also maintain longevity by coming to be expected by users. In other words, some Easter eggs 'upgrade' from being an Easter egg to being a core application feature. The Google Chrome Dino game is an example of this. Initially, it was only available without an internet connection, or at "chrome://network-error/-106", an internal page. However, the Easter egg later became a "feature" of Chrome, when the developer made the functionality more accessible by hosting it at "about:dino" [106] (which, incidentally, is an "about:" page).

Getting "a life of its own"

Borrowing the phrase that Dan Wilk used to describe the After Effects sheep sound, an Easter egg can "[get] a life of its own" [203], continuing to exist beyond the control of the original developer, sometimes going as far as becoming part of a tradition.

Recurring Easter eggs can lead to traditions with social value to developers and users. For example, the developer's anticipated user reaction of "I wonder what they did in the next version?" [91] to the Android Easter egg suggests that Android users expect the Easter egg to be continued in future releases of the operating system. The tradition of having these Easter eggs has become a part of the Android brand image, and has led to online communities discussing and sharing these Easter eggs (e.g., [244]). This idea is also applicable to application developers. *D2* told us that "Some of the [product] easter eggs are part of a tradition. [A specific Easter egg] has occasionally reappeared in various places... ever since" an early version of the software. *D1* said that "New developers working on [the application] are warned that any work... should retain this particular easter egg, it became part of the identity of the platform and it was replicated on at least one other platform". These Easter eggs have contributed to the identity of applications, even if only in the minds of the developers.

When Easter eggs are removed, they can gain nostalgic value. We note that this is different from our conceptualization of Easter eggs that contain embedded nostalgic media. An example is the Microsoft Excel 97 flight simulator. Online discussion often revolves around users reminiscing about how impressive the 3D technology supporting this Easter egg was, and telling stories about using it in school: "[G]ood times. I remember once in computers class in primary school I played this sim and the teacher yelled at me"; "Lol I remember playing this in high school on our computers in class. The teacher thought i installed software and started to write me up to send me to the principal" [243].

As alluded to earlier, even when Easter eggs are remembered, their original developers are often forgotten. Despite the fact that *D1*'s Easter egg became "part of the identity of the platform", they noted that "Besides a few developers that were present back in the days, I think most, if not all, of the current maintainers don't even know I was the original author." *D2* shared a similar sentiment: "The easter eggs tend to linger in memory longer than their creators unless there's some controversy surrounding it... The ratio of the number of people who know there used to be [two specific Easter eggs], relative to the number of people who know who wrote those easter eggs..., has to be many thousands to 1. People don't mostly write easter eggs for the fame or reputation."

Creating playful exchanges even when fictitious

Easter eggs do not have to be real or implemented in an application to stimulate online playful discussions about them. An example of this is the Microsoft Excel "=CAKE" function, which only ever appeared as a fabricated screenshot in the Microsoft Excel team's Twitter feed, yet resulted in a large amount of playful discussion including sarcastic exclamations, jokes about using the Easter egg, and jokes about using the software more generally. One user implemented and shared a real function with the name "=CAKE" using Visual Basic, with functionality inspired by the original tweet [246]. From a user perspective, often as pranks or

April Fools' Day jokes, people have concocted elaborate instructions for Easter eggs that do not actually exist (e.g., the CAD-PAC Easter egg described earlier), which have fooled users in discussion forums [107].

4.4.2 *Challenges with Easter Eggs*

Our Easter egg purpose categories highlight that Easter eggs are mostly made in good faith. However, because Easter eggs are undocumented and often untested, we highlight how Easter eggs, even those made with good intentions, have raised challenges affecting their development and use, or caused tensions between developers and users.

Becoming a maintenance burden

The need for quality assurance testing has been a motivating factor for companies to exclude Easter eggs from software applications. In response to a blog post about Easter eggs in Matlab, Moler recounted the fate of the "reshape" Easter egg: "As our code base has increased, including such goodies in the MATLAB core has become problematic because of the strain it puts on rigorous automated testing. It is still possible to include them in a few 'leaf' M functions, like 'spy', that other functions do not depend upon" [151]. This comment suggests that testing Easter eggs that are part of core features puts an additional burden on the company. Despite the fact that only a few Easter eggs remain in Matlab, its users still enjoy them and discuss them online. Some of the other Easter eggs we described are also effective at minimizing testing burden. In reference to the application that *D2* develops, they identified that "Some teams at [the company] permit them as long as they're not time-based or random (because that represents too much of a testing / quality risk)". In the case of Microsoft Word's Clippy background Easter egg, the Easter egg is built into the image resources of the application, and would not need separate functional testing. There is also the option to construct an entirely fictitious Easter egg, like the "=CAKE" function promoted by the Microsoft Excel team.

After a certain period of time, many people who were going to discover any given Easter egg will have already discovered it, and Easter eggs centred around jokes or references become less novel over time. The *man* Easter egg gained a level of notoriety six years after it was created, when a developer posted a question on the *Unix & Linux* StackExchange noting that the Easter egg caused some of their automated tests to fail [224]. In response, Colin Watson, the developer, removed the Easter egg, later explaining that "It was getting a bit stale, though, and humour does require novelty", highlighting that "six years seems like a pretty good run for that sort of thing" and "it probably isn't going to get significantly better exposure than it already unexpectedly has" [224]. Removing "stale" Easter eggs eliminates the requirement to maintain this code and the risk of unexpectedly breaking user workflows.

Becoming a distraction

Both the acts of creating Easter eggs and using Easter eggs have been described as a "distraction". This process contrasts with Gkogka's categorization of Easter eggs that "serve as a distraction" [82], which refers to developers including them

as a way to distract users from "negative or unpleasant" situations caused by the application, like 404 error pages. Instead, our identified process focuses on how Easter eggs can distract developers or users from their work.

In the case of developers, *D1* described that they created their Easter egg when "play[ing] with [animations] as a distraction". Others have described creating Easter eggs as a break from ordinary coding work. *D4* described that they create Easter eggs because of "Sometimes just being bored with useful work and wanting to add somet[h]ing useless that might make people smile". Netscape developer Jamie Zawinski blogged about adding his personal "about" page Easter egg [240], explaining that programs should be "fun to write". He adds: "If dropping in an easter egg allows a hacker to blow off some steam and consequently stick around the office for a few hours longer, and put in a 20 hour day instead of merely a 16 hour day, then those are resources well spent." *D2* suggested a similar sentiment, indicating that Easter eggs are often created "after too many late hours coding".

From a user perspective, Easter eggs are usually considered secondary to the functionality of the software application that contains them. However, Easter eggs can be 'too' entertaining, to the extent that they risk distracting worker or student audiences that need to use the application for important purposes. An example of this was the dinosaur game in Google Chrome. The game is hugely popular, and was becoming such a problematic distraction in schools and businesses that Google had to add a way for system administrators to disable it [84].

Causing controversy and polarization

We have emphasized the value of the expression afforded by Easter eggs. However, if software expresses values that are too controversial or polarizing, this can result in social and economic harm. A value or message carried by an Easter egg may be independent from, or even in conflict with, the purpose of the software; the meaning of an Easter egg may be taken differently by users of different backgrounds.

There have been instances of time-based Easter eggs inserted by developers that have offended users. An example of this is the Santa hat in VLC Media Player. Some users complained that the hat is a religious symbol, the developers are being selfish by including it, and it should be removed from the application. The reply from the developers stated that there was an option to disable this feature in the preferences, and that it is open source software – users can make their own fork, or use a different application altogether [111]. A very similar situation arose more recently, with a Santa hat icon added in VS Code, an open source text editor application developed by Microsoft. A user opened a GitHub issue stating that they were offended by the Santa hat and wanted it removed. The developers promptly removed the icon, despite a backlash from other users referring to the original poster as a "troll" [60, 191]. In both cases, whether the Easter egg was left in or removed, it led to divisiveness within the community. However, in the case of VS Code, this also prompted developers to add a feature for customizing the icon in question, enabling users to add celebratory icons of their choosing.

A more extreme example, involving the popular web UI framework Ant Design, was blogged about by software developer Shun Liang [129]. The developers of the framework had decided to stealthily insert a Christmas Easter egg that, for all websites using the framework, changed the page titles to "Ho ho ho" and rendered snow on top of the UI buttons. Unsurprisingly, this became problematic,

leading to several very heated GitHub issues, partially fuelled by local Chinese government crackdowns on Christmas celebrations. One user thought that the codebase was hacked [215], two users claimed to have a pay reduction [128], and one user claimed to have been fired [22]. The feature was removed shortly thereafter, with an apology from the developer [183].

A noteworthy property of the Ant Design example is that the Easter egg would *propagate*; in other words, it would activate in unintended situations, in other software dependent on the software containing the Easter egg. This property also applies to the PHP version Easter egg, which contained humorous images of animals and people making funny faces, and propagated to any website using PHP. Independent of security considerations, if the Easter egg were somehow accidentally exposed in a business-critical context, this could cast doubt on the professionalism of the website owners. Time-based activation can exacerbate the risk of Easter eggs that propagate, because they can be triggered without any change to the workflows dependent on the software containing the Easter egg. *D2* told us: "Using [less common] signals or especially program state and date makes [Easter eggs] more time-consuming to develop and riskier to deploy. Date-related easter eggs, for instance, were specifically forbidden at [the company] after [an incident involving an Easter egg]. The same considerations would apply to having other triggers, like camera data, network traffic, etc. trigger an easter egg." This risk is also evident with the *man* Easter egg, which, as mentioned above, caused a developer's automated testing to fail only at certain times.

These examples converge to an important idea, captured by Larry Osterman in his blog post about why Microsoft products do not have Easter eggs [176]: "It's about trust. It's about being professional. Yeah, it's cool seeing your name up there in lights. It's cool when developers get a chance to let loose and show their creativity. But it's not cool when doing it costs us the trust of our customers." Osterman claims that Easter eggs are "irresponsible" because everything on one's computer should be "planned". If there is one hidden feature, how can users and businesses *trust* that there will not be more? What is "professional" and "responsible" will vary depending on the developers, the users, and their relationship. For example, Adobe products have Easter eggs, yet this software is widely used by professional multimedia creators. Whether developers make Easter eggs purely for their own satisfaction or target them at users, there is a complex social, political, trust- and value-driven dynamic.

4.5 FUTURE DESIGN DIRECTIONS FOR SOFTWARE APPLICATION EASTER EGGS

Based on gaps and opportunities we identified through constructing the Easter egg purposes and processes above, and inspired by work in the contexts of playful interaction and CSCW, we propose a series of directions for how ideas associated with Easter eggs could be applied in software application interfaces in new ways. Before looking at specific directions, we emphasize two broad perspectives from which we approach the subject.

First, many of the previously identified Easter egg purposes, such as sharing a personal message from the developer, mocking or seeking revenge, and boosting moods with simple jokes or references, could be associated with expression, or what Pogue calls "software as an art form". For the same reasons that drawing,

making music, and building crafts bring emotional value to people's lives, the personal expression enabled through the act of creating and sharing Easter eggs can too. In a blog post, Netscape developer Zawinski emphasized that "dropping in an easter egg allows [for]... a better program because the people who wrote it *cared* about it", also describing creating Easter eggs as "creative" and as "art" [240]. Enabling "self-expressive[ness]" (*D2*) through creative outlets in the software development or usage process is a desirable goal. From a developer standpoint, computers impose interesting hardware and software constraints, which can boost creativity through "out-of-the-box" thinking [92]. From a user standpoint, thinking about Easter eggs is one way we can work towards the goal of enabling applications to provide emotional value [4], also serving as inspiration for other user interface approaches.

Second, independent of social value fostered by the expressiveness of Easter eggs, their diversity and hidden nature provide a medium for building social communities. Our Easter egg examples demonstrate that there are many communities formed around Easter eggs, such as Easter egg "hunters", who search for and share Easter eggs; developer communities, for which Easter eggs enable tradition; and "maker" communities, who share ideas with developers and make Easter egg-like media of their own. Throughout our discussion below, we address some of these communities in more detail.

USER-MADE EASTER EGGS The rise of social media and propagation of popular culture via the Internet has led to a new range of possibilities for interactions between developers and users of software applications. In the past, users of software have been involved in Easter egg development by discussing ideas with developers over social media. Examples of this include the *man* Easter egg, which the developer implemented in response to a user's tweet; the "=CAKE" Excel Easter egg, which enabled a playful communication channel between the software team and the users; and the "moo" Easter egg in *apt-get*, which inspired joking behaviour with users, requesting different visuals for the displayed cow [210]. In other words, Easter eggs can form a topic of discussion that fosters dialogue providing emotional value to, and mutual understanding between developers and users through playful behaviour, and guiding more tailored interfaces based on user feedback.

Following this idea further, our expanded definition of Easter eggs considers that they may be created by users themselves. If we consider user customizations to software applications as a form of Easter egg, then we can make a connection to other related ideas such as "modding" and remixing. Cheliotis and Yew [39] outline that remix culture enables personal expression, supports social relationships, and helps develop communities. In the context of Easter eggs, software customizations that are shared can themselves contain Easter eggs, allowing for an exchange of Easter eggs between application users. This is comparable to the ability for players to share their own levels in the game Super Mario Maker, or for users to share their own keyboard command scripts made with applications like AutoHotkey. The ability to share, remix, and discuss extensions to applications fosters an additional social level and forms a community around an application's users. Users may also make customizations as a form of *appropriation* [64], through which people "adopt and adapt technologies, fitting them into their working practices". For example, work by Hecht et al. [96] shows that the "Location" field

in Twitter user profiles has been used for purposes other than sharing location. Because the location field in many online social platforms can be customized, it enables personal expression in a way that is 'hidden' from normal view. Slack, the communication tool, lets users provide a "status", which can be instead utilized to hide Easter egg-like messages in the tooltips of their names in the sidebar. Creating software applications with appropriation in mind could open opportunities for users to create their own forms of Easter eggs.

