Beyond Cute: Exploring User Types and Design Opportunities of Virtual Reality Pet Games

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ABSTRACT

Virtual pet games, such as handheld games like *Tamagotchi* or video games like *Petz*, provide players with artificial pet companions or entertaining pet-raising simulations. Prior research has found that virtual pets have the potential to promote learning, collaboration, and empathy among users. While virtual reality (VR) has become an increasingly popular game medium, little is known about users' expectations regarding game avatars, gameplay, and environments for VR-enabled pet games. We surveyed 780 respondents in an online survey and interviewed 30 participants to understand users' motivation, preferences, and game behavior in pet games played on various medium, and their expectations for VR pet games. Based on our findings, we generated three user types that reflect users' preferences and gameplay styles in VR pet games. We use these types to highlight key design opportunities and recommendations for VR pet games.

CCS CONCEPTS

• **Human-centered computing** → **User evaluation**; • **Applied computing** → **Game design**

KEYWORDS

Virtual Reality, Virtual Pet, Pet Game, User Types.

1 INTRODUCTION

Playing video games is a complex, entertaining, and highly rewarding activity for many users. Games are often considered an idle pastime, but have been shown to offer many potential benefits in cognitive, motivational, emotional, and social domains [Granic et al. 2014]. The games we focus on in this paper are *pet games*, where the player controls, accompanies, or interacts with virtual pets. Research has found that virtual pets can be used in lieu of real pets as artificial companions or for therapy [Adams and Hannaford 1999]. These applications often mimic existing animal services. For example, some people use animal-assisted therapy, a type of therapy using real animals, as a form of treatment to improve their social, emotional, or cognitive functioning. Virtual pets may be a valuable alternative for those who are not able to access real animals, due to physical, psychological or practical restrictions [Lin et al. 2017]. However, no prior research describes who is attracted to pet elements in games, and how users' engagement with pet games varies with their game-playing style.

Game experiences are heavily dependent on technological advancements. Video games on different platforms, from PCs to augmented reality systems, offer different levels of immersion to players. Specifically, a user's engagement with a game is limited by the input devices of the platform, which can range from low-fidelity buttons to high-fidelity motion sensors. Moreover, evolving technologies reshape user's expectations for their game experience. Prior research with a focus on users of pet games, especially in extremely immersive VR environments, has been scarce. Leveraging the recent widespread release of commercial VR headsets, we focus on exploring how VR technology may

shape user's expectations of game experiences with virtual pets in VR, and investigate the challenges of VR pet game design.

In this paper, we integrate findings from a survey study (n=780) and in-person interviews (n=30) to map the features of users who are attracted to pet-related games, such as their play motivation, preferences, and behavior, and explore their expectations of VR pet games. Survey respondents described their prior and desired experience with pet games. Based on their responses, we had interview participants play three commercial VR games, *Vesper Peak*, *Secret Shop* and *Lava Tube*, with a HTC Vive headset right before they were interviewed to provoke them to consider what experiences VR games might support.

We describe three key findings related to users' preferences for VR pet games. First, we articulate key factors which motivate pet game adoption and abandonment. Second, we detailed three user types of VR pet game players, based on user's motivations and expectations: (1) *pet-keepers*, (2) *animal teammates*, and (3) *cool hunters*. Lastly, we highlight key design opportunities and recommendations for the future development of VR pet games.

2 RELATED WORK

Below, we describe applications of VR technology, studies of virtual pet games, and classifications of user types in games.

2.1 Virtual Reality

Virtual reality (VR) refers to computer technologies that simulate a user's physical presence in a virtual environment via *VR headsets*, head-mounted goggles which generate realistic images and sounds that simulate a user's physical presence in the virtual world. Users of VR equipment can interact with virtual items via controllers, which may provide the user with haptic feedback, or other input like gestures. VR is especially powerful for its' ability to render an extremely immersive environment, which has great potential for the field of video games [Padgett et al. 2005], healthcare and clinical therapies [Venson et al. 2016], education and training [Brown and Green 2016], entertainment [Bates 1992], and other fields. While our study explores user features of all pet games based on various technologies, we primarily focus on investigating whether and how VR technology may impact a user's expectations in playing VR pet games.

2.2 Virtual Pet Games

A *virtual pet game* refers to a video game of a pet-raising simulation. Featured gameplay of these games focuses on the care, raising, breeding of virtual pets. The first widely popular virtual pet game is *Petz*, a series of single-player video games where users can adopt, raise, care for and breed their own pets. Handheld virtual pet simulation games, like *Tamagotchi* (1996), were extremely popular in the 1990s. Virtual pet games exist on various technologies and platforms, including console or handheld games (*e.g.*, *Nintendogs*), social network games (*e.g.*, Pet Society on Facebook), mobile games (*e.g.*, *My Talking Tom*), PC or computer games (*e.g.*, *Zoo Tycoon*), browser-based games (*e.g.*, *Neopets*) and augmented reality games (*e.g.*, *Pokémon Go*).

Prior research has explored the derived value of virtual pet games to their players. Apart from giving companionship to users [Wilks 2010], virtual pet games have been applied as effective applications to promote user's physical and psychological health (*e.g.*, healthy eating [Byrne et al. 2012], asthma self-management [Lee et al. 2010], increasing social interaction [Pering 2002], and learning social norms and behavior [Hildmann et al. 2008]).

