"The Collecting Itself Feels Good": Towards Collection Interfaces for Digital Game Objects

Zachary O. Toups[1], **Nicole K. Crenshaw**[2], **Rina R. Wehbe**[3], **Gustavo F. Tondello**[3], **Lennart E. Nacke**[3]

[1]Play & Interactive Experiences for Learning Lab, Dept. Computer Science, New Mexico State University
[2]Donald Bren School of Information and Computer Sciences, University of California, Irvine
[3]HCI Games Group, Games Institute, University of Waterloo
z@cs.nmsu.edu, crenshan@uci.edu, rina.wehbe@uwaterloo.ca, gustavo@tondello.com,
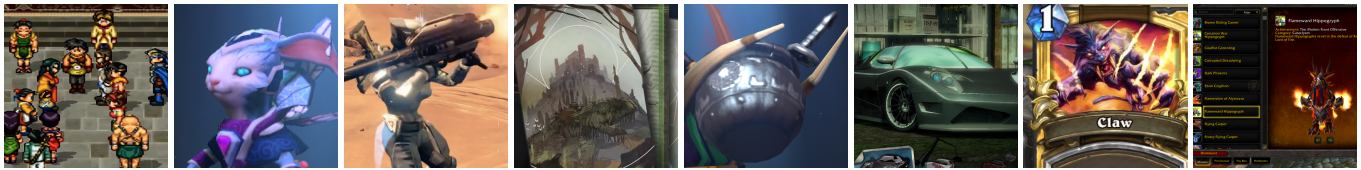lennart.nacke@acm.org

Figure 1. Sample favorite digital game objects collected by respondents, one for each code from the developed coding manual (except MISCELLANEOUS). While we did not collect media from participants, we identified representative images[0] for some responses. From left to right: CHARACTER: characters from *Suikoden II* [G14], collected by P153; CRITTER: P32 reports collecting Arnabus the Fairy Rabbit from *Dota 2* [G19]; GEAR: P55 favorited the Gjallerhorn rocket launcher from *Destiny* [G10]; INFORMATION: P44 reports *Dragon Age: Inquisition* [G5] codex cards; SKIN: P66's favorite object is the Cauldron of Xahryx skin for *Dota 2* [G19]; VEHICLE: a Jansen Carbon X12 car from *Burnout Paradise* [G11] from P53; RARE: a *Hearthstone* [G8] gold card from the Druid deck [P23]; COLLECTIBLE: *World of Warcraft* [G6] mount collection interface [P7, P65, P80, P105, P164, P185, P206].

ABSTRACT

Digital games offer a variety of collectible objects. We investigate players' collecting behaviors in digital games to determine what digital game objects players enjoyed collecting and why they valued these objects. Using this information, we seek to inform the design of future digital game object collection interfaces. We discuss the types of objects that players prefer, the reasons that players value digital game objects, and how collection behaviors may guide play. Through our findings, we identify design implications for digital game object collection interfaces: enable object curation, preserve rules and mechanics, preserve context of play, and allow players to share their collections with others. Digital game object collection interfaces are applicable to the design of digital games, gamified applications, and educational software.

ACM Classification Keywords

H.5.2. Information Interfaces and Presentation (e.g. HCI): User Interfaces; User-centered design.

Author Keywords

Digital game objects; collecting behaviors.

INTRODUCTION

People collect objects for many reasons, such as filling a personal void, striving for a sense of completion, or creating a sense of order [8, 22, 29, 34]. We find meaning in our collected objects [2, 26], and internet culture has allowed us to take our collecting practices into digital realms [16, 17, 28, 36, 37]. In digital games, we can collect explicit and improvised items including meta-game rewards (e.g., Xbox Achievements), modifications to game rules and mechanics (e.g., Pokémon), and personalization options (e.g., clothing).

We lack a clear understanding of players' collecting behaviors and how players perceive the value of their digital game objects. Prior research has explored how players value digital game characters (e.g., [20]) and general digital collections (e.g., [16, 17, 36]), yet questions remain about how players value *digital game objects*. We surveyed over 180 gamers about their digital game object collecting practices. Our research offers a broader investigation of value attribution in games, because it includes non-tangible objects (e.g., armor dyes) and games without characters (e.g., *Ingress* [G17]).