EASTER EGGS TO ENCOURAGE TAKING BREAKS We identified that some Easter eggs entertain users when they are waiting, like the Chrome dinosaur game, or try to cheer users up when they are frustrated, like some 404 error pages. These purposes of Easter eggs can also be understood as ways to enable users to take a mental break from the task at hand. Because interactions with Easter eggs are usually brief, Easter eggs may be able to inspire the design of microbreaks built into software, which help reduce fatigue when using computer interfaces [97] and may or may not be entertaining. Easter eggs could be integrated directly within the process of completing a task, for example, by showing a short entertaining movie clip when clicking on an unexpected UI element. Alternatively, they could be integrated within dedicated microbreak sessions as a form of hide-and-seek game mechanic, similar to how Dai et al. [51] include other forms of game-like microbreaks during a crowdwork task to improve crowdworker retention.

COLLABORATIVE AND COLLECTIVE EASTER EGGS Our qualitative analysis revealed that Easter eggs are mostly an individual phenomenon, in that individual developers are usually responsible for crafting Easter eggs, and Easter eggs are usually activated and experienced by an individual user. For example, *D2* described the creation of Easter eggs as "generally the result of... an individual engineer". Given that social play activities can strengthen social bonds [4], we see an opportunity for Easter eggs to enter into this space, and be designed to be activated and experienced by multiple users in collaborative contexts. Wikström et al. developed the "SynchroMouse" game [233], in which players must move their mouse cursors in unison. Taking inspiration from a game like this, a remote collaborative application could unlock an entertaining Easter egg when remote participants synchronize their actions to simultaneously perform a secret gesture. Hunting for Easter eggs could serve as form of ice breaker activity built into remote collaboration software, or accidental discovery of Easter eggs activated collaboratively could serve to improve social bonds between remote collaborators.

EDUCATIONAL VALUE FROM EASTER EGGS We identified that some Easter eggs are designed to educate users. We propose some additional ways Easter eggs could inspire the design of educational user interfaces.

For example, Easter eggs can improve people's engagement with software by indirectly teaching them something about its implementation or usage, perhaps by improving the discoverability of less-well-known features. The well-known webcomic *Mr. Lovenstein* released a comic in which an application was not responding, and the user responded by repeatedly clicking the mouse. The program resumed, displaying "317 clicks has corrected the error" [232]. While this is a facetious example, Easter eggs could be designed with this idea in mind. For example, if a user does not understand how to use an application, and

repeatedly clicks the mouse button, the application could trigger an Easter egg that brings up a tutorial. In other words, Easter eggs can serve as alternative pathways to achieve application functionality, so long as the preferred way to achieve that functionality is made clear.

As another example, Easter eggs may be able to improve comprehension of website or software terms of service license agreements. In the case of the WordPress "treat" hidden in their terms of service, the Easter egg is so atypical, that rather than convincing people to read the terms of service, it acts only as a reward for those who do. However, if terms of service had more frequent Easter eggs, it may convince users to read them, and improve comprehension. This is similar to how adding visual elements, such as pull-quotes and icons, to license agreements can improve comprehension [109].

Combining the ideas of educational Easter eggs and Easter eggs that reward users for their actions, the above two examples suggest that Easter eggs could also gamify software applications in an educational way. However, some users may respond to this type of design more positively than others [214].

Another take on educational Easter eggs is to consider how they can provide eudaimonic value, in other words, longer-term value associated with well-being and "striving towards one's personal best" [145]. One way this could be achieved is by helping users work through their emotions. Work by Chin et al. [40] demonstrates that if a user verbally abuses (e.g., insults) a conversational agent (which is likely not a documented or intended use case), then the agent's choice of response can influence the person's anger and guilt levels. The "f***" (swear word) function in old versions of Matlab, discussed earlier, is an example of how an Easter egg has been designed to respond to verbal abuse-like input. Though this particular example produced an unsavoury response, Klein et al. [116] argued that this Matlab Easter egg could be considered a form of emotional support, because it provides feedback similar to active listening. They also describe an anecdote of how the Easter egg turned a user's "utter frustration" into "surprise and delight". Following this idea, the principle of trying to cheer up users when they are frustrated with a user interface may be a promising direction for future Easter eggs. Undocumented behaviour like this could be designed by therapists, to help calm users of software who are prone to anger outbursts, or for software used in high-stress situations.

From an open source software development perspective, having new contributors create Easter eggs could help them familiarize with a new codebase, gain interest in contributing to a project, and address some of the social barriers that Steinmacher et al. [205] identify, like finding a task to start with or lack of domain expertise or technical background. This is similar to how *D1* created an Easter egg to familiarize with developing for a new platform. Such an approach could also contribute to establishing traditions around Easter egg development as discussed earlier. In line with the above ideas about user-made Easter eggs and remixing, a more specific possibility would be to have newcomers remix an existing Easter egg in the software, considering that Dasgupta et al. [52] show how remixing supports learning and is positively associated with computational thinking.

4.6 CONCLUSION

To better understand the stories behind, motivations for creating, and intended perceptions of software application Easter eggs, we performed a qualitative analysis of non-game software application Easter eggs, including archival research and select developer interviews. We identified 14 different purposes that Easter eggs serve. Some were shared across many Easter eggs, such as *boosting moods with simple jokes or references* and *acting as a creative, expressive outlet for developers*. However, we also identified Easter eggs with other important goals such as providing functionality, recruiting developers, and teaching something to users. Through the process of constructing the purposes, we categorized a set of processes associated with Easter eggs, highlighting ways that Easter eggs can impact developers and users, for example, by gaining nostalgic value or becoming a maintenance burden. We also presented future design directions for applying ideas from Easter eggs in new ways, emphasizing how users could be involved in Easter egg creation, or how Easter eggs could form microbreaks or sources of educational value for users.

Future work could investigate Easter eggs from the perspectives of other audiences. For example, it would be interesting to understand the goals, methods, and impressions of online Easter egg "hunter" communities. As another example, interviews with Easter egg developers could provide insight into how developers feel that practices around Easter eggs impact their development workflow and workplace culture, independent of end user experience considerations.At a more fundamental level, controlled studies and interviews with users could be conducted to understand how users encounter and respond to Easter eggs. For example, a study could be conducted comparing software with and without Easter eggs to measure effects on emotion and productivity. It would also be interesting to compare how well developers' intentions match up with users' perceptions in practice. Systems or toolkits for integrating Easter eggs into popular user interface frameworks could also be designed and evaluated. This may encourage the creation of more Easter Eggs, while also standardizing their development to make quality assurance testing easier and maintaining control over security and ethical policies.

Through this work, we have illustrated how Easter eggs are more than just "software surprises", and we hope that this work inspires developers, users, HCI researchers, and designers to consider the value that Easter eggs can bring to user interfaces.

5

DIGITAL KNICK-KNACKS: STANDALONE AUDIOVISUAL DIGITAL POSSESSIONS OR EMBELLISHMENTS IN DIGITAL ENVIRONMENTS

The exploration of computer capabilities in early graphical user interfaces resulted in numerous playful and creative features, such as interactive characters (e.g., Neko [37], a cat that chases the mouse cursor[1]), screensavers based on procedural drawing code, playful mouse cursors (e.g., Windows XP dinosaur cursor [149]), custom ringtones and notification tones, playful virtual agents (e.g., Clippy [148]), desktop widgets (e.g., xeyes [73]), and virtual pets. We refer to features like these as *digital knick-knacks* (DKKs for short), which we define as standalone audiovisual digital possessions or embellishments contained within non-game digital environments. By "contained", we mean that digital knick-knacks are "exhibited" ([222]) or 'on display' in the digital environment in a way that the user can continually choose to interact with them.

Modern user interfaces have moved away from including many DKKs like these. One potential reason is that certain examples of historical DKKs were considered "childish", "gimmicky", or otherwise unsuitable for professional environments [197, pp. 175–176]. The trends of minimalism, "digital detox", and so on, are another potential reason, because they have led to favouring simpler designs and possibly fewer user customization options; for example, "flat" UI rather than skeuomorphism.

We suggest that the sterile and minimal designs of modern digital environments might not always be conducive to supporting our emotional well-being, perhaps similar to how old-age homes without an occupant's personal furniture have been described as a "destruction of [the] self" by eliminating part of one's identity embedded as memories in the furniture [49]. In the same way that personal physical possessions on display in one's home or office environment can bring emotional value to their owners, through this work, we show that introducing DKKs into digital contexts can do the same.

Digital possessions are generally defined to include items such as music files, documents, text messages, and software. Past work on digital possessions focuses primarily on their collection practices (e.g., [220, 222]), designing them to be cherished (e.g., [83]), and on virtual goods in video games (e.g., [90, 223]). Past work on personalization [23] and in psychology [166] has shown that when people make something themselves, they perceive the object as having greater value. In contrast with past work on digital possessions, but motivated by the potential value that self-made possessions can provide for their owners, we focus on investigating DKKs that are 'on display' for extended periods of time within other non-game software contexts, and for which users have control over the design.

To understand the range of possible DKK types, what types users most value, and to support their design, we create a taxonomy by synthesizing work from

1 Neko can be traced back to an original PC-98 version created by "<tenten> & naoshi" around 1988 [135].

the areas of meaningful personal possessions [49, 186], motivations for personalization [178], consumption behaviour [144], and the "extended self" [17, 212]. We conduct a brainstorming session with 9 HCI researchers to generate example DKKs in the context of mobile phones and desktop computers, by using the dimensions and categories from the theories in the taxonomy. From this session, we characterize 11 types.

We then design and implement three types of DKK templates as a form of technology probe: an ambient noise machine, a virtual pet, and a virtual picture frame. In a 10-day diary study, 10 participants each design their own variant of one of the templates, and report on their experience of having it on their personal computer. Based on a qualitative analysis of the diary entries and post-study interviews, we characterize perceptions of DKKs, learning that they are capable of bringing joy and providing emotional value. From the analysis, we produce a series of design implications.

The main contributions of this work are a DKK taxonomy, comprising connections between past theoretical works and DKK design examples based on a brainstorming session, and a categorization of DKK types; and considerations and implications for the use and design of DKKs, based on a diary study using exemplar DKK design templates.

5.1 BACKGROUND AND RELATED WORK

Our work primarily sits between the areas of digital possessions and personalization. DKKs are like digital analogues of physical possessions, yet they are not embodied in files like photos and music, and DKKs can be seen as a kind of personalization, yet are standalone entities rather than modifications to an existing system. We also outline related work in the areas of physical possessions and consumer research.

5.1.1 *Meaningful Possessions and Consumption*

There is a plethora of research on the role and value of people's physical possessions, from areas like anthropology, psychology, and consumer research. Csikszentmihalyi and Rochberg-Halton's seminal work [49] investigated the role of cherished objects in people's households through a large-scale interview study. Richins [186] also investigated people's possessions, distinguishing between "personal meanings" and "public meanings". Belk defined the notion of the "extended self", that possessions form a significant part of people's identities [16]. A more recent follow-up work [17] revises the concept for a "digital world", accounting for considerations such as the lack of materiality of digital goods and the ease with which they can reproduced and shared.

There has also been work focused on an office work context. Elsbach investigated how non-territorial workspaces or "hot desks" were perceived as an identity threat [68], highlighting the value of personalizing work environments. Wells investigated the types of personal items displayed at work and reasons for displaying them [134]. Tian and Belk used the notion of the extended self as a lens for understanding employees' perceptions of possessions at the workplace [212].

In addition to the work on the extended self, consumer research has also focused on the role of personal possessions. McCracken [144] discussed the

movement of meaning between the world, consumer goods, and consumers themselves. Some consumer research specifically investigates the digital context. For example, Lehdonvirta [126] characterized the benefits of virtual goods and related social structures, and Denegri-Knott and Molesworth [55] proposed a taxonomy for "consumption-like experiences" in online spaces.

While these works mostly focus on physical possessions, we borrow ideas from key works in our DKK taxonomy.

5.1.2 *Digital or Virtual Possessions*

A number of works investigate or characterize digital possessions. Cushing [50] defines digital possessions as "digital objects/items that individuals *recognize* as theirs". Digital possessions can include items such as photo and music files, documents, text messages, websites, software, and video games. The terms "digital" and "virtual" are often used interchangeably; however, work in the area of digital virtual goods emphasizes the distinction, using the term "virtual" to refer to being imaginary as opposed to real and material, and "digital" to refer to being computer-mediated [55]. We use the term "digital", except in the context of "virtual pet" because it is already an established term.

Some works focus on describing the characteristics and properties of digital possessions. Cushing [50] defines and characterizes digital possessions based on participant interviews, such as how digital possessions represent an individual and are perceived as having value. In a law context, Fairfield [69] describes how virtual properties and real properties share the characteristics of "rivalrousness" (i.e., exclusive control), "persistence", and "interconnectivity". Odom et al. [170] discussed "experiential qualities" of virtual possessions: "placelessness" (accessible from anywhere), "spacelessness" (not taking up physical space), and "formlessness" (being easily reproduced). In contrast, the 'on display' nature of DKKs is one of their key defining features compared to other types of digital possessions such as music or photo files. DKKs go against the grain of conventional digital possessions by trying to have a place, space, and form. More specifically, they have a place, in that they are installed on and associated with only one computer, they take up (digital) space, in that they consume screen real-estate, and they have a form, in that they are designed uniquely by and for their owner. If a DKK design leans too far into embracing the digital (e.g., cloud saving), it may limit the perception that it is primarily an object to be displayed.