To strengthen the effectiveness of these interventions, researchers have developed a suite of design methods specific to building game experiences. Concepts such as creating emotional relationship with virtual characters [Kasap et al. 2009; Rolls et al. 2003], building believable agents with narrative intelligence [Stern 1999] and storytelling [Swain 2008], have been used. However, few studies focus on the users who are attracted by games that incorporate pet elements. Understanding user characteristics, including their motivation, in-game behavior and preference, is important to the game design process.

2.3 User Types in Games

Research on game users aims to understand why users enjoy a game, and what parts of games are most compelling for them, to create effective and engaging game experiences. *User types* in games are taxonomies or models that define features of users in game environments. Bartle identified four main character types for massively-multiplayer online games (MMOGs) – Achievers, Explorers, Socializers, and Killers – based on gaming preferences [Bartle 1996]. Marczewski created a similar five user type system for a broader range of games (Philanthropist, Free Spirit, Player, Socializer, Achiever) [Marczewski 2015]. Other player analyses focus on specific games. Xu *et al.* identified five player types along the dimensions of motivation, behavior, and influence on others in their study on multiplayer pervasive health games for youth [Xu et al. 2012]. To our knowledge, there has been no previous work on user types in pet games or VR settings. In this paper, we attempted to identify user types for VR pet games based on dimensions of the user's motivation and preference for play.

3 METHODS

We conducted an online survey and a follow-up in-person lab study to investigate features of players interested in VR pet games, and what elements they desired in these games. The online survey played two roles in influencing our lab study design. First, it guided the procedure design of our lab study (*e.g.*, since the survey revealed that most people had not used VR games before, we added an introduction to of VR and initial game exploration for users before the interviews). Second, the survey guided questions in the semi-structured interview by giving us a broad picture of users' prior pet game experiences.

3.1 Survey

The online survey included three sections. The first section collected participant demographics. The second section collected participant's game-playing habits (*e.g.*, time playing games per

Figure 1: Left to right, in-game scenes from *Vesper Peak*, *Secret Shop*, and *Lava Tube*, and a user playing the VR games.

week), motivations (*e.g.*, why they play games/pet games), behaviors (*e.g.*, how much they would like to control or interfere with the game world), desired game elements (*e.g.*, elements of the games that attracted them the most), experience with general games and, if any, pet games (*e.g.*, what pet-related games are their favorite). The third section evaluated participant's connection to and relationship with animals in real life (*e.g.*, how easily can they recognize different pet's personalities) and their experience with real pets (*e.g.*, are they a pet owner).

The survey was distributed on social media platforms including Facebook, Twitter, Reddit, and discussion boards on game forums. Respondents for the survey had to be over eighteen years old and interested in playing VR pet games, and are identified as R# throughout the paper. On average, it took respondents 5 to 12 minutes to complete the survey. Respondents were incentivized by offering a $5 virtual gift card to the first 200 participants who completed the survey. Distribution began on March 1, 2017, and total survey respondents reached 780 by June 28. The full completion rate of the survey was 74% (n=578), but we analyzed all complete question responses, removing incomplete responses on a response-by-response basis. We used descriptive statistics to code quantitative data, and used affinity diagrams [Beyer and Holtzblatt 1997] to code qualitative data.

3.2 Lab Study

The lab study included two parts. First, participants were asked to play three VR games with an HTC Vive headset and two controllers. Before playing the VR games, participant received a brief introduction to the VR equipment and were informed that they were allowed to explore the games freely. Participants could play each game for up to 5 minutes, or tell the researcher to go to the next game when they wanted. We set the maximum time of playing because we found in pilot studies that it was sufficient for participants to get the idea of the potential of VR games without fatiguing them for the interviews that followed.

The three VR games we chose for the lab study were *Vesper Peak*, *Secret Shop*, and *Lava Tube*, displayed in Figure 1, from Valve Corporation's "The Lab" collection. We chose these games because they included various animal-related avatars, such as animals with abstract appearances such as a capsule dog, or with concrete appearances such as an octopus. All games were open world, so that participants could explore without distraction.

The second part of the lab study was a 20 to 40-minute interview conducted after the participant had played the three

VR games. Interview questions focused on participants' previous pet game experience (*e.g.*, what pet games have they played and why) and preferences emerging from their VR experience (*e.g.*, what VR pet games would they expect to play and why).

Individuals older than eighteen years of age with an interest in VR pet games were invited to participate our lab study, and are identified as P# throughout the paper. No VR experience was required. Participants were compensated with a $15 Amazon virtual gift card. From March 28, 2017 to April 4, 30 students and alumni from Indiana University participated in the lab study in our virtual reality lab. 16 participants were female and 14 were male, aged between 19 and 37 years old with a mean age around 26 years old (one female participant only provided her age range, 20 to 30). 24 had never used VR before, and the other six had only used VR once or twice. Eighteen participants were current or former pet owners. Interviews were recorded and transcribed by the primary researcher who conducted the lab study. This researcher performed an affinity diagramming process on the observations and notes from the lab sessions. Codes generated in this process were then reviewed and refined with two additional researchers through iterative meetings to resolve disagreements.

4 FINDINGS AND ANALYSIS

In this section, we first introduce the general features of users who are interested in playing pet games based on data from both the online survey and interviews. Then, we articulate three user types of VR pet game players which emerged from the studies.