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[0]Figure 1 source information (left to right): ⓒⓘ YetiFreeze on YouTube (https://www.youtube.com/watch?v=cTUPNo8vBd4) (game [G14] © Konami); screenshot taken ⓒⓘ by author Toups (game [G19] © Valve); screenshot taken ⓒⓘ by author Nacke (with Daniel Johnson's digital game object) (game [G10] © Bungie); ⓒⓘ Ben Pope Games on YouTube (https://www.youtube.com/watch?v=oHpywDFM464) (game [G5] © EA); screenshot taken by ⓒⓘ author Toups (game [G19] © Valve); screenshot provided ⓒⓘ William A. Hamilton (game [G11] © EA); screenshot provided ⓒⓘ Igor Dolgov (game [G8] © Blizzard); screenshot provided ⓒⓘ Mark Toups (game [G6] © Blizzard).

From our data about the objects players collect, we developed a coding manual, following methods outlined by Saldaña [30]. With this manual, we are able to understand the composition of players' collections. We connect our digital object types with prior work on digital character value (e.g., [20]) to understand *why* players value digital game objects and what drives them to collect. Through our data, we develop an understanding of why players collect digital game objects, why digital game objects are valued, how sociality plays a role in digital game object collections, and how players compose their digital game object collections.

We connect our findings to data on personality and player types, conducting an exploratory analysis of multiple pairs of independent variables with players' behaviors towards digital game objects. Our data show some possible associations between player typologies and digital game object preferences that are worth investigating in future work. Players' ages were associated with their reasons for collecting objects, their reported practices towards purchasing personalization options, and their digital game object sharing behaviors. The player's BrainHex class [23] was associated with their preference for collecting rare objects and their reported practices towards sharing their digital game objects.

From our findings, we develop design implications for *digital game object collection interfaces*. Such interfaces should enable curation, preserve rules and game mechanics, preserve context of play, and enable sharing of digital game objects. The design implications support designers of digital games, gamified applications, and educational systems by offering guidance on how collection interfaces can enhance these systems, supporting users / players and driving motivation.

For those readers interested in the specifics of the survey instrument, we have supplied the instrument verbatim in the Appendix.

Reporting Conventions
In addition to references, we also supply a ludography, which provides data on the games discussed in the present research. Referenced games are prefixed with a "G" (e.g., [G6]). When we discuss game series, we only cite a single exemplar (either the specific one from our data or the first entry).

When we discuss data from participants, we use the participant's serial identifier prefixed with a "P" (e.g., [P124]); the serial identifiers match the data rows and were not modified after cleaning the data (and so there are identifiers beyond the total number of participants).

Finally, following Saldaña's convention [30], we specify codes from the coding manual in SMALL CAPITALS.

Paper Outline
We continue the present paper by discussing previous literature on game design, collections research, and prior game interfaces. We provide details of our methods, including the specific questions we are interested in in the present research, the composition of our participant population, details of our coding manual, and details of our quantitative analysis methods. Our results section describes our quantitative findings and

Code	Description
UTILITY	Enables accomplishing game tasks.
INVESTMENT	Represents player time, effort, achievements.
COMMUNICATION	An expression to a social group.
MEMORY	A record of activities in game.
ENJOYMENT	Fun to play.
RELATIONSHIPS	Represents player / group relationships.
NEW EXPERIENCES	Enables new in-game experiences.
CREATIVITY	Enables creating aesthetically pleasing forms.
SOCIABILITY	Enables engagement with friends.
SELF-EXPRESSION	Express player attitudes or beliefs.

Table 1. Livingston et al.'s [20] types of value for game characters. The value types were applied in the present study to digital game objects.

qualitative themes that provide insight into digital game object collection behaviors. We use the themes from our participants' qualitative responses to develop design implications for collection interfaces in games, address cautions about building digital game object collection interfaces, and outline plans for future work. We conclude with a call to action for developers.

BACKGROUND
The present research builds on game design and collection scholarship. We begin by discussing game mechanics, then discuss research on how players value digital game objects and how personality types are used in the game design space. We discuss collecting research in the physical and digital realms. We close the section by discussing games that provide inventory and catalog interfaces, which offer a simple means for players to collect digital game objects.

Game Mechanics
Games are made up of rules, within which players make decisions (to play) [31]. *Game mechanics* thus represent moments of player choice within those rules, modifying the game state [15, 31]. One interesting element of digital game objects is that they can influence the operation of game mechanics. They may represent a combination of modifications to game rules (e.g., a sword with a specific statistics) or may enable new forms of play (i.e., mechanics) in and of themselves (e.g., a character with a range of new actions to perform).