Some works focus on collecting, archiving, and hoarding digital data; for example, investigating physical and digital artifacts that are part of the home archive [115], investigating digital possessions in the cloud [168], connecting past theories of materiality to digital collecting [140], and characterizing digital data preservation practices [220]. Watkins et al. [222] developed a taxonomy of digital collections, and found that "digital collections were less socially visible" than material collections and that "lack of curation can make such displays less meaningful". Many works focus specifically on the context of video games, investigating motivations or factors for purchasing in-game content [33, 89, 90, 142, 207, 235] or experiences associated with in-game content [71, 223, 231].

Following in the footsteps of Csikszentmihalyi and Rochberg-Halton, there is also work investigating cherished digital possessions; for example, understanding the experience of "ownership" of digital goods [56] and understanding teenagers'

use of physical and virtual possessions [169, 171]. Going a step further, some works focus on creating interactive "hybrid" ([115]) physical objects with digital aspects, to investigate how to imbue materiality into technological things [19, 118] or design possessions that are more cherishable [81, 83, 182]. Such works could be considered forms of DKKs; however, they blur the line between what is a digital versus physical knick-knack.

Within the sustainable design community, some works investigate how it may be possible to reduce the "rate of product consumption" by designing technological possessions that people are more attached to [175]. A seminal design philosophy work in this space is Verbeek's book *What Things Do* [219], which proposes the notion of "culturally durable objects": there are ways to design products to which people develop an attachment that need not "aim at 'devotion'". Other works in HCI propose design suggestions [167] and hybrid technological object designs [15, 175] in pursuit of this goal. While sustainability is not the focus of our work, DKKs may be able to support sustainability because of the emotional value they provide and their association with a particular device. These properties could discourage purchasing a new device with similar functionality, and avoid disposing of a device that contains one's DKK.

Overall, past work on digital possessions focuses on incorporating physical and digital components into designs, designing possessions that people become more attached to, or on conventional digital objects like photos and music files, which are most often stored away. In contrast, our focus on DKKs emphasizes their 'on display' nature and specific focus on designing within fully digital spaces.

5.1.3 *Software Customization and Personalization*

Much of the literature on personalization focuses on automated methods or digital content recommendation (e.g., [72, 208]), which is not relevant in the context of our work. Instead, we consider a broader definition of personalization: "a process that changes the functionality, interface, information content, or distinctiveness of a system to increase its personal relevance to an individual" [24]. A form of personalization relevant to DKKs is what Fan and Poole refer to as "architectural" personalization [70], with the goal to "create a functional and delightful [system] environment that is compatible with a sense of personal style", or what Marathe and Sundar call "customization": "letting users themselves modify some aspect of an interface to a certain degree so as to increase its personal relevance" [137]. Campbell [35] also uses the term "customization" to refer to this process, and distinguishes it from the concept of "craft consumption", in which "the consumer must be directly involved in both the design and the production of that which is to be consumed". We see the design of DKKs as straddling the boundary between "customization" and "craft consumption".

Several works investigate the role of personalization in this context of "customization" or "architectural" personalization; for example, relating personalization behaviours to self-determination theory [178], investigating the role of personalization on attachment to phones [218], and showing that the feeling of control and identity are supported by customization [137]. Blom and Monk [23] developed a theory of personalization of appearance of computers and mobile phones based on a series of discussion groups and interviews, explaining reasons for initiating and effects of personalization. One key result was how personaliza-

tion supported "a feeling of attachment toward the device". This is related to the notion of the "IKEA effect", that there is an "increase in valuation of self-made products" [166]. While DKKs could be considered a form of personalization, they are standalone, or perceived as an addition to rather than modification of an existing system. DKKs could also be characterized as digital possessions, which means that they may have unique properties not captured by work focusing exclusively on personalization. Based on the results of Blom and Monk and the notion of the IKEA effect, we propose that enabling users to design their own DKKs may provide greater value.

5.2 DIGITAL KNICK-KNACK TAXONOMY

To develop a range of ideas for DKK designs and an understanding of their different types, we created a taxonomy of DKKs. The objective was not necessarily to suggest a minimal spanning set of design dimensions or categories, but rather to form a resource for generating designs. The taxonomy has two parts that each characterize DKKs in separate ways. First, we synthesized a selection of influential theoretical works from four related areas (Table 5.1), with the goal of using these works to serve as provocation for designs. We conducted a brainstorming session with HCI researchers, which enabled us to generate a large, diverse set of feasible DKK design examples, and form direct connections between theoretical works and the design examples. Second, we categorized the generated examples into "types" (Table 5.2), which can serve as design inspiration for future DKKs, and which supported our DKK design templates. Appendix C summarizes examples from the brainstorming session, along with their corresponding theoretical work and DKK type.

We selected the theoretical works because they are influential in prominent research areas about personal possessions. We include works that primarily focused on physical objects and possessions, because unlike conventional digital possessions, these are often put on display, so we hoped they would be useful for generating novel designs for 'on display' digital possessions. Table 5.1 lists the selected theoretical works, categories, and dimensions, along with descriptions where the meaning is ambiguous. Below, we explain the reasons for selecting each work in more detail.

PHYSICAL POSSESSIONS IN THE HOME We include the "meaning classes" from the seminal work by Csikszentmihalyi and Rochberg-Halton [49], which investigates cherished possessions in the home, as well as similar work by Richins [186]. Because there is considerable overlap between the categories from these two works, we combine them into a single set of nine categories. From Csikszentmihalyi and Rochberg-Halton, we additionally include the three "purposes" and two "modalities" of possessions, and from Richins, we include three possession value dimensions. We include these works to consider how different types of and values placed in physical possessions might be applied to DKKs.

PERSONALIZATION MOTIVATIONS Oulasvirta and Blom [178] relate personalization behaviours to self-determination theory, producing categories describing motivations for personalization. We include this work to consider the roles that DKKs might play as a form of personalization.

Table 5.1: Selected theory categories and dimensions, including an example design generated from each theory.

Theory	Theory Category/Dimension	DKK Example
Csikszentmihalyi & Rochberg-Halton and Richins Categories	Memories e.g., being a memento	**Memories**: Show a memorable photo from a year ago
	Associations e.g., being a gift	
	Experience e.g., supporting relaxation	
	Intrinsic Qualities of Object e.g., being unique	
	Style/appearance e.g., being fashionable	
	Utilitarian e.g., enhancing efficiency	
	Personal Values/Identity e.g., embodying an ideal	
	Interpersonal Ties e.g., representing or facilitating them	
	Financial Aspects e.g., being valuable	
Csikszentmihalyi & Rochberg-Halton Dimensions and "Modalities", and Richins Dimensions	"Personal", "Social", and "Cosmic" "Cosmic" refers to people and the natural world	**Differentiation**: Visualization for comparing friends' screen time
	"Differentiation" and "Integration" standing out or fitting in	
	"Instrumental" to "Symbolic" e.g., computer vs. diary	
	"Ordinary" to "Prestige" e.g., dog to mink coat	
	"Necessities" to "Recreational" e.g., money vs. golf clubs	
Oulasvirta & Blom Individual and Social Motivations	"stabilization" alignment to cognitive capabilities	**Emotional Expression**: System that plays background music based on mood
	"interest"	
	"exploration"	
	"differentiation" skill acquisition	
	"emotional expression"	
	"ego-involvement" management of others' impressions	
	"identity expression"	
	"territory marking" e.g., reserving a desk space	
McCracken "Rituals"	"exchange" e.g., gifts	**Exchange Rituals**: Digital postcards
	"possession" e.g., showing off	
	"grooming" e.g., preparing for an event	
	"divestment" e.g., redecorating to remove previous meaning	
Tian & Belk Concepts	"prosthetic possessions" e.g., computer keeping track of user's calendar	**Possessions for Play**: On-screen virtual pet
	"atmospheric texture" e.g., making white noise with fan	
	"identification with corporate self" e.g., gifts given to employees	
	"sense of past and sense of future" e.g., photos of past experiences	
	"possessions for play" e.g., candy dispenser collections	
	"work self and home self" "possessions that extend the home self into the workplace", such as family photos	
Belk Concepts	"dematerialization" digital possessions lack material analogues	**Sharing**: Public display of how much time one has spent time in each app
	"reembodiment" ability to represent different "selves"	
	"sharing" e.g., loss of control over information online	
	"co-construction of self" e.g., comments from others on personal photos	
	"distributed memory" e.g., digital clutter	

CONSUMPTION BEHAVIOUR McCracken [144] proposes "world to good" and "good to consumer" meaning transfers. We include the four "rituals" associated with "good to consumer" meaning transfers, to consider the ways that people may wish to interact with DKKs.

EXTENDED SELF We include two works pertaining to the notion of the "extended self" [16]: work by Tian and Belk applying to understand possessions at the workplace [212], and more recent work by Belk that revises the concept for a "digital world" [17]. We include these works to consider how DKKs could be designed to more meaningfully become part of people's identity. We include both of these works because Tian and Belk's work is focused only on a work context but provides concrete categories for how the self is extended, whereas the Belk's work is more general, but proposes more abstract categories that may be harder to use as design inspiration.

5.2.1 *Brainstorming Session with HCI Researchers and Digital Knick-Knack Types*

We conducted a brainstorming session with 9 HCI researchers (7 male, 2 female) pursuing Master's or PhD degrees at our institution, with the goal of developing example DKK design ideas based on the design dimensions and categories from the selected theoretical works. We recruited HCI researchers because they have experience translating abstract theories and concepts into feasible design artifact ideas. Participants were 22–33 years old (mean 28), with an average of 4 years (SD 2 years) combined research and industry experience in HCI or UX.

The one-hour session was held over videoconferencing software, using a shared digital whiteboarding tool for collaboration. Participants were provided with our definition of a DKK and examples of relevant contexts (e.g., including desktop and mobile screens, excluding physical spaces). For each of the 7 selected sets of dimensions from the theoretical works, we explained the dimensions and then participants were given 4 minutes to generate corresponding ideas. Participants were told that they could provide generic or personal examples. After developing ideas individually, participants were given an opportunity to share their ideas with the rest of the group.

During the session, the participants generated 144 design examples. Examples were primarily in the form of brief textual descriptions, but one participant also used images to describe an idea. We excluded 36 examples for not satisfying the "standalone" requirement. For example, some ideas focused on changing colours, themes, or features of existing applications. This resulted in a total of 108 design ideas. Note that the generated examples are not necessarily intended to be novel. Rather, the goals of generating examples were to understand and characterize what types of DKKs people might value or find useful, understand what kind of functionality might be possible in the form of a standalone digital possession or embellishment that is on display, and serve as a design resource and inspiration for the creation of DKKs.

We categorized the examples from the brainstorming session into 11 types of DKKs, described in Table 5.2. To construct the types, I inductively coded the examples using a form of manifest inductive qualitative content analysis [67], which resulted in 21 types. Through discussions with another researcher, we refined the types into the final 11 types (e.g., by merging different variations of

Table 5.2: DKK types and descriptions, with an example of each from the brainstorming session.

Type	Description	Example
Meaningful Media Display	A display of imagery (e.g., photos) or text (e.g., quotes) that is of value to the user (e.g., triggers memories, conveys a mood or personal interest)	Display of photos from one year ago
Informatic	An interactive visualization of data about oneself (e.g., number of steps walked), the computer context (e.g., how much time spent in app), non-personal generic information (e.g., phase of the moon), or data of no immediately obvious utilitarian value (e.g., number of pieces of bubblegum chewed)	Visualization of how often commands are used in an application
Help/suggestion System	A non-anthropomorphic system that helps the user learn how do do something in another application (e.g., where the tool options are) or recommendations for content or activities (e.g., 'suggested recipes', 'add a profile picture')	Display of recipe suggestions
Self-representation	A display representing the likeness or achievements of the user (e.g., avatar, virtual award indicator)	Badge representing gameplay achievement
Playful Notification	A brief playful sound or visual triggered by an external action	Sound effect upon bank transactions
Automation	A control that performs an automated task for the user	Button to automatically open applications for a particular work task
Calendar Events/Reminders	A representation of the user's calendar or reminders that were scheduled by the user themself	Calendar month view
Embedded Game	A minigame or interactive game-like toy that is displayed under certain circumstances	Game that can be played as a reward for completing tasks
Note-taking	A place for a person to write text for later access	Digital movie-watching journal
Soundscape	A system that plays music or ambient sounds (e.g., white noise) continuously in the background	System that plays ambient coffee shop sounds
Virtual Assistant/Pet	A virtual agent representing something other than the user (e.g., digital pet dog, chatbot)	Personal assistant that provides encouragement

informatics displays). This approach is similar to past work that has produced taxonomies based on brainstorm data (e.g., [99]). We see this type categorization as a valuable starting point for DKK designs to address many common use-cases.

5.3 EXEMPLAR DIGITAL KNICK-KNACK DESIGN TEMPLATES

To continue the study of DKKs more closely, we created a set of design templates to prototype. We created multiple designs to be able to investigate a variety of types and modalities. We use the term "template" to refer to how the designs concretely implement one of the DKK types from the taxonomy, while intentionally keeping aspects of the design and contents open for control by the users. For the templates to both serve as design exemplars and as a technology probe for understanding people's feelings towards DKKs, we have the following design goals:

1. *Playful* — We focus on non-utilitarian, playful kinds of DKKs, to investigate how we might be able to bring back some of the playfulness of historical DKK designs without the perception of being gimmicky or childish. This focus also narrows down design options by excluding utilitarian DKK types.