We allowed participants to define the term 'pet game' themselves, without providing them with a formal definition. As a result, some games mentioned in this section may not considered to be conventional pet games, but were defined that way by our participants. For example, some participants considered *World of Warcraft* (2004), a massively multiplayer online role-playing game, as a pet game because of the virtual pets you can tame in it.

An initial analysis of the survey and lab experiment described how affective bonds were formed between VR players and virtual pets, and tested for statistical differences between motivation, perception, and affective response between pet owners and non-owners [Lin et al. 2017]. This paper qualitatively builds on that analysis to identify specific demographic characteristics and user types that may impact how players interact with virtual pets. Occasionally throughout the results, we will reference quantitative findings from [Lin et al. 2017] to support the new findings presented in this paper.

Table 1: The top ten pet games mentioned by participants

Rank	Name of the game	Platform(s)	Input	Pet Related Gameplay
1	*Petz*	PC	Mouse, keyboard	Players adopt, raise, care for and breed their own pets.
2	*Nintendogs*	Handheld console	Touchscreen, microphone	Players play with, train, pet, walk, brush, and wash a dog.
3	*Pokémon Go*	Augmented reality, game for mobile	Touchscreen	Players physically travel to locate, capture, battle, and train creatures (using geo-location on the mobile phone).
4	*Tamagotchi*	Handheld, keychain-sized computer	Buttons	Players adopt, raise, care for and breed their own pets.
5	*Neopets*	Web game	Mouse, keyboard	Players create, care for pets and explore the virtual world.
6	*The Sims Pets*	Cross-platform	Controllers	Players create pets, then embark on adventures with them.
7	*Digimon*	Handheld, keychain-sized computer	Buttons	Players care for and train their pets, then make them battle with another owner's pet.
8	*Sonic Adventure 2*	Cross-platform	Controllers	Players choose to advance in either one of two storylines.
9	*Kinectimals*	Cross-platform	Kinect	Players feed, play with, care, and raise the pets.
10	*Animal Crossing*	Cross-platform	Controllers	Players live in a village inhabited by anthropomorphic animals, and perform various activities (e.g., fossil hunting)

4.1 Users of Pet Games

One goal of this study was to describe general features of users interested in playing pet-related games. We specially focus on demographics, pet games users enjoyed most, factors that led to adoption and abandonment of a pet game, and what patterns may exist in these users' in-game behavior and preferences.

4.1.1 Overview of Demographics

In total, 780 adults from 31 countries responded to our survey. The majority (87.77%) of the sample was from United State (U.S.). 91% were between 18 to 35 years of age. Overall, female participants were younger than male ones. The primary age group of females was 18 to 25 (51.28%, n=140) followed by 31 to 35 (22.34%, n=61), while males were 18 to 25 (35.42%, n=164) followed slightly by 31 to 35 (31.10%, n=144). More respondents were male (62.90%, n=468) than female (36.69%, n=273); and were in a relationship (dating, engaged, and married, 61.96%) than were single (38.04%). Many respondents (51.02%) had higher education degrees (*i.e.*, bachelor, master, Ph.D.) while 48.03% of them had graduated high school or equivalent. The majority were either full-time professionals (46.40%) or students (33.24%), while the rest were part-time workers (14.52%), stay-at-home parents (3.53%), and unemployed or retired (2.31%).

4.1.2 Game Experiences

64.50% (n=467) of our survey respondents reported that they had played pet-related games while 35.50% (n=257) had not. The top three reasons for not having played pet-related games were: (1) "I don't have time." (34.17%, n=95), (2) "something related to my personal experience." (29.86%, n=83), and (3) "I haven't found the one I like" (24.10%, n=67). For users who have played pet-related games, a total of 98 games were mentioned as their favorite ones, the top ten of which are described in Table 1. We extend our analysis on users' game experiences in two dimensions: (1) why do users play pet games? and (2) why do users stop playing pet games?

Why Do Users Play Pet Games?

Four themes emerged when participants explained the factors that motivated them to play pet games: (1) getting access to animals, (2) getting emotional support, (3) learning, and (4) to kill time. While (1) and (2) were briefly described in [Lin et al. 2017], we elaborate on participant motivations here.

(1) Access to animals: Most of our participants claimed that they played pet games specifically because they loved the pet elements in games. This statement was common in both pet owners and non-pet owners. However, animal lovers who were currently living without pets were slightly less into playing pet games (mean = 3.75) than those who were physically living with real pets (mean = 3.78). Some participants mentioned that they played pet games to make up for the fact that they couldn't have real animals due to factors like allergies, geographical separation, or commitment issues. For example, P20 (female, 24) played pet games when she was a kid because she had a very bad allergy at that time. She said "*when I was about 12 years old, people around me had their own pets. So, I'd like to have a Tamagotchi.*" When she was in undergraduate, she played *Sonic Adventure* because her real pet dog was not around. In her words, "*it [playing pet games] filled the gap in my heart when I want to play with animal.*"

Some users played pet games simply because they would like to have more pets in real life, but could not take the risk or spend the necessary time taking care of real ones. As P14 (male, 28) explained:

> "*There are a lot of games that have dogs. I play these games since I love dogs. I felt they are the only animals that understand you most. And also, these games are designed in that way. They understand you in the game. ... you can command them to like go fetching, fetch something for you, secretly kill animals and come back to you. I play these dog games two hours a day.*"

P23 (female, 31) played *Nintencats* as a way of playing with cats, since her real pet dog hated cats and she could not own one. P22 (female, 30) played *Tamagotchi* and enjoyed the fact that:

"I don't need to get up to clean it, feed it or else and then I made the virtual pet happy! I just click the button and magic happens!"