Valuing Digital Game Objects
Prior studies have explored how players value their characters in online games. Manninen and Kujanpää [21] used Yee's [38] categories of motivational play to analyze how players valued their characters, and found that value could be categorized according to achievement- (e.g., statistics, wealth), social- (e.g., friendships, player interactions), and immersion-oriented (e.g., physical appearance, role) components. Kujanpää et al. [18] discuss financial implications of value in games by exploring how players spend real-world currencies for character customization. Guo and Barnes [10] examined *Second Life* [G15] and *EverQuest* [G12] to model why players buy digital objects in digital games for real-world currencies.

Livingston et al. [20] identified ten ways that players value characters, summarized on Table 1. We build on this work by examining the ways that players value digital game objects using Livingston et al.'s value types.

Player Personality

Previous research has examined the classification of personality types for determining human behavior. For example, the Five Factor Model (FFM) of personality developed by Costa and McCrae [6] classifies personality according to five traits: openness to new experiences, conscientiousness, extraversion, agreeableness, and neuroticism. Many variations of this personality inventory exist, varying in size; the largest of which contains 240 items [7].

Bartle defined four specific player personality types in multiuser dungeons (MUDs): Achievers, Explorers, Socializers, and Killers [1]. Players were categorized according to ingame interests and behaviors. For example, a player who finds enjoyment in player-versus-player combat might be considered a Killer, while a player who enjoys completing a map of the gameworld might be considered an Explorer. The resulting personality types have since been applied to virtual worlds and have inspired several extensions and new models [12].

BrainHex [23] is a more recent model constructed from the analysis of previous gamer typologies as well as player data. It is more general because it was built independently of game genre. Therefore, we use the BrainHex typology to measure the participants' motivations towards games. The BrainHex model classifies player motivation in seven archetypes: Achiever (goal completion), Conqueror (challenge), Daredevil (excitement), Mastermind (strategy), Seeker (exploration), Socialiser (social relations), and Survivor (fear).

However, none of BrainHex's player archetypes specifically address the activity of *collecting* in digital games. In some situations, collecting may be motivated by achievement, in others, exploration. For some players, the digital game objects that they collect may be for socializing and displaying their objects to friends. To better understand potential motivations for collecting behaviors, we use the more general Ten Item Personality Inventory (TIPI) as a measure of player personality [9], which is based on the FFM. The brevity of the TIPI allows for an economically efficient and direct assessment of player personality without assuming motivation, and allows us to analyze collecting as an activity that is not necessarily restricted to the game world.

Collecting

People collect items in the physical world for a variety of reasons [33]. Digital items, and thus digital game objects, are no different. Based on an analysis of prior collection scholars investigating collecting behaviors of physical objects, Pearce offers the following to scope the term "collection":

> From this discussion we glean that ideas like nonutilitarian gathering, an internal or intrinsic relationship between the things gathered – whether objectively 'classified' or not – and the subjective view of the owner are all significant attributes of a collection, together with the

notion that a collection is more than the sum of its parts. At some point in the process the objects have to be deliberately viewed by their owner or potential owner as a collection, and this implies intentional selection, acquisition and disposal. It also means that some kind of specific value is set upon the group by its possessor, and with the recognition of value comes the giving of a part of self-identity. But collecting is too complex and too human an activity to be dealt with summarily by way of definitions. [27, p159]

Digital Collecting Behaviors

Beyond physical object collections, researchers have begun to explore the role of digital collections as well. Previous research has explored digital collections in the cloud [24], the differences between digital and physical collecting practices [25], and design implications for technologies that might support these collections. College students collect digital data for research, which creates large, problematic collections that are infrequently used [17]. Recently, Watkins et al. [36] investigated digital collection practices in a variety of contexts (including one gamer). An interesting finding is that digital collections are more *used* that physical ones; people rarely engage with physical collections. The data suggest that game players who collect digital game objects will use them when they involve game mechanics (a finding on which the present research builds).

State of Digital Game Object Collection Interfaces

Many games offer rudimentary forms of digital game object collections, which players use (or, rather, improvise with) to develop their collections. Game catalogs, through which players unlock content, are widely available, especially in games with a complex backstory. Many games allow players to store items in inventory interfaces, generally as a means of play. Further, some meta-game systems enable players to build up collections of rewards. The present state of such interfaces does not support players' needs, as our data indicate.