2. *Personal* — In the same way that physical possessions are valued because they are personally meaningful [175] or designed by the owner [166], we focus on DKKs that can be made personal via user-configurable design and content options. This means focusing on DKK types with many aesthetic configuration options (e.g., an artistic decoration rather than a content recommendation system).

3. *Not distracting* — Playful DKKs need to be able to provide value while remaining unobtrusive when the user is working. Designs need to be effective even while occupying a small screen area.

4. *Diverse* — We create multiple designs each representing different DKK types in the taxonomy. This supports *Goal 2: Personal* and enables a technology probe to delve into the value of different aspects of DKKs (e.g., output modalities).

5. *Easy to study* — We focus on DKKs that do not require excessive implementation complexity or invasive privacy permissions in the context of a technology probe (e.g., contacts, webcam). This narrows down design options by filtering out DKK types like *Calendar Events/Reminders*.

6. *Desktop computer context* — We focus on the context of desktop computer (i.e., laptops and desktop computer screens). Compared to mobile phones, desktop computers are more often used for work-related tasks, which enables us to gain more insight into how playful DKKs are perceived in work contexts (supporting *Goal 1: Playful*). Focusing on a specific device form factor also helps facilitate *Goal 5: Easy to study*.

With these goals in mind, we created three different DKK design template prototypes. Each takes the form of a 256×256px floating window that can be zoomed and resized as desired to suit different screen arrangements and high-DPI screens. We intentionally went with simple designs to satisfy *Goals 1: Playful* and *2: Personal*, because open-ended designs can encourage playful interpretation

(a) Virtual Pet (b) Picture Frame (c) Sound Machine

Figure 5.1: Example renditions of the three exemplar DKK design templates.

and a wider range of customization possibilities, and *5: Easy to study*, because simple designs keep the study focused and reduce deployment complexity. Since the templates are also technology probes, simple designs were important, because technology probes "should be as simple as possible" and "open-ended" [103]. Their designs are as follows:

VIRTUAL PET (FIGURE 5.1A) A virtual pet in the form of an anthropomorphic alien-like character. The shapes and colours of body parts can be pre-configured. Clicking on the character triggers one of three predefined animations. This is based on the *Virtual Assistant/Pet* DKK type.

PICTURE FRAME (FIGURE 5.1B) A digital picture frame that cycles through a fixed set of user-pre-selected photos every 30 minutes. The style, colour, and size of the frame and mat are pre-configurable. This is based on the *Meaningful Media Display* DKK type.

SOUND MACHINE (FIGURE 5.1C) A continuous stream of one of six user-pre-selected ambient sounds, like crickets or rain falling. It is housed in window with a slowly animated visual of pre-configurable ambient scenes or abstract shapes, and the colour is also pre-configurable. The volume can be changed in real-time using a volume slider at the side of the window (the default volume is 0%). This is based on the *Soundscape* DKK type.

5.4 DIARY STUDY: EFFECTS OF DIGITAL KNICK-KNACKS

We used our DKK design templates as a form of technology probe [103] in a 10-day diary study. The goal of the study is to understand feelings towards DKKs and how they integrate into daily life.

The study took place in three phases: (1) a set-up session in which participants each designed their own variation of a DKK template; (2) participants lived with their DKK and wrote daily diary entries about their experience; and (3) a closing interview probed further into participants' perspectives. The set-up and closing interview sessions were conducted in person or over videoconferencing software. The study was approved by our institution's research ethics board.

While technology probes are often physical technological artifacts, we consider our DKK templates to be a technology probe because they share the same

distinguishing features [103]: they are designed to be simple and open-ended, they are not intended to elicit usability feedback, they log data about their use, and they are designed to influence design rather than serve as iterative product prototypes. Similarly, this study is not intended to be a comparison of different types of DKKs. Instead, the different templates serve as an opportunity for participants to design a DKK that is more personally meaningful to them.

5.4.1 *Participants*

We aimed to recruit participants with a broad range of ages and occupations to obtain a range of unique perspectives. We sought participants who used their computer regularly for more than three hours per day, and who used a desktop web browser supporting unsigned web extensions (e.g., Chrome, Edge). We distributed the DKKs as web extensions because of their relative ease of deployment, ability for remote logging, and widespread platform support.

We recruited 10 participants (median age 30, IQR 11, 4 male, 6 female) via message boards and snowball sampling. Participants had a diverse range of occupations (e.g., engineer, nurse, physician, teacher, student, retiree). Regarding familiarity with desktop or portable devices: 3 participants described themselves as extremely familiar, 5 very, and 2 moderately. Regarding time spent using desktop or portable devices: 5 participants responded more than 8 hours per day, 3 for 6–7 hours, 1 for 4–5, and 1 for 2–3. We asked about participants' experience with specific examples of related forms of digital personalization: 4 participants used custom ringtones or notification sounds (1 of which used them regularly), all used custom wallpapers (6 regularly), 4 used animated screensavers (2 regularly), 9 used custom skins such as light/dark mode (7 regularly), 8 used home screen or desktop widgets (5 regularly), and 5 used custom icon or font themes. 2 participants selected the picture frame template, 1 selected the sound machine template, and the others selected the virtual pet template. Participants received an $80 e-gift card as remuneration.

5.4.2 *Phase 1: Digital Knick-Knack Design Set-up Session*

We created a web app for configuring the different design options of each DKK template. The tool took the form of a wizard that first gave the choice of template, then contents (e.g., photos to put in the picture frame and sounds to put in the sound machine), then appearance options, including different visuals and tweaks to the visuals like size and colour.

In the initial set-up session, participants had the opportunity to explore the DKK tool and the different configuration options for their DKK. Once participants finalized their design, they would not be able to change it later during the diary portion of the study. We structured the study in this way to give participants a feeling of having a central role in the design. The session lasted approximately 10–30 minutes, depending on the participant.

At the end of the session, the design tool created a specification file that we embedded into a web extension representing the participant's DKK. We helped participants install the extension in their browser and verify that it was working. Participants were requested to keep the DKK open as much as they could for the

remainder of the study, but they could interact with it as much or as little as they liked. The DKK remotely logged interaction events.[2]

5.4.3 *Phase 2: Diary Study*

Participants lived with their DKKs on their computers for 10 days, completing a daily diary entry. We set the study duration as 10 days to be long enough for novelty effects to wear off but short enough to not excessively encroach into participants' computer environments. This is similar to many past diary studies investigating novel software (e.g. [53, 187]), and participant comments indicate that they became used to and comfortable with their DKKs after only a few days of the study.

At the end of each day, participants were requested to complete a brief diary entry questionnaire with three questions: the valence and arousal scales of the Self-Assessment Manikin (SAM) [27], as well as a short-answer question asking participants to reflect on their experience living with the DKK that day and write down their observations, thoughts, or opinions.

5.4.4 *Phase 3: Closing Interview*

At the end of the diary study phase, we conducted a semi-structured interview with each participant. We asked about participants' overall experience, whether they felt the DKK changed their experience of using the computer, why they designed it the way they did, and questions about aspects of the DKK, such as whether it matters who made it and whether they would like it on multiple devices. We also used the interview session to clarify points raised in diary entries. Each interview lasted approximately 25 minutes.

If a participant wished to keep using the DKK after the study period, we showed them how to disable the remote logging in the web extension.

5.4.5 *Diary and Interview Data Analysis*

For our qualitative analysis of the diary entries and interviews, we used a Template Analysis [114] style of thematic analysis to construct themes. Unlike Braun and Clarke's approach of *reflexive thematic analysis* [28], Template Analysis develops initial themes (the "template") earlier in the process, has a focus on iteratively developing and "trying out" the template during coding [30], and does not make as strong of a distinction between "codes" and "themes" [29].

I independently performed the analysis over several iterations. Before conducting the study, several concepts of interest had already been identified, specifically the notions of distraction, emotional value, and personal meaning. These were used as tentative initial codes in the template. I analyzed the diary entries before each respective interview, which allowed the interview to include more focused questions, but also led to the incorporation of additional concepts into the template, including the notion of using a DKK on multiple devices and the framing of the DKK design tool as a constraint. I then transcribed and coded the entire

2 A supplemental video available online demonstrates the DKK design process and usage: https://dl.acm.org/doi/suppl/10.1145/3613904.3642695/suppl_file/pn9971-supplemental-material-1.mp4

set of interviews (approximately 3.9 hours total) to construct inductive codes as well as extend and refine the earlier tentative codes. Our analysis recognizes knowledge as socially constructed, in that our experience as researchers and the context of our study shape the way we make meaning from the data. For example, I am familiar with theories and concepts related to games and play, which may have implicitly informed the analysis.

5.4.6 *Results: Usage Log Analysis and Diary SAM Ratings*

When the DKK was open, it was visible on average 25% of the time (SD 33%) for a given participant, indicating that participants did use their DKKs during the study, but there was large variability in usage across participants.

We calculated information about 'active sessions' with DKKs, in other words, periods of time that they logged interaction events (opening, clicking, hovering) within one hour of each other. On average, participants had 1.6 active sessions with their DKK each day (SD 1 session). The sessions were 33 minutes long on average (SD 60 minutes), but with a median duration of 6 minutes, indicating that most interactions were short, but some participants engaged in prolonged interactions. On average, in each session, a participant would click on the DKK 7 times (SD 24 times) and hover 7 times (SD 18 times). Participants also described regularly looking at their DKK, even when they were not interacting with it.

By dividing the computer screen into 9 equal sections from "top-left" to "bottom-right", we calculated the most common placements of the DKK on-screen, averaged across participants. Bottom-right, placing on a separate monitor (exact placement unknown due to browser API limitations), and top-left were the most common placements, followed by middle-right and top-right, which were considerably less common, followed by other placements. This indicates that screen corners were a generally favourable placement for DKKs.

For the SAM ratings in participants' diary entries, there were no clear trends in valence or arousal over the course of the study. Overall, the average valence and arousal ratings were neutral (5 and 6, respectively, on a scale from 1–9), but with large variance across participants (SD of 2 and 2, respectively). This level of variability is unsurprising given that participants had varied perceptions towards the DKKs and participant diary entries frequently described changes in mood independent from the DKKs.

5.5 QUALITATIVE ANALYSIS OF DIARY ENTRIES AND INTERVIEWS

From the analysis of participant diary entries and interviews, we constructed five themes for perspectives on DKKs. These do not represent unanimous or universal opinions, but rather different perspectives that were prevalent among our participants.

5.5.1 *Bringing joy and positivity*

DKKs can bring joy and a positive mood to one's day through several aspects. Participants appreciated the design of their DKKs; for example, the style of the picture frame (P4), the cuteness of the virtual pet (P3), the slowness of the visual changes (P1), and the incorporation of favourite colours (P2). The interactivity

was also appreciated; for example, the ability to dynamically change between photos in the picture frame (P1) and to explore the different animations of the virtual pet (P6). DKKs were associated with positive memories or evoked feelings of nostalgia; for example, seeing photos from one's hometown in the picture frame (P1), and reminiscing about past virtual pets like Neopets (P3) or Webkinz (P2). Avatar-based DKKs can bring an additional form of joy when considered as a form of companion. For example, P8 described hers as: *"I always feel happy whenever my digital buddy greets me every day. It's like having a good friend who's always there to brighten my mood"*.

Some participants felt that looking at and interacting with their DKKs supports their mental health (P8), and this was seen as a way of managing stress and anxiety. For example, P4 said the picture frame *"soothes me"* and *"keeps me calm"*, P2 felt that interacting with the virtual pet was a healthy way to *"manage the stress"* before an important meeting, and the sound machine helped P10 stay *"focused and calm"* when writing a document. The feeling of companionship from the virtual pet DKKs was also perceived to help with loneliness or provide cheer on a *"gloomy day"* (P1). For example, in a diary entry, P3 wrote: *"I was particularly sad today. The digital knick knack made me cheer up a little bit. Just having silent company can be comforting."*

Although the exemplar DKKs were not designed in support of social situations, they sometimes led to unexpected and joyful social interactions. For example, P2's DKK was a *"conversation starter"* and an opportunity for *"showing off what I had made"*, and P3 engaged in a discussion with a friend about her DKK's design. On computer screens in shared environments, DKKs can take on a life of their own in the broader space. For example, P8 had hers open on her home office computer, and family members would smile when they passed by and saw it. DKKs could also be designed to more intentionally encourage social interaction. For example, P7 suggested that he would be interested in a pair of *"corresponding knick-knacks"* that let one person send a *"wave"* to a friend with the other DKK.

5.5.2 *Balancing the level of presence when working*

DKKs can provide value in a work context, for example, by supporting taking breaks, but this is hampered if their on-screen presence is too strong or weak.

On one hand, DKKs were sometimes felt to be a distraction during work, perceived as *"in the way"* (P5) or *"annoying"* (P1) if they covered work-related windows. To see content underneath, participants needed to move the DKK to a different part of the screen, resize it smaller, or resize other application windows to not be underneath. Screen space also can come at a premium, especially on small devices. For example, P1 would use her small laptop in bed, limiting the availability of screen space. Some participants used multi-monitor setups and moved their DKK to a non-primary monitor to make more effective use of space.

Another consideration is that although the exemplar DKKs were not designed to demand attention, subtle changes, such as when the picture frame changed pictures or the virtual pet blinked, were something new that participants needed to adjust to. P8 described the process as: *"[The] first two, three days is just you always get distracted because [...] I have, like, colourful stuff over there, which blinks. So peripheral vision always sees it. But then you get used to it, right?"* Some participants specifically felt a sensitivity towards changing sounds or visuals, and chose a

DKK template accordingly. For example, P1 avoided the sound machine template because of sensitivity to sounds.