All of these participants spent time playing pet games as a way of getting access to animals.

(2) Emotional support: The emotional support received from pet ownership was another specific factor that motived animal lovers to play virtual pet games. A certain number of participants played pet games to relax, control their emotion, take responsibility, feel accomplishment, and so on. For example, P11 (female, 23), who played *Pokémon Go* when she felt stressed out due to work said that *"it gives me a fresh moment when I play Pokémon Go."* P25 (female, 27) has anxiety, which often makes her experience states of panic. So, she played *Animal Crossing* and talked to the *'adorable'* animals in the game which helped her relax and calm down. P26 (male, 19) who played *Nintendogs* enjoyed the positive emotional feedback from nursing virtual pets:

"I have sort of a responsibility which I enjoy having over these pets. I always treat them as my own children. And I get so much positive response from these creatures which is very encouraging to keep playing. They love me."

Among different types of emotional motivators, the accomplishment gained from various in-game activities (e.g., building, training, fighting, etc.) was most frequently mentioned by participants. For P19 (male, 25), although he loved having tons of animals in games, what primarily engaged him in playing pet games was the sense of accomplishment he could receive. He illustrated that by saying:

"[In Zoo Tycoon,] I build the habitats for the animals and let them live comfortably. After build the habitats, I felt success. Imagining you build everything there and you set a price for people coming to the zoo. The better your zoo is, the more people will come. I have stopped playing this game since it is updated. Their newer game doesn't give me the sense of accomplishment and success."

Similarly, P27 (female, 20) who played *Nintendog* enjoyed the experience of *"training the animals for competition in the game to gain accomplishment"*. P21 (female, 23) who was living with four real dogs, has continued playing games from the *Pokémon Series* for 18 years since she wanted to be a Pokémon master, a symbol of success in the game. She explained why she was not able to gain this same kind of achievement in her real life:

"They have different abilities and can fight each other. In real life, you can't have the animals fought - they will get hurt. In the game if they get hurt, you can take them to hospital and they will be healed in five minutes."

(3) Learning: Learning is the third explicit theme that reflects why users engage in playing pet games. Unsurprisingly, users can learn how to take care of real pets in these pet games, as a lot of pet games provide them with explicit pet ownership simulations. However, some users playing pet games actually intended to learn social skills, not pet ownership skills. In P17

(male, 29, *Nintendogs*, *Tamagotchi*, *Pokémon Go*, *Sims*, etc.)'s words:

"[my favorite part in pet games is] seeing how they [virtual pets] interact with the world and how they learn things and grow. Like Sims game - it is about how to interact with virtual people. Sometimes interacting with pet just like interacting with people. They have their own personalities."

(4) Killing time: Last but not least, a certain number of users played pet games simply to kill time. This motivation may be attributed to the simplistic gameplay of most pet-related games. P13 (female, 26) explained that she played a phone pet game to kill time because the animal avatars were cute, and the game did not require her to do much in order to play. P6 (female, 22) described a story of how she decided to play *Horse*, saying:

"I played, I stopped, then I played again. Because I was bored. I was sitting on my bed. I couldn't figure out too much what should I do, what can I do, and then I thought, 'oh, why not play this game?'"

Why Do Users Stop Playing Pet Games?

The above quote illustrates that users often *abandon,* or quit playing, pet games they have used. Three key factors we found to be frequently related to game abandonment were respectively: (1) repetitive and dull in-game activities, (2) lack of attachment to virtual pets, and (3) distractions outside the virtual world.

(1) Repetition: Most participants blamed their pet game abandonment on the repetition and dullness of in-game activities. P6 (female, 22) explained why she stopped playing *Nintendog* was that she got bored very easily because after she passed all the tests in the game, all she could do was care of the dogs she already owned or adopt more dogs, but *"nothing new will happen"*. P11 (female, 23), P13 (female, 26), and P17 (male, 29) provided similar reasons, noting that when they had tried out everything in the pet game, they felt bored and just stopped playing. In P11's description:

"With Pokémon Go, it is repetitive. I catch a Pokémon, then I catch another Pokémon - it is very repetitive. I think the repetition gets you bored after a while."

(2) No attachment: Lacking attachment to a virtual pet was another factor that led users to leave pet games. Users who play pet games as a way to get access to animals tended to seek experiences of raising virtual pets that were similar to raising a real pet. However, when conflicts between what the user expected and what they got from a game occurred, the user's goal will not be achieved, which led them to leave the game. P17 (male, 29) who had played several pet games including *Nintendogs*, *Tamagotchi*, *Pokémon Go*, *Sims*, etc. explained that the conflict was about emotional connections:

"...for the fun part and emotional support, virtual pet game can replace the real pet to some extent, but not at the same level. Companionship with a real pet is constant and healthier. You don't need to stare at the screen. A virtual pet has less emotional connections because it is not there in your life."

P18 (male, 30) also indicated the conflict of forming emotional connection, and attributed it to unsatisfactory animal avatar design. He described that the animal avatars in the pet games he played were just static images, and could not dynamically respond to a user's actions. R553 (female, 18-25) attributed the conflict specifically to the impassive behavior design of animal avatars, claiming that: "*They didn't have unique personalities, and they acted the same from when you have put a lot of time and effort into the dogs.*" On the other hand, some participants, such as P11 (female, 23), stated that they would never build emotional connections with virtual pets, since they knew that those virtual pets "have been programmed" and they were just virtual.