Many existing collection interfaces function as *catalogs*, where players monotonically unlock data over the course of play. The *Pokémon* [G13] series provides the player with a "Pokédex", which automatically captures data about all critters encountered in the game. In the *Katamari Damacy* [G16] series, the player can review various items that were picked up during play. The *Mass Effect* [G4] series (as well as many other role-playing games) provide a means of unlocking lore about the gameworld and story as the player progresses. These interfaces address *classes* of objects (e.g., general information on Pokémon encountered), but do not enable the player to curate a collection of object *instances* (e.g., specific Pokémon with names, levels, etc.).

A primary means through which players presently develop collections are inventory interfaces. Inventory interfaces enable players to store digital game objects for the purpose of gameplay (e.g., a character may carry multiple pieces of gear to equip at different times in the *Diablo* [G9] series or *World of Warcraft* [G6]). While these interfaces address the desire to maintain collections of specific instances of digital game objects, their primary purpose is gameplay; as such, many lack

features that players may desire (e.g., the ability to display collections) or offer only basic support for organization. Recently, Blizzard announced a new interface in *World of Warcraft* that allows players to collect different armor styles to "transmogrify", or change the appearance of, their current armor [3]. Previously, players needed to carry items in their inventory, creating a high demand for storage space. Blizzard paired the announcement of this new interface with the comment: "It feels good to look good" insinuating that the company is aware of players' desires to collect and display their personal armor collections.

Many game communities support meta-game reward collection interfaces. Xbox Achievements, Steam Achievements, and Playstation Trophies are unlocked by accomplishing specific tasks in-game; these meta-game rewards are visible to other players and are unlocked monotonically. Steam goes further, with the Steam Inventory and Trading Cards, which provide a set of collectible meta-game items and functions to craft new items that can be displayed in the social components of the gaming community.

Through the present research, we argue for personalized collection interfaces, in which players can curate libraries of objects, providing their own microcosm of order and knowledge [8, 29].

METHODS
The present paper reports on an online survey of digital game object collecting behaviors, with a focus on specific parts of the dataset. The research protocol was approved by the New Mexico State University IRB (#12994). We build on our prior work-in-progress paper [35], using an extended dataset with 189 responses (including the 155 used previously). While our prior paper focused on game genre, we now focus on the specific objects that players value.

Survey Instrument
To understand why players collect digital game objects and what they do with them, we developed an online survey (see Appendix for the complete instrument). The survey covered the following points:

1. demographic information;

2. players' collection behaviors;

3. the BrainHex Player Typology [23]; and

4. the Ten Item Personality Inventory [9].

The present analysis specifically looks at a subset of all responses, focusing on the following questions (which are labeled as below in the Appendix):

Q1. "What is your favorite object (or collection of objects)?"
[Free-response.]

Q2. "What is the main reason that you value your favorite virtual object(s)?"
[Respondents were directed to select one of the Livingston et al. [20] reasons for character value as on Table 1.]

Q3. "In what games did you collect objects that you value?"
[Free-response.]

Q4. "Out of the games above, which contains your favorite object or collection of objects?"
[Refers back to Q3; free-response.]

Q5. "Have you shared the object(s) with others?"
[Responses one of: "No.";
"Yes, by showing the object(s) to other people in my game on my device." (showing in-game);
"Yes, by using the object(s) in a game online with others." (using in-game);
"Yes, by publicly displaying the object(s) online." (publicly displaying)]

Q6. "Have you purchased digital objects in one or more games with real-world currencies?"
[Responses one of: "No."; "Yes."]

Q7. "Have you ever purchased a personalization feature with real-world currencies?"
[Responses one of: "No."; "Yes."]

Participation
We recruited participants via snowball sampling through social media and posting flyers on the New Mexico State University (Las Cruces, NM, USA); University of California, Irvine (Irvine, CA, USA); and University of Ontario Institute of Technology (Oshawa, ON, Canada) campuses. The call to action was specifically aimed at recruiting participants who had an interest in collecting digital game objects. We expected our sample to be biased towards players who are actively engaging in collection practice; unsurprisingly, all responses to the opening question of "Have you collected digital objects in one or more games?" were answered in the affirmative.