On the other hand, because the exemplar DKKs were not designed to demand attention, when participants were busy with tasks, their DKKs were sometimes left aside, forgotten, or lost behind other windows. For example, a DKK could be *"completely ignored"* (P10) if another window was maximized on top of it. This neglect prevented it from being able to provide joy or help calm.

Several participants held the attitude that a computer is a *"tool"* (P5), in that playful or entertaining things do not belong in this context. For example, P5 explained that he used to use a typewriter, implying he feels the computer is its spiritual successor. Although some participants disliked the non-utilitarian nature of the DKKs, these participants felt more accepting of more utilitarian forms, and provided suggestions. For example, P10 wanted a DKK to provide reminders to grocery shop and communicate any discounts. Some participants who used their computer for both work and leisure activities felt they would be more inclined to engage with their DKK when they are not working. For example, P1 wished hers could be displayed according to a schedule based on *"'on' and 'off' hours"*. More broadly, there was a desire to moderate encounters with or control the *"amount of presence"* (P3) of one's DKK.

A related attitude is that of being a digital *"minimalist"* (e.g., P4), in that anything perceived as not providing functionality, such as *"visual clutter"* (P7), is superfluous and should be removed. Similarly, there is an impression that extra content may consume excessive electricity or computer memory. However, some participants preferred having a more *"fun"* computer environment. For example, P1 said, *"I like when [widgets that are very productivity focused] also have things that are a bit more fun and casual, like pictures in them"*.

5.5.3 *Being within "eye's reach"*

Interactions with DKKs were usually brief, and could be used as a form of break while working or when switching tasks. P2 described this as: *"So there was a couple tasks this week that I really didn't want to do [...] but I would intersperse it with playing with it and making it jump around, just making it a little bit more of a positive endeavour in that task."* Some participants related or compared the interactivity of their DKK to their physical knick-knacks. For example, P3 related her virtual pet to the figurines she keeps on her desk, contemplating how with the figurines, *"you can kind of like wrap your fingers around and do more motions with your fingers that way"*, and clicking on a DKK also has a *"tactileness"* that is *"satisfying in a unique way"*. P4 described the interactivity of the picture frame DKK as advantageous over a physical picture frame. Several participants also related their DKKs to a *"fidget toy"*, for example P7:

> *"I've always been a little bit like a doodler or fiddler. [...] And I found that on this phone call, I was sitting around waiting on hold, being transferred between departments, and just kind of having it up, looking at it, tapping on it, it gave me something to kind of distract myself from what was going on."*

Participants appreciated that DKKs were right on their screen, in that they were *"always within my eye's reach"* (P3) and could provide value at opportune times without needing to switch contexts. For example, P3 said:

> *"I know that there was moments when I was a little upset during the time I was using my computer. And I didn't really even have the mental capacity to think about having to look elsewhere. Just having it on my screen was incredibly convenient. And it did manage to kind of elevate my mood without me having to put much effort into it, which I appreciated."*

This highlights a perceived level of effort needed to switch focus away from the task at hand on the computer screen, which enabled DKKs to substitute for less desirable distractions, such as *"doomscrolling"* (P2), *"scrolling TikTok"*, or *"watch[ing] a YouTube video"* (P6), because the DKK is the more convenient option. Some participants also highlighted that because DKKs are on-screen, they could fiddle with something during a remote meeting without taking their eyes off the screen to still appear *"engaged"* (P7).

Another effect of having DKKs on-screen was that over time, some participants felt that their DKK came to be associated with the particular screen it was on. For example, P8 described her DKK as *"like a soul of this computer"* and that she would not want the same one anywhere else, and P6 described his as: *"it's like it becomes your 'work buddy' as opposed to like just 'take everywhere buddy'"*. This desire to have the DKK in a dedicated place helped participants feel more in control over moderating the amount of time they were spending with it. P3 described this using cat behaviour as an analogy:

> *"I feel like I'm more of a cat person, for example. Cats, they're not always by your side all the time. They're kind of wandering and only sometimes do you see them. I feel the same way about the knick-knack where I'm only occasionally seeing it when I'm on my computer, but I'm not seeing it in every single moment of every device I use."*

5.5.4 *Forming a personal and contextual connection*

Overall, participants felt that having put effort into the design of their DKKs gave them a stronger personal connection. P8 described this process as: *"if you cook something, it tastes better"*. When participants designed their DKKs, the process enabled them to incorporate their own memories. For example, P1 included a photo of *"me and my mom that always made me happy"*, and P3 designed her virtual pet to resemble a character from a video game she played as a child, engendering a feeling of nostalgia.

Personally designing a DKK also supports a feeling of ownership and control over it; in other words, a sense of pride because *"I designed this"* (P7), and satisfaction from deciding on a design that one *"really liked"* (P8). Having a say over the design also supports individual aesthetic preferences. P3 reflected on this in reference to a friend's negative reaction towards her DKK's appearance:

> *"I mean, based on, I think, my friend's very visceral reaction, I imagine if I had given her this one that I designed, she wouldn't have enjoyed it as much. And I think I would probably be the same way. I'm sure that her tastes would be very different to mine. And I think that that would affect my enjoyment of the knick-knack in the same way that when you choose a physical knick-knack, I think how it looks is very important. And you usually pick the one that visually looks the nicest to you. So being able to design it and make it the way you would like it to look, I think is very important."*

Some specific examples of personal aesthetic decisions included P9's desire to incorporate her favourite colours and P10's desire to choose sounds that she associates with comfort rather than nervousness.

Another important aesthetic consideration for participants was how well the DKK fits into the surrounding computer desktop context. For example, P1 would have preferred if her DKK had rounded corners because *"everything else"* has rounded corners, and P9 felt that having a window border on hers made it stick out in an unappealing way.

When participants reflected on their experience using the DKK designer tool, some felt that *"you really did not [do] much to [the digital knick-knack], to make it yours"* (P6), and that the amount of effort they put into designing their DKK counted as less than *"design"* and was more akin to *"customizing"* (P9). Yet, while some participants would have preferred additional control over design options (e.g., P3 would have liked if the virtual pet could be rendered in a *"different art style"*), others appreciated the lower level of control because it required less perceived effort or technical ability. For example, P6 felt that if he were to make a DKK from scratch, his artistic abilities would limit its quality and personal value:

> *"I mean, to me, the ability that [...] you didn't have to draw anything or come up with any type of idea was a positive. Because if you were to ask me to go design my own thing [...] I don't think I would have come out with anything that I would [...] interact with nearly as much, just because it'd be like, too ridiculous and too silly."*

In other words, it may be challenging for some individuals to devise a valuable design from scratch, but there is still a strong desire to have a say in what it is like, and a perception that this level of control would still facilitate forming a personal connection with the DKK.

5.5.5 *Retaining personal value over the long term*

Participants appreciated the novelty of their DKKs after installing them, because they were something *"new and exciting"* (P2) and it was interesting to *"explore [their] features"* (P8). However, the DKKs became less exciting over time, because one *"will know what to expect"* (P8). For example, P1 started becoming tired of the photos in her picture frame DKK, and she regretted not adding more. Some participants found new uses for their DKKs, which provided emergent functionality. For example, P1 used hers to cover on-screen advertisements.

For longer-term use, participants felt it could be valuable for DKKs to support a greater variety of interactions to keep them interesting. For example, P6 suggested incorporating more Easter egg-like *"hidden actions"*, because he was interested by *"the idea that it did things without you knowing [everything] it did"*. Similarly, P7 suggested that a DKK could be more appealing if it provides a *"reason to look at and engage with"* each day; for example, if *"it gives you a little factoid of the day like, 'blue whales weigh 18 tons'"*. These two examples show how a DKK could be designed to foster curiosity about what it will show or do. Some participants also felt it would be valuable for DKKs to have a way to change appearance based on mood or season. For example, P8 said:

> *"I like to change things according to the season. During the winter time, I probably want it to look like a snowball or something like that. Because, you know, I think everyone wants to change things up a bit."*

Even if DKKs were considered less exciting over time, some participants felt they became closer to, or more positive about them over time. For example, in a later diary entry, P4 wrote that his DKK is *"a part of my daily routine now"*. Similarly, P6 formed a tendency to refer to his virtual pet DKK by nicknames like *"Mr. Fuzzy"*, and attribute a *"personality"* towards it. In this view, one can come to *"grow to enjoy"* (P3) a DKK without feeling a need to change its appearance.

5.6 DISCUSSION AND IMPLICATIONS

Based on our DKK taxonomy and analysis, we reflect on DKKs that are self-made, connect to past work and suggest implications for DKKs on other device form factors and social DKKs, and discuss the value of non-utilitarian DKKs.

5.6.1 *Reflecting on the Self-made Nature of Digital Knick-Knacks*

SUPPORTING VARYING LEVELS OF CONTROL OVER DESIGN Our *Forming a personal and contextual connection* theme addresses how people desire different levels of control over the design of a DKK. For example, P6 felt that having a starting point for design was useful in creating something personally valuable, whereas P3 felt that more control over the artistic style of the DKK would be desirable. This relates to Campbell's distinction between "customization" (like P6) and "craft consumption" (like P3) [35]. This indicates that although a DKK is considered more personally valuable when the user has a say in its design, it may not be critical to have a highly-involved design process. DKK creation tools could borrow ideas from creativity support tools and computer-assisted content generation (e.g., text-to-image generation [117]) to facilitate a greater depth of design exploration for less design-oriented users.

DIGITAL KNICK-KNACK DESIGN AS A CONTINUAL PROCESS Blom and Monk [23] found that people continually personalize their computers and phones over time to "accommodate their current emotional states". In contrast, our study restricted design changes to the set-up session, with no personalization options later. DKKs could also be designed to support continual modification by or interaction with the user.

For modification, a DKK could be decorated in anticipation for events, different moods, or seasons (e.g., P8) to make it feel new and relevant to the present. Taking this a step further, DKKs could be designed to support a continual process of creating through a craft-based process. This is similar to how bullet journals are an artifact that supports continual crafting, which can provide the creator with joy [209].

For interaction, a DKK could provide content that changes regularly, such as trivia (e.g., P7's suggestion for a *"factoid of the day"*) or secret functionality (e.g., P6's *"hidden actions"*), which would stimulate surprise and curiosity, and motivate maintained interest over the long term. Such DKKs could incorporate generative design or content, for example, similar to the "memories" features in popular

social media and photo management applications. However, there is a tension between being personally meaningful and adapting with new generative content. Our analysis shows that DKKs were felt to be more valuable by being self-made. Participants highlighted that even personalized content can feel *"imposed"* (P6) if not intentionally displayed by the user, similar to how "memories" features can be insensitive about what content is brought up, and display content at inopportune times [105]. There is also a risk of excessive changes damaging the perception that a DKK is something personal. It could be valuable for DKKs to incorporate strong aspects of user design, while allowing for continued surprises based on curated sets of content. For example, they could artfully combine photos and quotes selected by the user into a combined view, similar to a photo collage idea discussed in the brainstorming session.

NORMALIZING CRAFT AND MAKING More broadly, DKKs as self-made artifacts could serve to challenge the role of automation encroaching in our lives, such as automatic music playlists, news feeds, and photo "memories". Bunz [31] argues that modern interfaces are "engendering stupidity as the desirable state [users] should be in", highlighting how this leads to a tension between empowerment and patronization. It is important we design interfaces to empower users to create, rather than propagate the idea people should be passive content consumers. In line with this, Gauntlett [76, pp. 85–87] argues for the value of creating digital things that "conve[y] the powerful, inclusive, happy message that 'anyone can do this'" and maintain a "human connection [...] with the work". He proposes a vision for the future in which people "embrace a more social and connected life of creative exchange" [76, p. 237]. We see self-made DKKs as supporting a digital culture that places stronger value on craft and making, similar to how websites like Neocities[3] aim at reviving and normalizing the concept of unique, personal, and often playful webpages.

5.6.2 *Digital Knick-Knacks Beyond the Desktop*

MOBILE FORM FACTORS Although our DKK taxonomy accounted for multiple device form factors (e.g., desktop computer, mobile phone), we focused on a desktop computer context in the diary study, which applies to both work and leisure contexts. Even with this focus, smartphone-related considerations were raised by participants. On one hand, it may be preferable to display non-utilitarian DKKs in leisure contexts associated with smartphone use (e.g., P1), but on the other hand, phones have reduced screen space, meaning that DKKs could more easily get in the way of other content (e.g., P7). Another consideration is that smartphones and other smart devices like smartwatches are designed to facilitate brief glances and interactions. If DKKs occupy this transient digital space, it may move them from being 'on display' closer to being "placeless" [170] like conventional digital possessions that are stored away.

Because smartphones are associated with leisure activities such as browsing social media, there are also unique concerns around smartphone dependency. For example, P6 said, *"it's easy to switch from one thing to another"*, referring to how easy it is to be distracted by other content on a smartphone. In line with our *Being within "eye's reach"* theme, situating a DKK in the same context as an

3 https://neocities.org/

ongoing activity could help avoid context switches. This is also supported by habit-forming psychology, which proposes increasing the accessibility of healthier alternatives as an effective way to avoid interference from bad habits [237].

SPATIAL DIGITAL KNICK-KNACKS Aside from conventional screen-based contexts, DKKs could extend to contexts like XR (extended reality). In XR, they could occupy physical space and take on more properties of physical knick-knacks (e.g., sculptures), while still leveraging advantages of the digital (e.g., self-made artwork created in a 3D painting application). Haptics could be used to support novel tangible interactions with such DKKs, supporting an enjoyable *"tactile experience"* (P3) like that of fidget widgets [108]. Alternatively, 2D DKKs like our templates could be placed as interactive 'stickers' or posters on flat surfaces in the environment like walls and tables. They could also integrate more seamlessly into environmental surfaces by adopting ideas from ambient displays (e.g., projections of content on surfaces [104]) and interactive architecture (e.g., shape-changing displays [160]).