(3) Distractions: External distractions outside of the game world also played a significant role in the users' game abandonment. These distractions include having a real pet in life, physical or device issues, and so on. For example, P20 (female, 24), having played *Tamagotchi* since she was 12 years old, didn't go back to the pet game after she got a real pet. Her explanation, "*I have my real pet now which is always nice and keeps me company*", indicated that she stopped playing pet games due to the fact that she would no longer need to play them as substitutes for raising pets. P11 (female, 23) quit playing *Pokémon Go* since the game required users to physically walk a lot while she didn't like walking. P22 (female, 30) recalled that it was the bad battery life that made her reluctant to keep playing *Tamagotchi.* She complained that "*...the game caused high power consumption. I needed to recharge it again and again.*"

4.1.3 Game Preferences and Behavior Patterns

Apart from understanding users' motivations for adopting and abandoning pet games, we investigated their general in-game preferences and behavior patterns. Our survey showed that more users of pet games are attracted by gameplay (42,40%, n=187) than avatars (37.64%, n=166), both of which are followed by stories (7.26%, n=32), environment settings (5.67%, n=25), and music (2.04%, n=9) in games.

Moreover, as displayed in Table 2, our survey data showed that users of pet games are more explorers and socializers than achievers and killers basing on Bartle taxonomy of player types

Table 2. Survey respondent's Likert scores to Bartle's taxonomy indicate that they are significantly more likely to be explorers and socializers than achievers and killers.

Player types	Attributes	Mean
Explorer	Players who prefer to discover areas, creating maps and learning about hidden places.	3.88
Socializer	Players who prefer to interact with other players or computer-controlled characters with personality.	3.81
Achiever	Players who prefer to gain "points", levels, equipment and other concrete measurements of succeeding in a game.	3.54
Killer	Players who prefer to compete with other players or interfere them.	3.56

[Bartle 1996]. There was a statistically significant difference in Bartlett player type scores, $\chi^2(3)$ = 79.3, p < 0.05 (using a Friedman's test for non-parametric data). Post-hoc Wilcoxon signed rank tests (with a Bonferroni correction) indicated that there was no significant difference between likelihood to identify as an Achiever and Killer-type player (Z=-0.714, p=0.475) or as a Socializer and Explorer-type player (Z=-1.749, p=0.08), but players were significantly more likely to identify as an Explorer than a Killer (Z=-5.226), as a Socializer than a Killer (Z=-5.254), as an Explorer than an Achiever (Z=-7.099), and as a Socializer than an Achiever (Z=-5.596), with p < 0.0083 for all comparisons.

4.2 User Types of Virtual Reality Pet Games

Based on the open-ended responses from both the surveys and interviews, we found three typical user types differentiated by the game elements users were looking for in VR environments. We have named these three types *Pet-keepers*, *Animal Teammates*, and *Cool Hunters*. We do not provide the proportion for each user type among our respondents, since these types are based on qualitative, rather than quantitative, classification. These types are not necessarily exclusive of each other, and a single user may present several characteristics that belong to different user types at the same time. For example, participants categorized into the type *Pet-keepers* based on their primary motivations may have extra expectations that fall into one of the other user types. Third, we assume that one's user type may change over time, a consideration which should be explored further by future work.

In this section, we present each user type through the following two dimensions: player motivation, and preferences for game elements (*e.g.*, avatar, gameplay, and environment setting, etc.). Additionally, we provide suggestions for VR pet game design strategies for each specific user type. Given that a single user may present several characteristics belonging to different user types, the design recommendations should similarly not be considered as mutually exclusive.

4.2.1 Pet-Keepers

We defined *pet-keepers* to be the group of users who keep virtual animals primarily as substitution of real pets. *Pet-keepers* enjoyed the fact that "they don't need to have a real pet" (P7, male, 19). *Pet-keepers* pay attention to the simulated interactions between themselves and their virtual pets, by performing actions like feeding pets, petting pets, and taking care of pets, and essentially tend to build emotional connections and attachment with their virtual pets.

Pet-keepers indicated that it is not only fun and entertaining to play with a virtual pet, but also it fills an emotional gap for them. As P10 (female, 24) noted,

"*[In Vesper Peak] I love the fact that when you move around with a stick, the dog follows you and jumps to get it. It makes me very happy watching a dog. I can't own a real one.*"

P18 (male, 30), an international student who missed his own dog in his home country, said that he would like to play a VR pet game because he found that:

"Playing this VR game [Vesper Peak] evokes in me the memory of my dog. The evoked memory makes me feel better when I am stress-full."