Our data set contained 189 responses after cleaning. We removed responses with an age over 99, all neutrally answered questions, and entries with identical qualitative responses, which eliminated 18 entries. When referencing specific qualitative data, we refer to participants by serial number, which was determined prior to cleaning (so some values exceed 189). The sample included 126 male, 53 female, and 6 non-binary/other respondents (4 preferred not to say). Respondents were 18–58 years old ($M = 29.6$; $SD = 7.5$; respondents were required to be 18 or older to participate). Highest education attained was 21.2%: high school, 41.8%: bachelor's degree, 21.2%: master's degree, and 14.3%: Ph.D. (1.6% declined to state). Responses were collected from March–September 2015. All responses were anonymous.

Qualitative Analysis and Coding Manual
Three of the researchers developed a coding manual to analyze players' favorite digital game objects (responses to Q1). Code creation followed traditional simultaneous and attribute coding methods [30] to categorize object types and provide descriptions. Constant comparison to the data by the three researchers resulted in several iterations of the coding manual.

Following the creation of a coding manual, two independent coders read and coded all responses to Q1 using answers from Q4 to provide context for inconclusive answers. All data was coded in a fully-crossed design [11]. Following completed

coding, coders addressed any discrepancies. We calculated inter-rater reliability using Cohen's Kappa [5, 11, 30]. The kappa value was 0.995, which indicates nearly perfect agreement by commonly agreed definitions [5, 11].

Each object was assigned a main code that addressed the object's type and one or more modifier codes that addressed the object's features. Modifier codes, one or both of which could be applied with any main code, were emergent during coding. Table 2 describes each of the codes in detail.

Quantitative Analysis

To investigate what factors could influence players behavior towards collecting digital game objects, we conducted an exploratory data analysis aimed at identifying possible associations between the independent variables and different indicators of player behavior. The independent variables that we considered were: age, gender, education level, BrainHex primary class (derived using the BrainHex methodology from the appropriate questions), and the five factors of personality (derived from the TIPI). The different indicators of player behavior towards digital game objects collections that were considered include: main reason for object value (Q2), type of object (Q1, coded using the coding manual), rarity of object (Q1, coded using the coding manual), purchase of digital game objects (Q6), purchase of digital personalization options (Q7), and digital game objects sharing (Q5).

The association between age with the dependent variables was calculated using one-way analysis of variance (ANOVA) tests and by calculating Eta-squared (η^2) as the effect size. However, the Kolmogorov-Smirnov test showed that the age variable is significantly not normal in our data: $D(189) = 0.86$, $p < .01$. For this reason, we also executed Kruskal-Wallis and Mann-Whitney tests as appropriate, but these non-parametric tests confirmed the significance calculated from the ANOVA tests. Thus, we conclude that the lack of normality was not enough to invalidate the ANOVA tests and in the results section we only report the ANOVA tests. The associations between each trait of the FFM with each of the dependent variables were also calculated using one-way ANOVA tests and by calculating Eta-squared. For all significant results, we also use the method suggested by Smithson [32] to calculate and report the 90% confidence interval for Eta-squared.

The association between gender, education level, and BrainHex class with the dependent variables was calculated using methods for categorical data. We could not use Person's Chi-square because our sample violated the test assumptions: the expected values tables frequently contained values less than one. For this reason, we employed Fisher's exact test instead. We calculated Cramer's V as the effect size. All tests were run in SPSS 23 [13] using a Monte Carlo method with a confidence level of 99% and 10,000 samples. We also report the 99% confidence intervals for p.

RESULTS

We present the analyzed results of our survey, covering the types of favored digital game objects, the reasons players valued objects, and insight into the factors of influence on player behavior. The results synthesize the quantitative data

Code	Description
CHARACTER	Party members, playable characters, or townsfolk.
CRITTER	Animal-based mounts and pets (combative or not).
GEAR	Items that can be equipped on a character.
INFORMATION	Text- or image-based items that represent in-game information.
SKIN	Items that modify the appearance of a character, but not its statistics.
VEHICLE	Technology-based modes of transportation.
MISCELLANEOUS	All other items, including achievements and other meta-game rewards. No more meaningful sub-codes were discovered through the data.
RARE*	An item that is hard to acquire or of which there are few in a game.
COLLECTIBLE*	Items of which there are a set number (either player- or game-defined).

Table 2. Coding manual developed for analyzing players' favorite digital game object and classifying by type. Un-starred codes are main codes. Modifier codes, those that are always applied in combination with a main code, are starred.

and qualitative data from the free-response questions, which we develop into themes.