5.6.3 *Social Considerations for Digital Knick-Knacks*

AGENT-LIKE DIGITAL KNICK-KNACKS Although the focus of our exemplar DKKs was not social, DKKs could be designed to have social function by creating agent-like *Virtual Assistant/Pet* DKKs that communicate with the user in some way. Conventional interfaces like Clippy, or hybrid digital objects, like anthropomorphic smart home assistants or smart speakers (e.g., Sense Mother sensor hub [196], LG Hub robot [122]) could serve as inspiration. However, such agents conventionally tend to have fixed personalities and appearances with limited customization options [239]. To provide more personal relevance, agent-like DKKs would need to break from this homogeneity by satisfying personal aesthetic *"tastes"* (P3). A possible advantage of agent-like DKKs is that they could provide personal support beyond the mental health considerations raised by participants (e.g., P8). Given that chatbots can have meaningful impacts on users' emotions, such as easing feelings of anger [40], DKKs that integrate such functionalities could provide stronger emotional value or foster a feeling of nurturing.

SELF-PRESENTATION IN SHARED SPACES If displayed in public contexts, DKKs also have implications for self-expression and self-presentation. Our templates primarily focused on being meaningful to an individual, rather than something shown to other people. However, technology is often put on display in public situations; for example, on shared computer screens in a home, or on a smartwatch worn in public. In these contexts, DKK design needs to expand to consider whether it reflects how one wants to express oneself. For example, to support a *"minimalist"* self-image like that of P4, DKKs could provide simple or elegant design options. As another example, DKKs could take inspiration from smartwatch faces, which people set according to their desired self-presentation or to match a given outfit [85].

Self-presentation also extends to shared digital environments; for example, how avatars on online communication platforms serve as a form of personal expression. Avatar DKKs (a subset of our *Self-representation* type) could incorporate social status within a platform. For example, our brainstorming session identified that

DKKs could change appearance to represent achievements or show the quality of contributions to an online platform. In digital virtual spaces or sandboxes like Mozilla Hubs[4] or Roblox[5], avatars and props can be displayed within a more immersive virtual environment, leading to additional considerations similar to those for XR.

FACILITATING SOCIAL BEHAVIOURS Digital-knicks could also provide value by facilitating social behaviours, such as establishing a remote connection between family members. For example, a participant in the brainstorming session described how a DKK could display a real-time feed of a child's drawing. Similarly, P7's suggestion for a pair of *"corresponding knick-knacks"* could be achieved in a similar way to Sengers et al.'s "Virtual Intimate Object" [195], in which the colour of one's DKK changes based on a someone else's interaction.

5.6.4 *Digital Knick-Knacks for Play and Work*

Works that discuss certain historical playful features (e.g. [197]) have dismissed them as unsuccessful in work contexts, and participants such as P8 initially thought that DKKs would provide limited value beyond *"just entertainment"*, before changing their minds. Our analysis shows it is possible to design non-utilitarian DKKs that provide value today.

BALANCING ATTENTION DEMANDS AND LEVEL OF PRESENCE Historical DKKs were sometimes designed in ways that demanded attention and disregarded the importance of having a balanced level of presence. For example, Clippy would pop up at inconvenient times [238], and the Neko mouse cursor extension [37] would cover other content. Virtual pets incorporated game-like design elements that required continuous attention, such as feeding and cleaning. It is important for non-utilitarian DKKs to maintain a balanced level of presence. If too hidden, they can be forgotten (e.g., P10), which limits their ability to provide value, whereas if too present, they can get in the way and become distracting (e.g., P5). Presence could be reduced by appealingly fitting into the surrounding context (e.g., P1). DKK designs also need to offer a choice of output modalities to avoid becoming overbearing. For example, designs that produce sounds may interfere with already-playing music (e.g., P3). Similarly, sudden visual or auditory changes, even if small or infrequent, can grab attention and be distracting (e.g., P2 near the beginning of the study, in reference to the virtual pet blinking). When the user is not interacting, smooth, slow transitions between states are preferable. Nevertheless, there may be value in intentionally designing DKKs to evoke nostalgia associated with historical designs. For example, software Easter eggs sometimes incorporate design elements from historical software, such as how one theme in recent versions of Microsoft Office includes a rendering of Clippy in the background [123].

INCORPORATING PLAYFUL DESIGN Recent work by Altarriba et al. [4] highlighted how play can provide joy, support people's agency, and facilitate social connection. They give examples of how play can "re-signify" serious contexts

4 https://hubs.mozilla.com/
5 https://www.roblox.com/

such as office environments, and they borrow Gaver and colleagues' notion of ludic design [79], in that designing for ambiguity and flexibility of interpretation can elicit curiosity and exploration. In line with this, designing DKKs to be intentionally ambiguous [78] could support emergent functionality and improve long-term engagement. For example, because our DKK templates were dynamically resizable, P1 repurposed hers to cover advertisements. Similarly, a participant in our brainstorming session described how a *Help/suggestion System* DKK that shows computer coding best practices could be displayed on top of less relevant information in the user interface. More broadly, based on our taxonomy, non-utilitarian DKKs could provide value to users through a number of playful ways, such as aesthetics (e.g., being soothing or funny to look at or listen to), interactivity (e.g., acting as a fidget toy, piquing curiosity), triggering memories or nostalgia (e.g., embedding personal media), or acting as a companion (e.g., anthropomorphic design). While not everyone will receive all DKK designs positively, there is a potential for personally-relevant designs to provide value across a wide range of people.

5.6.5 *Limitations and Future Work*

We conducted this research in a North American cultural context. It would be valuable to investigate perceptions of DKKs in other cultural contexts. For example, how should they be designed for households in which devices are shared by multiple people, and how do cultures that have different norms surrounding technology use perceive DKKs?

As mentioned earlier, our diary study focused on a desktop context. Mobile devices have a number of differences, such as generally being less associated with work and more frequently used when travelling, and having different patterns of interaction, smaller screen areas, and generally shorter product lifespans. Future work could further investigate DKKs in the context of mobile devices to understand the effects of and design opportunities afforded by these differences.

Although our exemplar DKK designs included options for audio, our understanding of DKKs is primarily as a visual-first type of digital possession. It would be valuable to understand how DKKs can be designed by and for people with sensory disabilities and how they can better leverage different output modalities; for example, in the vein of work investigating the visual art experiences of blind people [127].

Most participants in the diary study selected the virtual pet template. The primary reasons for this were that many of our participants already used their desktop background to display personal photos, listened to music when using their computer, or had a sensitivity to sounds. Because of the smaller-scale size of our diary study (10 participants) and this weighting towards the virtual pet template, we learned more about the value of the pet template than the others. However, the goal of our work is to investigate the general concept of DKKs and how people feel about living with them, and the primary purpose of having the different templates was to provide the most opportunity for participants to design a DKK that was personally meaningful. Future work could conduct larger-scale studies, including focusing on particular contexts (e.g., only in office environments), or investigating nuances of specific types of DKKs, especially

utilitarian designs and designs that deal with more personally-relevant data (e.g., contact information).

5.7 CONCLUSION

We defined a class of digital possessions called *digital knick-knacks* (DKKs), which are audiovisual digital possessions or embellishments. Unlike conventional digital possessions, which are are often stored away, duplicated, and shared across multiple devices, DKKs are digitally 'on display', analogous to how physical possessions are put on display in physical spaces.

We developed a taxonomy for designing DKKs, and we used it in a brainstorm with HCI researchers to generate example DKK designs for us to categorize into different types. We created three exemplar DKK design templates based on three of the types. We deployed them as a technology probe in a 10-day diary study in a desktop computer context, in which participants designed their own variants of the template designs. Based on a qualitative analysis of the results, we learned that DKKs are capable of bringing joy. They can be distracting in work contexts, but they can also take the place of more undesirable distractions such as scrolling social media feeds. Incorporating users into the design enables DKKs to support a stronger feeling of personal connection. DKKs are something that one can grow more fond of over time, but they are also susceptible to novelty effects. From our analysis, we also proposed implications for design, such as how DKKs can be made more suitable for work contexts.

We hope this work inspires thinking about digital environments as more than utilitarian tools, and leads to more explorations of the capabilities computers have for supporting humans emotionally and socially.

6 CONCLUSION

This thesis defined *paidian play* as an "open", "exploratory", and "free-form" experience [59], associated with terms such as "curiosity", "diversion", "exploration", "invention", and "wonder" [77]. We explored the potential for paidian play to provide benefits to users of non-game software applications, such as social and emotional value. Below, we discuss common points across the three main thesis chapters, address limitations and future work, and conclude with a call for responsible incorporation of play in non-game user interface designs.

6.1 PLAY AS A RESOURCE FOR DESIGN

Our studies show how the concept of play can serve as a resource for the design of non-game user interfaces. From *Playful Experiences*, we learned what types of activities are considered playful when using interfaces, such as experimenting, learning, and socializing. This can help us design and modify interfaces to integrate features that support these activities. *Easter Eggs* shows how investigating specific types of features associated with playful experiences can serve as inspiration for a broader range of interface designs. We suggested a number of valuable ways that Easter eggs do this. They show how intentionally designing hidden or ambiguous features could encourage taking breaks, strengthen social bonds (e.g., through shared secret gestures), teach skills (e.g., alternative pathways to shortcuts), support users with generating their own content, and form "paratextual" [44] online communities discussing the features. *Digital Knick-Knacks* provides insight into a number of approaches for presenting non-utilitarian functionalities encouraging play in non-game computing contexts. We provided exemplars for how three of these approaches could be implemented in practice, *Virtual Assistant/Pet* as an anthropomorphic character, *Meaningful Media Display* as a digital picture frame, and *Soundscape* as an ambient sound machine. We also demonstrated the feasibility and value of these implementations through the diary study.

At a higher level, play can serve as a lens for approaching design, because it relates to a range of other design goals such as creativity support, education, and well-being. While designing for play cannot replace designing for these individual other goals, it is a way of looking at interface design that simultaneously addresses multiple aspects at once. For example, in *Digital Knick-Knacks*, we chose playfulness as a design objective. Because of this, the resulting implementations ended up supporting several types of play characterized in *Playful Experiences*, including types that we did not explicitly consider beforehand. Participants discussed how their digital knick-knacks were personal because they were self-made (*Customizing and Personalizing*), how they appropriated their digital-knick knacks for other purposes (e.g., covering other windows; *Using Feature in Unintended Way*), and how their digital knick-knacks led to social experiences (e.g., starting conversations; *Socializing*). Further examples of connections between our playful experience types and the case study chapters are presented in Table 6.1.

Table 6.1: Connections between playful experience types and perspectives from Chapter 3 and concepts from the case study chapters (Chapters 4 and 5).

Chapter 3: *Playful Experiences*	Chapter 4: *Easter Eggs*	Chapter 5: *Digital Knick-Knacks*
Playing Game within System	e.g., Chrome dinosaur game	*Embedded Game*
Learning	*Teaching users transferable knowledge and skills*	*Informatic* and *Help/suggestion System*
Balancing Between Diversion and Dependence (play as a break)	*Occupying users while waiting* and *Easter eggs to encourage taking breaks*	*Being within "eye's reach"*
Customizing and Personalizing and *Creating Content*	*Acting as a creative, expressive outlet for developers*	*Self-made Nature of DKKs*
Using Feature in Unintended Way	*Educational value from Easter eggs* (emergent help features)	e.g., covering other windows with DKKs (*Retaining personal value over the long term*)
Socializing	*Creating hype*, *Getting "a life of its own"* (online Easter egg communities), and *Creating playful exchanges even when fictitious*	e.g., as "conversation starter" (*Bringing joy and positivity*)

6.2 THE UNIQUENESS OF A PAIDIAN PLAY APPROACH IN HCI

Our studies show that approaching play in software user interfaces through bottom-up investigation (e.g., *Playful Experiences*) and through unconventional application of theory (e.g., use of theories on personal possessions in the home in *Digital Knick-Knacks*) can yield unique perspectives beyond those from studying games. For example, *Playful Experiences* shows how play can be beneficial for, or even fundamental to productivity contexts, by enabling creative freedom, supporting learning, and improving personal software workflows. Similarly, *Easter Eggs* shows the breadth of serious purposes that something seemingly playful can serve, such as recruiting developers, increasing product engagement, teaching skills, and serving as a break. *Digital Knick-Knacks* incorporated play in a drastically different way from gamification, which emphasizes behaviour change [57]. We achieved this by consciously choosing non-utilitarian designs. All these forms of play integrate into everyday user interfaces such as photo editors, web browsers, and desktop environments, rather than serving as standalone apps or devices.

We also situate our work in the context of design, for example, by drawing from Gaver's notion of ludic design [77] in *Playful Experiences*, and work on the design of virtual possessions (e.g., [170]) in *Digital Knick-Knacks*. This concern for design facilitates our engagement with the potential challenges with interfaces

brought on by play, and with the potential challenges that play can address. For example, *Easter Eggs* highlights how features that encourage play have the potential to cause controversy and polarization, and their designers need to consider the social context in which they are created. As another example, *Digital Knick-Knacks* pushes back against the sterile and minimal designs of modern digital environments, instead offering a more supportive and self-expressive alternative.