P12 (female, 29), stated that having a virtual pet didn't require you to take on responsibility, and you can *"go to play and have fun for an hour and then come back."*

Although *Pet-keepers* look forward to playing VR pet games as an alternate way to enjoy the ownership of pets, based on the fact that VR technology has the potential to offer users the most immersive experience among state-of-the-art technologies, they indicated that a virtual pet may not be a complete replacement for a real pet. For *pet-keepers*, the main differences between keeping a virtual pet and a real pet are about responsibility and attachment. P8 (male, 24) explained that *"If you forget your virtual pet, nothing happens. If you forget a real pet, that's bad."* Also, since getting access to a VR pet requires users to put on a headset, the companionship of the virtual pet can be interrupted. Without commitment and constant companionship, the user-virtual pet bond may be weak. In P9 (male, 22)'s words, *"With a virtual dog, there is no actual living thing. It is fun, but since it is not actually there, there is no emotional attachment with it."*

Game Elements Preference

Pet-keepers show diverse interests in the types of animals they desire to raise as pets in VR environment. Specifically, there are three types of animals that *Pet-keepers* would like to own, namely general household pets (*e.g.*, dogs, cats), wildlife (*e.g.*, lions, wolves) and fantasy animals (*e.g.*, dragons, jackalopes). *Pet-keepers'* pet preferences are affected by their expectations for the interactions with a virtual pet. For example, P7 (male, 19) looked for a VR dog rather than VR cat because *"it is an animal that we can interact with so much more than a cat".* Some *Pet-keepers* who look for wildlife and fantasy animals explained that it was because they couldn't interact with them in real life (P18, male, 30 and P28, female, 20). P13 (female, 26) noted that having something she didn't see in daily life *"is the point of game. You expect something not real so you can have fun."*

Pet-keepers care about their interactions with virtual pets. As a result, they expect virtual pets to be as responsive as possible, which may contribute to the formation of a user-virtual pet bond [Lin et al. 2017]. These expectations mostly originate from their experiences with real animals. *Pet-keepers* were interested to see how a VR pet responds to their physical contact, voice, or body movements. Specific interactions with VR pets can be classified into two main themes: nursing (*e.g.*, feeding, washing) and training (*e.g.*, teach a pet to sit). In P10 (female, 24)'s words, *"I'd also like to command the dog or the animal to sit or roll over or something like that. It is very easy to make me happy."*

Additionally, *pet-keepers* would like to be able to tell the differences between distinctive personalities and emotional states of virtual pets based on their responses to diverse styles of interactions. As P22 (female, 30) noted,

"[I expect to see] each animal has its own personality. They react to the same object differently. For example, my dog doesn't care about fetch, but the other will play fetch."

P25 (female, 27) hoped that a virtual pet would be able to react to the emotion state of the user's voice, as she explained,

"Real dog can recognize the motion of your voice. When you say 'Raggie' [the name of the participant's dog] with a happy tone, he will know you are happy. I think it will be very cool if it is cooperated with VR."

The third significant game element that mentioned frequently by *pet-keepers* was sociability. *Pet-keepers* desire to meet other players and interact with them. As P6 (female, 22) stated, *"I expect to meet other people and animals in the game. I'd like to play with my friends in the same game. It could be fun!"* P11 (female, 23) illustrated that

"I will prefer to play with other participants in such environment as a park where there is a lot of people with dogs. I'd like to interact with other ones. I will feel like I am not alone in the game and feel more natural."

Last but not least, *pet-keepers* expect to customize their virtual pets as well as the environmental settings, which to some extent reflects that they are seeking a personalized experience in VR. For example, P22 (female, 30) expect customizations on breeds, coloration, curly tail or straight tail of a virtual dog to make it "more personally", and she hoped that *"the decoration of the pet matches the owner. So, different owners will have matched animals in the game."* P23 (female, 31) noted that *"Nintendogs is nice since people can choose the breed of dog that people want the most, such as husky."*

Design Recommendations

We recommend that pet game designers should give priority to providing *pet-keepers* with personalized experiences in VR pet games. For example, providing various breeds and personalities of animals (either real and imagined) so that users can choose from them according to their own interests. Additionally, gameplay features, such as giving options for users to groom pets or enable users to train pets in their own way, will help establish connections between *pet-keepers* and their virtual pets.

Based on our findings about pet game abandonment, we suggest that designers avoid repetitive physical interactions between users and pets. More dynamic mechanisms, such as making virtual pets respond differently or randomly to user's verbal commands, gestures, pose, or emotions, may greatly improve the sense of reality and immersive experience. These suggestions align with flow theory, which has been applied widely in video game design for decades to help players achieve the feeling of complete and energized focus in game worlds, with high level of enjoyment and fulfilment [Csikszentmihalyi 1996]. Technology such as haptic interaction [Adams and Hannaford 1999; Richard et al. 2006], olfaction sensors [Chen 2006; Richard et al. 2006] and taste sensors [Narumi et al. 2011] that enable five-senses based interaction (*i.e.*, sight, hearing, touch, taste, and smell) are ideal to be applied into VR pet games. In these ways, users will be able to touch, pet, or even smell the virtual animals. These design strategies will help build lifelike pet ownership simulations and will keep users from getting bored easily.

Finally, we suggest adding sociability to VR pet games which may keep *pet-keepers* engaged. For instance, integrating social techniques such as providing multi-player scenes [Manninen 2000] where *pet-keepers* can share thoughts or feelings with each other in the game.

4.2.2 Animal Teammates

Animal teammates refer to a group of users who enjoy the partnership or companionship of virtual pets when they are performing activities or exploring in games. The virtual pets may either help users fulfil tasks, or keep them company. While partnership with animal avatars is not uncommon in existing pet-related games, *animal teammates* highlight the companionship that is possible in VR environment, as our participants reported that it was easier to feel lonely in VR settings than in general video game worlds. Although *animal teammates* do not focus on the caretaking-style interactions with pets in the VR game world, virtual pets still play a significant role in their engagement when playing VR games. For example, P27 (female, 20), who wanted to perform in-game activities with a virtual cat, indicated that "*I like [real] cats. But cats don't do a lot of human activities. They don't care about adventures with humans.*" P12 (female, 29) expected: "*...something like being alone on a planet with a dog or shooting zombies with a dog... achieving a target with a dog will be fun*".