6.3 THE RELATIONSHIP BETWEEN PLAY AND DISTRACTION

Our studies also show the potential risk for play in software user interfaces to become a distraction. Playful distractions are not always inherently negative. For example, sometimes what initially appears to be a distraction can end up helping with personal goals. In *Easter Eggs*, *D1* discovered a simple way to add animations in Android apps, and became distracted by playing with this functionality. Yet this distraction ended up leading to *D1* creating a useful code demonstration for teammates on implementing animations. As another example, playful distractions can also provide comfort by diverting attention away from less pleasant tasks or while waiting. This was shown by the Chrome Dino game in *Playful Experiences* and *Easter Eggs*, which provides entertainment while waiting for internet connectivity. Similarly, in *Digital Knick-Knacks*, there was an instance where one participant's digital knick-knack served as a fidget widget, providing comfort when waiting on a phone call.

In cases where playful distractions have the potential to become problematic, we identified possible design approaches to avoid this. The simplest and most drastic approach is to provide a way to disable the playful aspect entirely. This was exemplified by the Chrome Dino game in *Easter Eggs*, which school and business system administrators needed to disable. However, this only works when the playful aspect can be decoupled from the rest of the software functionality. In the *Play as Peripheral* perspective in *Playful Experiences*, we identified that this is a minority of cases.

Digital Knick-Knacks highlights three additional subtler ways to design for non-distracting play. First, designs could make it easier for users to draw boundaries between between play contexts and non-play contexts. For example, we only allowed digital knick-knacks to be installed on one system, which enabled participants to designate their digital knick-knacks to individual contexts (e.g., "work buddy"). Second, designs could focus on being unobtrusive, to avoid intentionally drawing attention towards themselves. Based on our digital knick-knack design goals and results, features that are large, brightly coloured, or have excessive levels of animation all potentially contribute to distracting from the task at hand. Third, user interfaces could provide options for users to dynamically adjust the "amount of presence" of features designed for play, as suggested by several of our *Digital Knick-Knacks* participants. This could involve giving control over the size of features on screen or limiting the times that they can be used.

Even still, if someone wants to distract themself, they will always be able to find a way by appropriating available software features or switching to an alternative activity (*Individuality of Play Preferences* perspective in *Playful Experiences*). Recall the case in *Playful Experiences* where a participant described how their playful experience of automating tasks "snowballed" to become more involved than

they had initially planned. In these situations in which play is fundamental to a broader task, the system cannot really distinguish between play and other activities. And who is to say that the playful diversion will not end up providing value in the end?

In many cases in commercial software, distracting or addictive playful designs are intentionally designed as such to maintain engagement with the platform, like the interactive game advertisement and unlimited scrolling examples raised in *Playful Experiences*. We discuss this idea further in *Dark Play Patterns* (Section 6.4.1), below.

6.4 LIMITATIONS AND FUTURE WORK

We discuss limitations and future work in reference to dark play patterns, well-being, play outside of software, and play in different cultural contexts.

6.4.1 *Dark Play Patterns*

Play can cause other forms of harm beyond distraction. Recent work by Sicart [201] draws from María Lugones' essay "Playfulness, 'World'-Travelling, and Loving Perception" [133] as a theoretical framework. He argues that software encouraging play "can also be an instrument for perpetuating inequalities, exploitation, abuse, and isolation". He defines *playful capitalism* as "When digital forms of capitalism turn interactions with software into forms of play [...] to prevent critical engagement with the infrastructures and apparatuses of oppression." He gives the example of how the "creepy" face recognition capability of Apple mobile devices is hidden away behind playful features like Animoji, which are emoji that animate according to the facial expressions of the user. He also suggests examples of "competitive quantification of emotional engagement", such as likes and shares on social media, which can lead people to "see each other as competitors, not comrades". With these considerations in mind, investigating negative aspects of play is an important goal for future work in HCI.

Playful Experiences identified different types of play, which can help us categorize the ways that play is employed in harmful ways in real-world systems. However, future work could focus more specifically on negative forms of play in software user interfaces. Interviews and archival research could be employed to understand how the different playful experience types can manifest in harmful ways. People could be encouraged to critically reflect on harmful aspects of play, like past work reframing smartphone addiction [74]. Future work could also investigate and evaluate the design of interventions that mitigate risks associated with negative playful experiences.

6.4.2 *Moving from Social and Emotional Value to Well-being*

We emphasized social and emotional value as two of the main outcomes from play provided by software user interfaces. By drawing from positive psychology, we can consider how we might be able to expand the range of possible outcomes of play. For example, the "Positive Emotion, Engagement, Relationships, Meaning, and Accomplishment" (PERMA) model [194] is well-known in psychology, and describes different "elements" that are argued to represent well-being. Emotional

value relates to the PERMA *Positive Emotion* element, and social value relates to the *Relationships* element. However, the studies in this thesis did not explicitly consider the other three elements, which we now examine below.

Engagement refers to aspects such as *flow* (Section 2.1) and absorption in tasks [32]. User interfaces could be designed to help users maintain focus when playfully using software. For example, applications could eliminate unwanted distractions from other parts of the application or from other applications, and applications could help automate away tedious parts of tasks and provide stronger assistance for more challenging parts. For mundane tasks, we could borrow from gamification by providing interventions that give additional meaning to the tasks. Even better, we could design interventions that encourage users to "reambiguate" [200] mundane situations on their own, because this is a skill which they could carry to other tasks and contexts.

Meaning refers to the feeling of "having direction" and purpose, being part of "something larger than oneself", and "feeling that one's life is valuable" [32]. In *Playful Experiences*, some participants mentioned how organizing digital content like emails made it feel like they had their lives "in control". Future work could investigate the value of using visual representations that emphasize or exaggerate the orderliness of digital content to help instill a feeling of *Meaning*. User interface interventions could also be designed to encourage users to reflect on their software use to see if it aligns with their self-image and long-term personal goals.

Accomplishment refers to the "sense of working toward and reaching goals, mastery, and efficacy to complete tasks" [32]. *Accomplishment* is highly intertwined with goal achievement, which would make gamification appear to be a strong solution. However, gamification can only be part of a potential solution, because encouraging people to reach goals is only one aspect of accomplishment. There are also concerns over whether game elements can maintain behaviour changes even after being removed [193]. Interfaces could be designed to enhance the feeling that tasks are being completed. For example, task progress could be visualized in playful ways using embellishments that increase its memorability, similar to past work on chart embellishments [14]. Interfaces could also enhance the actual level of mastery; for example, through educational features.

6.4.3 *Extended-reality and Tangible Contexts*

This thesis primarily focused on a conventional graphical user interface context, but the research questions and results could potentially be applied in other contexts such as extended reality (XR) and with tangibles.

In *Digital Knick-Knacks*, we briefly discussed how digital knick-knacks could extend to other contexts by giving digital properties to physical objects, such as virtual stickers on objects in the environment, or by taking on volumetric or physical properties, like unconventional ambient displays (e.g., [8]). "Waba",[1] a virtual, anthropomorphized green blob for the Apple Vision Pro, is an example of a commercial knick-knack in an XR context.

We might refer to such artifacts and systems as *hybrid knick-knacks* (HKKs), an extension of the *digital knick-knacks* concept. *Hybrid* means the artifacts or systems may be fully digital, or combine physical and digital elements (e.g., electronics). There is potential for future work to investigate the benefits of the process of users

1 https://apps.apple.com/us/app/waba-spatial-pet/id6478746269

crafting their own HKKs, and benefits of using the resulting HKKs themselves. For example, future work could investigate how to design authoring systems that support the playful processes involved in creating personal artifacts. This could draw from past work about enabling people to make gift cards and other physical objects that embed trackable markers to support digital functionality [19]. Future work could also explore how users could situate HKKs in their home and work environments to provide social and emotional benefits similar to digital knick-knacks, such as educational value, mental health support, and feelings of pleasure and happiness.

Expanding beyond the idea of HKKs even further, beyond self-made standalone artifacts, we can consider the future of *hybrid paidian playful experiences*. For example, systems could be designed to facilitate the creation and discovery of augmented Easter eggs that provide contextual clues about the environment or serve as team-building exercises. Physical tools like paper notebooks and sewing machines could be digitally or electronically augmented to foster play as a way of enhancing creativity. For example, systems could enable people to mix digital and physical materials, or digitally create custom patterns to be applied in physical art practices. Future work could also investigate how novelty and familiarity effects impact the long-term experiences of living with objects designed to facilitate play.

6.4.4 *Cultural Context of Play*

Our studies of play are primarily situated within a Western, capitalist context. We were able to resist the status quo of play in this context in a number of ways. We critiqued the dominance of utilitarianism and minimalism in user interfaces. We pushed back on the idea that play is separate from work, by highlighting the ways that productivity-related tasks can involve play. We were also critical of application of concepts from the Game Studies literature to non-game contexts. This is because the Game Studies literature often draws from more competitive forms of play (e.g., Huizingan play [101]), rather than other forms of play that may be better suited to non-game contexts.

At the same time, *paidian play*, the class of play we explore in this thesis, makes specific assumptions about the activity of playing, such as characterizing it as voluntary, and associated with individuality and freedom. Sutton-Smith critiques such "Rhetorics of Self", and characterizes play as highly variable across cultures [206]. In contrast with the definition of paidian play in our context, play may be a primarily collective experience, and it may be driven by external goals, rules, and obligations.

We echo Sutton-Smith's argument that "forms of play, like all other cultural forms, cannot be neutrally interpreted". It is important for future work to investigate software user interface play in other cultural contexts, and make different assumptions than our own. There are other lenses for looking at play; for example, as a way of understanding each other [133], or in terms of rituals [216]. Future work should explore lenses like these in a software user interface context, and new lenses should be invented.

6.5 CALL FOR PLAYFULNESS IN USER INTERFACES

This thesis demonstrated the value of non-game forms of playfulness in software user interfaces. While there is value from drawing from games when designing and researching user interfaces, there is also knowledge to be gained by explicitly rejecting them. If we could wish for three things for future design and research work on software user interfaces, they would be that:

1. We do not dismiss "play" as something only for children, leisure, or "non-serious" contexts;
2. We recognize that efficiency is not the only goal of user interfaces, and that playing with user interfaces has inherent value that is not always a means to an end;
3. We design for play that enables personal expression through craft and making processes.

In non-game user interfaces, play is also always occurring within a broader context, including the software environment, the underlying activity, and the social and political context. It is important that we respect this context and be mindful of the potential social and political implications when implementing playful interactions and representations.

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APPENDICES

A PLAYFUL EXPERIENCES: SUPPLEMENTAL DETAILS

A.1 STUDY 1: SURVEY DETAILS

The prompt provided to respondents used in Study 1 was as follows:

> Let's use the term "playful" to mean an experience that is "open", "exploratory", and "free-form", such as an experience associated with "curiosity", "diversion", "exploration", "invention", and/or "wonder".
>
> **Keeping this definition of "playful" in mind, try to remember a specific, recent time that you *experienced*, *encountered*, or *did* something "playful" with one or more *features* that you interacted with in an app or a piece of software.**
>
> Recalling a playful experience could take several minutes, and there's no wrong answer.
>
> The experience could be:
>
> - Positive, neutral, or negative
> - In a business, entertainment, or social context
> - On a smartphone, tablet, laptop, desktop computer, or virtual/augmented reality headset
> - Something that only happened once, or something that's habitual
> - **Please think of an example where the app/software was NOT a game** (i.e., the *experience* can be a game, but the containing *app/software* should not be a game).
>
> The following questions will ask you about this recent "playful" experience. We'll refer to the feature in the app/software that enabled the "playful" experience as the "playful feature".

It was challenging to design the prompt to encourage responses that were both diverse and on-topic. The above prompt is the result of iterating based on several pilots with 2–5 respondents each. Our initial version had a shorter and less precise "try to remember" statement, and did not include the list of potential contexts at the end. It received largely homogeneous responses focusing on activities like watching movies and playing video games, which are outside our scope of non-game software application play. Providing the list of contexts significantly helped to improve the quality and diversity of the responses, while avoiding giving preconceived examples of specific types of play.

A.2 STUDY 1: SUPPLEMENTAL DESCRIPTIVE RESULTS

We provide some additional supplemental descriptive results for Study 1, describing what features respondents used for play, and the contexts of play.

A.2.1 *Features Used for Play*

Table A.1 summarizes the types of features that respondents said they were using during their reported playful experiences. There was a wide variety of feature types, with digital art tools, media playback, and search functionality being the most common. Because we define playfulness as a state of mind or activity, rather than a property of a feature, we do not claim that these features are inherently "playful", but they may become playful when used in certain ways by certain people. We received a large number of similar responses associated with the most common playful experience types, but also a 'long tail' of more unique responses associated with less common types.

Table A.1: Counts of different types of features used by respondents as part of their reported playful experiences.

Feature Type	Count	Feature Type	Count
digital art tools	8	3D simulation	1
media playback	5	audio recording	1
search functionality	5	chatbots	1
photo/video filters	4	continuous scrolling	1
Easter egg	3	digital form	1
social media post creation	3	gamified virtual currency	1
AR filters	2	health metrics tracking	1
button widget	2	home automation controls	1
data visualization tools	2	hyperlinks	1
digital notetaking tools	2	in-app advertisement	1
document theming tools	2	in-person meetup scheduling	1
photo editing tools	2	interactive educational tool	1
recommendation system	2	personal collection tracking	1
star map	2	plant identification	1
theming system	2	social media account following	1
word processing tools	2		

A.2.2 *Playful Experience Type Counts*

After completing the thematic analysis and settling on the playful experience types, we took an additional step of counting the experiences that could be considered applicable to each type. These counts help to provide additional context about our sample, and what is most often considered playful. Table A.2 provides an overview of the playful experience types and these counts.

Table A.2: The 14 playful experience types with software user interfaces. Counts do not sum to 63 because some respondents' experiences belong to multiple types. Subtypes have counts dedented.

Type	Count	Type	Count
1. Experimenting	17	7. Using Feature in Unintended Way	4
Creative Experimenting	7	Turning Features into Game	2
Testing System Limits and Capabilities	2	8. Body Appearance Play	3
2. Exploring Content	10	9. Discovering Unexpected Feature	3
3. Learning	10	10. Customizing and Personalizing	2
4. Creating Content	9	11. Improving Workflows	2
5. Engaging with the Real-World	8	12. Reflecting on System Operation	2
Remembering Memories	1	13. Appreciating Computer Graphics	2
6. Forming a Challenge	4	14. Playing Game Within System	2

A.2.3 *Contexts of Play*

Initiating Play

We define an "intentional" playful experience as a playful experience that someone initiated themselves for the sake of play, rather than being prompted by the app or by chance. Based on this definition, the majority of playful experiences (56) were started intentionally, whereas 7 were started "unintentionally".

Intentional experiences were started for four main reasons: curiosity (e.g., about "what new themes" are available; A4), seeking out specific playful content or features (e.g., Easter eggs; A63), wanting to learn about something (e.g., about stars; A24), and seeking entertainment (e.g., exploring videos online; A17). "Unintentional" playful experiences began in one of three main situations: through recommendation systems within the app (e.g., A46's music streaming app recommended an artist); beginning by chance, based on the circumstances (e.g., A11 encountered the Chrome dino game only because they did not have an internet connection, A56 happened to be shown an in-app advertisement that was a game), and when external motivations led to playful experiences (e.g., A59 using software for work, leading to expressing creativity with visual effects)

Play over Time

38 respondents indicated how frequently they engaged in their described playful experience. The majority (30) of these respondents only engaged in their described experience one time or over a short period of time. This occurred when there was a fixed outcome (e.g., A1 creating graphs for a research project), by chance (e.g., A11 only encountered the Chrome dino game because they "had no internet connection at the time"), or when the novelty of a feature wore off (e.g., A6 described their use of the star map app as: "I did this maybe a couple times after installing the app, but that was it. I never really used it afterward").

In contrast, 8 respondents engaged in their described playful experiences on a regular basis; for example, tracking a board game collection as a hobby (A13), and experimenting with digital art tools to practise drawing skills (A10).

A.3 BRAINSTORMING SESSION: EXPERT-GENERATED PLAYFUL EXPERIENCE EXAMPLES

Table A.3 shows the final ranking of playful experience examples generated by the experts. We use the participants' wording as much as possible, but we have corrected typos and added extra information to clarify the meaning of examples where applicable. The examples are in order from "Very Playful" to "Somewhat Playful", as ranked by the participants. The "E" and "N" prefixes for the example IDs correspond to whether the example was generated in the existing example phase or the novel example phase, respectively.

Table A.3: Ranked playful experience examples generated from the expert brainstorming session.

Rank, ID		Description	Rank, ID		Description
1	E1	Fitness activities with a theme/story (e.g., Zombies Run)	16	N9	What would a place look like under certain circumstances (e.g., what would a view look like in the 17th century)
2	E2	CYOA Stories in places they should not be	17	N10	See different information for places with AR (e.g., display history for a place when pointing at it)
3	E3	Interactive TV shows where viewer can chose the outcome	18	N11	Create your own badges/themes and share them
4	N1	Interactive learning materials (e.g., student can explore and navigate at will, and engage in simulated experiences for each learning topic that simulate real applications of that knowledge)	19	N12	Badges/trophies given after a conference for best/most questions, longest question/comment, most useful/useless, etc.
5	N2	Profile picture swapping/quiz (guess who each person is pretending to be)	20	N13	Playful descriptions of status, e.g., 'You read 10k words on Facebook, that equals volume 1 of War and Peace'
6	N3	Helping decorate each other's profile	21	N14	Changing virtual background in Zoom to show a movie but each person in the call has a different part of the screen
7	N4	Virtual yoga coaching: to improve poses	22	N15	Create a font based on your virtual yoga poses

Rank, ID		Description	Rank, ID		Description
8	E4	Strava: see you and your friend's performance and location when doing the same race	23	N16	Profile personalization options where user could also set a visual display of their liking (theme, badges, trophies, achievements, etc.)
9	E5	Easter eggs in websites	24	N17	Waze but wildlife version, e.g, 'Deer reported 10 mins. ago'
10	E6	Animated/fun error messages (e.g. the 'dinosaur' error message in browser)	25	E8	See where Santa is on Google Maps
11	N5	GeoGuessr for contexts beyond Street View	26	E9	Playful re-skins of Google Maps (Mario kart, Pokémon etc.)
12	E7	Manipulating image preview, reactions, etc. (e.g., making the YouTube like/dislike bar look like a light saber)	27	E10	Try on glasses virtually when shopping for frames
13	N6	Interactive presentations or videos, where users can annotate/react and see each others questions/comments/ reactions	28	E11	'View in 3D' in Google Chrome to see dog size in real world
14	N7	Fan-generated content/annotations related to media (e.g., fan-wiki entries, fan art)	29	E12	MSN messenger computer 'locks'
15	N8	Explore design suggestions for a room with photos/AR/VR	30	E13	Using emoji or reactions to convey emotion, fun, or draw larger images

B

EASTER EGGS: SUPPLEMENTAL TABLES

From an HCI standpoint, the ways in which developers hide Easter eggs and the user interactions needed to trigger them are of interest. These factors are related to the audience of an Easter egg, how the user is intended to perceive the software (e.g., should the discovery be accidental or purposeful?), and what the goals of an Easter egg are (e.g., supporting the user when upset, educating the user each day). We present these in two tables.

Table B.1 summarizes the ways in which Easter eggs are typically hidden in the interface. After being triggered, Easter eggs often appear in plain sight in the main view of the application, or in their own dedicated screen or window. All Easter eggs listed as "inside graphic used by application" are also displayed in the main view of the application, but are specifically in the form of a static graphic. Table B.2 enumerates different user interaction methods that trigger Easter eggs. Triggers can use one method or a combination of methods.

Table B.1: Examples of places in which Easter eggs are hidden.

Hiding Place	Easter egg Examples	Num.
Inside graphic used by application	VLC Santa hat, VS Code Santa hat, Matlab's "spy", Matlab's "image", Microsoft Office Clippy background, 3 *D2* Easter eggs	8
Inside debugging output	recruitment via web browser developer tools	1
On the main view of the application	Google Doodles, GIMP's "Goat-exercise", humorous Google Search results, *apt-get* "moo", *man* Easter egg, After Effects "Mask Embiggen", After Effects credits, Ant Design holiday theme, Excel's "=CAKE" function (fictitious), Matlab's "reshape", Matlab's "f***", *D1* Easter egg, 2 *D2* Easter eggs, *D4* Easter egg	15
In dedicated screen or window	Android version, Excel 97 flight simulator, "about" pages/Firefox's "about:mozilla", Firefox's "about:robots", "about:mozilla" page in Internet Explorer, Chrome dinosaur game, WordPress terms of service "treat", Windows "All Tasks" view, PHP version, AutoCAD's "CAD-PAC" (fictitious), Google Foobar, uTorrent's Tetris, Amazon Risher tribute, 2 *D2* Easter eggs, *D3* Easter egg	16
Sound	After Effects sheep sound	1

Table B.2: Examples of user interaction methods to trigger Easter eggs.

Method	Easter egg Examples	Num.
Clicking/tapping on an unexpected label or icon, often nested within a rarely used screen (e.g., an "About" screen)	Android version, WordPress terms of service "treat", Microsoft Office Clippy background, Amazon Risher tribute, *D1* Easter egg, *D2* Easter egg	6
Time: day of year (e.g., holidays), time of day (e.g., midnight), or random times	Google Doodles, VLC Santa hat, VS Code Santa hat, *man* Easter egg, Ant Design holiday theme, *D2* Easter egg	6
Entering a series of unlikely keystrokes or keyboard commands, sometimes into a form field	Excel 97 flight simulator, humorous Google Search results, "about" pages/Firefox's "about:mozilla", Firefox's "about:robots", "about:mozilla" page in Internet Explorer, Matlab's "spy", Matlab's "image", Chrome dinosaur game, AutoCAD's "CAD-PAC" (fictitious), Excel's "=CAKE" function (fictitious), Google Foobar, Matlab's "reshape", Matlab's "f***", uTorrent's Tetris, 2 *D2* Easter eggs, *D3* Easter egg, *D4* Easter egg	18
Opening a specific menu	GIMP's "Goat-exercise", recruitment via web browser developer tools, *D2* Easter egg	3
Running the program with specific command line parameters	*apt-get* "moo", Windows "All Tasks" view, PHP version	3
Holding down a modifier key (or keys) and clicking on an unexpected label or UI control	After Effects sheep sound, After Effects "Mask Embiggen", After Effects credits, 2 *D2* Easter eggs	5

C

BRAINSTORMING SESSION DIGITAL KNICK-KNACK TYPES AND EXAMPLES

Table C.1 provides a summary of participant examples generated in the brainstorming session, corresponding to the different digital knick-knack types and theoretical works described in the taxonomy.

Table C.1: Summary of participant examples from the brainstorming session.

Theoretical Work	Dimension	Examples
Csikszentmihalyi & Rochberg-Halton, Richins	Memories	meaningful media display (e.g., photos from one year ago)
	Associations	calendar events/reminders (e.g., list of upcoming religious holidays)
	Experience	help/suggestion system (e.g., recipe suggestions), note-taking (e.g., scratchpad for personal goals)
	Intrinsic qualities of object	N/A
	Style/appearance	self-representation (e.g., virtual fashion item representing self)
	Utilitarian	note-taking (e.g., digital movie journal)
	Personal values/identity	self-representation (e.g., virtual trophy)
	Interpersonal ties	informatic (e.g., heartbeat monitor of friend, visualization of most frequent contacts)
	Financial aspects	informatic (e.g., visualization of subscription costs, daily expenditures), playful notification (e.g., sound effects upon financial transactions)
Csikszentmihalyi & Rochberg-Halton	Personal	informatic (e.g., step counters, representation of facts about others in remote meeting)
	Social	informatic (e.g., public display of one's exercise amounts; displays of carbon dioxide emissions, stock prices), automation (e.g., tool for splitting prices)
	Cosmic	informatic (e.g., display of constellations), meaningful media display (e.g., display of nature images)
	Differentiation	informatic (e.g., visualization comparing friends' screen time), automation (e.g., grammar checking tool that accounts for personal style)
	Integration	informatic (e.g., visualize time spent with friend), automation (e.g., quick shortcuts to call contacts)
Richins	Instrumental	N/A
	Symbolic	N/A
	Ordinary	N/A
	Prestige	help/suggestion system (e.g., discount finding tool), self-representation (e.g., badges)

Theoretical Work	Dimension	Examples
	Necessities	automation (e.g., button to automatically order food), informatic (e.g., visualization of how often commands are used in an application)
	Recreational	self-representation (e.g., badges for gameplay), help/suggestion system (e.g., suggesting outdoor activities), embedded game (e.g., minigame activated as Easter egg)
Oulasvirta & Blom	Stabilization	informatic (e.g., visualization of most recently used commands)
	Interest	note-taking (e.g., place to collect snippets from the web)
	Exploration	playful notification (e.g., sound effect when finding a new application feature), help/suggestion system (e.g., suggesting rarely-used commands)
	Differentiation	help/suggestion system (e.g., tool for comparing commands in applications), automation (e.g., tool for creating further automations)
	Emotional expression	soundscape (e.g., system that plays background music based on mood), informatic (e.g., stress level visualization)
	Ego-involvement	informatic (e.g., visualization of how frequently contacts typically respond)
	Territory marking	calendar events/reminders (e.g., a public calendar highlights how one is feeling each day)
McCracken	Exchange rituals	calendar events/reminders (e.g., list of items that need to be returned to others), meaningful media display (e.g., digital postcards), informatic (e.g., visualization of what application commands friends frequently use)
	Possession rituals	self-representation (e.g., badges), automation (e.g., button to delete unused apps), informatic (e.g., visualization of how often commands are used in an application)
	Grooming rituals	help/suggestion system (e.g., tool to suggest outfits based on weather and current trends)
	Divestment rituals	playful notification (e.g., brief visual indicators of file actions), note-taking (e.g., digital whiteboard with 'clear all' function)
Tian & Belk	Prosthetic possessions	N/A
	Atmospheric texture	help/suggestion system (e.g., guide that shows coding rules and best practices), soundscape (e.g., system playing ambient coffee shop sounds), automation (e.g., tool for blocking notifications)
	Identification with corporate self	N/A
	Sense of past and sense of future	meaningful media display (e.g., showing motivational quote)
	Possessions for play	playful notification (e.g., animated flying bird animation when sending emails), automation (e.g., tool to monitor dog and automatically dispense food), embedded game (e.g., minigame activated by accomplishing important tasks), virtual assistant/pet (e.g., virtual pet)

Theoretical Work	Dimension	Examples
	Work self and home self	meaningful media display (e.g., real-time display of child's drawings), automation (e.g., tool to monitor home)
Belk	Dematerialization	N/A
	Reembodiment	meaningful media display (e.g., digital yearbook photos), informatic (e.g., visualization of fitness achievements), note-taking (e.g., place to list out New Year's resolutions)
	Sharing	informatic (e.g., visualization of time spent using software)
	Co-construction of self	self-representation (e.g., avatar with representation based on online communication quality), virtual assistant/pet (e.g., virtual friend that provides encouragement)
	Distributed memory	automation (e.g., tool to ask others online how to do something), meaningful media display (e.g., collage combining personal and friend's photos)