Game Element Preferences

Animal teammates desired specific goal-oriented gameplay in VR pet games, and otherwise may feel lost. For example, while P2 (male, 34) appreciated that there was a dog in *Vesper Peak* which engaged him to explore the open world further, he kept feeling confused about the objective of the game, and suggested that "*there should be a specific goal in the game. Otherwise it should not count as a 'game'.*" For this user, the pet's presence was not sufficient to create an engaging gameplay experience.

In terms of virtual pet selection, *animal teammates* tend to choose fantasy animals, such as dragons or "some made-up creatures like Harry Potter's" (P19, male, 25); or large animals such as horses as their teammates. All of these animals have extraordinary abilities to help *animal teammates* complete their tasks or objectives in VR pet games, and are dissimilar from domestic house-pets. As P5 (male, 23) illustrated,

"*I'd like the dog to be bigger and response to my command when I am climbing the mountain. Like 'can you pull me up?' If I can sit on the dog to roam to everywhere - oh my god, that will be so cool!*"

Likewise, P15 (male, 26) imagined:

"*a pet helps you adventure......that would be amazing if you can jump up on a huge animal and it takes you to other places. You can control the pet, pat its neck and say, 'this way, this way.'*"

Although *animal teammates* and *pet-keepers* enjoy different features of VR pet games, they have certain similar preferences about the virtual pets themselves. For instance, *animal*

teammates, like *pet-keepers*, prefer to customize their own pets, to meet a lot of pets and other players in VR, and to receive emotional responses from their virtual pets. P19 (male, 25) described that, when the virtual pets were accompanying him in performing in-game tasks, he:

"*expect[s] them to have a wide range of emotions. Betrayal, hungry, sad, a bunch of emotion styles that a real dog will have, especially when given scenarios...*"

He desired a lot of attention from the virtual pets, and wanted to fulfil their needs in a similar manner to *pet-keepers*.

Design Recommendations

We recommend that pet game designers provide *animal teammates* with task-oriented gameplay in VR pet games. Specific tasks could include traveling to designated destinations, removing barriers or building for surviving, or collecting inventory items for in-game barter, as suggested by some of our respondents. Additionally, we encourage designers to give users explicit directions on in-game tasks and feedbacks to prevent *animal teammates* from getting lost.

Regarding the game character design, giant, magical or intelligent animals with different levels of power or capabilities to assist users to carry out in-game tasks may be attractive to most *animal teammates*. We assume that adding fantasy or Sci-Fi elements to VR pet games may be helpful to transcend the player's sense of reality to some extent. We also encourage designers to pay attention to strategies that help improve emotional bonds between *animal teammates* and their virtual pets that maintain their comradeship.

4.2.3 Cool Hunters

We defined *cool hunters* to be users who keen on hunting for or collecting animals in the VR game world. Differ from *pet-keepers* who enjoy owning a virtual pet, and *animal teammates* who considered virtual pets as their assistants, *cool hunters* especially enjoy the journey of discovering and collecting virtual animals in a VR world itself.

Game Element Preferences

Cool hunters expect to play sandbox-like games in VR where they are allowed to roam freely. They enjoy the "*surprise moment*" of coming across a virtual pet in their journey. Most of them prefer outdoor settings to indoor ones for the in-game environment because of outdoor settings' larger scale. Typically, there should not be linear level goals or concrete ends to an open-world because *cool hunters* want to enjoy considerable freedom in their pursuit to discover and collect virtual animals.

For most *cool hunters*, taming unnatural fantasy or sci-fi animals to become their pets is the one of most appealing activities. Specific in-game activities that *cool hunters* expect to do with virtual pets include gathering or hunting food for them to build trust bonds, training pets to help them upgrade, and so on. R215 (female, 31-35) imagined the way she would like to tame an animal she caught in VR world as "*showing your pet how to do something by doing that yourself*" and "*changing the*

Table 3. User types, user preferences, and design focus of virtual reality pet games

User Type	Motivation of Playing Pet Games	Preference on Animal Avatars	Preference on Game Activities	Design Focus
Pet-Keepers	Keep virtual animals as substitution of real pets.	General household pet, wildlife, or fantasy animal.	Nursing pets, customizing pets, and social activities with other players.	Rich physical interaction, believable behavioral algorithms, evolutionary personalities, customizability, sociability.
Animal Teammates	Enjoy the partnership of virtual pets while performing activities.	Giant, magical or intelligent animal.	Cooperation with pets to carry out in-game tasks.	Task system, comradeship between users and their pets.
Cool Hunters	Enjoy the journey of discovering virtual animals.	Unnatural fantasy or Sci-Fi animals.	Exploring the world, discovering animals and taming them.	Open world, user-generated story, in-game teleportation.

personality of your pet by showing it what to do and what to avoid, punishing or giving a treat". Another example made by R215 was "*teaching a young fairy dragon to mix two colors of magic to produce a fireball or to heal a withering flower*". While similar to the desires of *pet-keepers* in this regard, these players prefer to continue improving or refining their pets, rather than repetitively meeting their pet's basic needs.

Design Recommendations

We recommend that designers create sandbox-like pet games in VR for *cool hunters,* where they are allowed to explore the virtual world without any restrictions or rules. This expectation implies that getting access to new places will be an important component of in-game activities. Accordingly, we go further to suggest designers to optimize the experience of travelling in VR worlds. For example, enabling users to teleport to as many areas in sight as possible in the virtual world, enabling users to teleport with voice command, improving and polishing the environmental setting, and so on would keep these users engaged in the experience of seeking out new pets.

Apart from paying attention to the game scenes and teleportation, a user-generated story reflecting the transition from taming a wild animal to one's own pet may be appealing for *cool hunters*. Accordingly, we recommend that the virtual animals present noticeable developmental and emotional states over time, keeping the user engaged with the pet and avoiding repetition.

5 DISCUSSION

We first investigated the aspects in existing pet games that users were satisfied or unsatisfied with, and users' in-game preferences and behavior patterns. We then focused on different users' motivations and expectations in playing VR pet games, and integrated lessons learnt from the first phase of research to generate design a number of design recommendations for each of the user types - *pet-keepers, animal teammates, and cool hunters* - we identified for VR pet game players.

5.1 Challenges and Opportunities

Our understanding of these user types can help motivate novel understanding of human interactions and practices while using VR technology, and can inform the technical development of new VR and AR experiences.

Both *pet-keepers* and *animal teammates* expressed a desire to supplement offline social relationships through their interactions with virtual reality pets. This interest in social relationships with VR agents raises challenging questions and opportunities for virtual pet design. Little is currently know about how these relationships form and evolve, and how they may be used to motivate other pro-social or pro-health behaviors (as in [Xu et al. 2012]). Additionally, forming strong affective relationships with virtual pets may cause distress if game characters are inadvertently deleted or corrupted, or may replace real relationships and lead to isolation. Understanding more about these virtual relationships and their impacts on players is critical for leveraging user types for design of engaging VR pet games.

Additionally, although some design challenges (such as gameplay design) can be optimized regardless of what platform a pet game is on, we found that some of the challenges of immersive VR experiences were created by technology itself. For example, as we have concluded, pet games users, especially the *pet-keepers*, care about rich physical interactions with virtual pets. These physical interactions, such as petting, are one of the key factors that users feel would help build attachment to the pets [Lin et al. 2017]. However, current pet games are mainly based on PC (*e.g., Petz*), handheld console (*e.g., Nintendogs*), keychain-sized computer (*e.g., Tamagotchi*), augmented reality (*e.g., Pokémon Go*) and Kinect (*e.g., Kinectimals*), all of which are confined to input and output devices that have limited space to incorporate haptic interfaces to the game. VR could be an ideal platform to fill the gap between user's expectations and technical limitations by enabling realistic physical interaction between users and virtual pets. Moreover, one of the essential differences between non-VR games and VR games is the level of immersion present [Bowman and McMahan 2007]. In non-VR games, users are not able to walk throughout the interface of a game. The input and output devices of non-VR games, such as a keyboard and mouse, make a user play pet games as an "outsider". On the other hand, in VR games, users are able to interact with their whole body and feel like they are "insiders".

5.2 Design Suggestions and Considerations

We recommend that designers tailor design strategies for the three user types we identified. We also suggest that the

challenges we uncovered in designing VR pet games can be overcome with the integration existing design theories and strategies. These include flow theory, which focuses on the mental state of complete absorption in what one does and loses sense of space and time [Csikszentmihalyi 1996]; persuasive design, which aims to change attitudes or behaviors of the users through persuasion and social influence [Fogg 2002]; and the application of multisensory interaction [Dinh et al. 1999] which provide users with believable perceptual experience via a coherent representation of different sensory modalities such as sight, sound, touch, smell, self-motion and taste.

Reflecting on our findings, we believe that virtual pets cannot only offer enjoyment, but also provide therapeutic and education value. Users believe it will be easier to engage and build connections to virtual pets in an immersive and believable VR environment than in non-VR games. Researchers have advocated that animals are "agents of socialization" and providers of "social support and relaxation" [Serpell 2006]. Therapists also use animal-assisted therapy, a type of therapy that involves animals as form of treatment, to improve a patient's social, emotional, or cognitive functioning [Altschiller 2011]. Considering that VR technology has the ability to simulate real world scenarios for people who cannot physically living with animals, we envision that VR pet games can have great potential to bring multidimensional positive value to our society. However, there are ethics concerns about VR pet games that need to be explored in future studies, such as whether a believable experience with virtual pet will end up impacting the rate of real pet abandonment.

5.3 Limitations and Future Work

Our work contains limitations which may be addressed by future work. Because of our recruitment, our sample is biased towards existing game players, and may miss other demographics who do not use gaming forums but would be interested in pet-specific games only. The user types we identified are not exclusive to each other, so it is unclear how a player's user type could be determined automatically by their gameplay behaviors. Finally, the data collected is based off of users' limited experience in VR environments – their preferences may evolve or change with long-term exposure to virtual pets.

6 CONCLUSION

Through an online survey and lab study, this paper provides game designers and researchers with an evaluation of pet games, with a focus on virtual reality. We discovered three user types of VR pet game players and developed design suggestions for each. We also provoked discussions on the challenges, opportunities and considerations important to future VR pet game design.

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