Types of Favored Digital Game Objects

We analyzed which types of digital game objects appeared most frequently in players' responses to Q1, according to our coding manual. The data indicate that GEAR was the most frequently collected object type, accounting for 34.4% of the responses. The next two types in order of prevalence were CRITTERS (21.2%) and MISCELLANEOUS objects (20.6%). While the number of MISCELLANEOUS objects may seem high, these objects could not be broken down into other meaningful categories. They included object types unique to a specific game, meta-game objects, or sets of finite collectible objects. The other object types appeared less frequently: CHARACTERS (7.4%), SKINS (7.4%), VEHICLES (4.2%), and INFORMATION (2.1%) (2.6% of participants did not answer this question).

Of all participants' favorite objects, 75.6% had no modifier code, 15.9% were COLLECTIBLE, and 8.5% were RARE. COLLECTIBLE objects were valued because they completed a set of in-game objects according to a schema defined by the game developer. One participant said that they enjoyed collecting *"Pets, all of them :)"* [P106; referencing *World of Warcraft* [G6]]. Though generally not functionally useful, pets and other non-combative CRITTERS add flair to characters that differentiates them from others in the gameworld.

The COLLECTIBLE distinction was especially relevant to sets of GEAR. P174 reported that his most valued objects were *"A matching set of 'gray' rarity armor."* "Gray rarity" means that the item is neither good, nor uncommon, and is generally considered useless. However, this player reveled in the hunting and collecting of this armor set:

The armor pieces themselves are worthless[...] I enjoyed completing the set piece by piece[...] it added extra fun to get excited about [gear] I had previously considered worthless. [...] The reason I had selected this armor set[...] is because I thought it aesthetically matched another activity I enjoyed doing in *World of Warcraft* [G6]-exploring, and breaking the game's world boundaries[...] I wore [the set] while exploring, adding further value due to the memories I accrued.

RARE objects were valued because they were difficult to obtain. One participant valued *"Ultimate weapons acquired from defeating optional bosses and completing side-quests"* [P8, regarding the *Final Fantasy* series [G18]]. Collecting these objects required optional play beyond what is expected of the average player.

Other players valued RARE objects for their uniqueness. One participant described her *"druid deck, gold collected"* [P23, regarding *Hearthstone* [G8]]. "Gold" cards function similar to holographic cards in traditional trading card games. Though they offer *no difference* in game mechanics or game play, they are harder to obtain, and signal to others that the player was willing to dedicate time (or money) to acquiring rarer cards.

Reasons for Object Value

We looked at players' responses to Q2 to understand why players value their digital game objects. UTILITY (26.5%) and ENJOYMENT (23.8%) appeared most frequently in responses. INVESTMENT (12.7%), MEMORY (10.1%), and SELF-EXPRESSION (7.9%) accounted for smaller portions of the sample. All other reasons appeared in less than 5% of responses.

Beyond explicitly stating how they valued objects, participants also noted the importance of UTILITY and ENJOYMENT in their qualitative responses:

I really enjoy collectibles that have an interesting and desirable design. I do not enjoy collectibles that have no inherent use or purpose. [P170; UTILITY]

I like collecting objects that give the user an in-game advantage. [P190; ENJOYMENT]

Not only does the data point to digital game objects being valued for their influence on game mechanics, players also value the social elements of collecting. Based on responses to Q5, sharing digital game objects was an important practice for a majority of our participants. When asked if they had shared a digital game object with other players at least once, 65.1% responded in the affirmative. Of those that shared an object, the way it was shared was: showing in-game (23.8%), using in-game (27.0%), or publicly displayed (14.3%). This is evident through the behaviors exhibited by players who share their digital game objects through a variety of mechanisms. This suggests that some objects' primary value is a combination of SELF-EXPRESSION, SOCIALITY, RELATIONSHIPS, and/or CREATIVITY. We suggest further research on these "vanity items" that serve no practical game function, but provide aesthetic value.

DV	Age (η^2)
object value (Q2)	**.107** **
object type (Q1, coded)	.023
object rarity (Q1, coded)	.003
object sharing (Q5)	**.049** *
purchased object (Q6)	.005
purchased personalization (Q7)	**.026** *

* $p < .05.$ ** $p < .01.$

Table 3. Effect values and significance of age in association with different player behaviors towards digital game objects.

Object Value (Q2)	N	Mean Age	SD
UTILITY	50	31.60	7.117
ENJOYMENT	45	28.27	6.340
INVESTMENT	24	26.71	5.645
MEMORY	19	26.16	6.635
SELF-EXPRESSION	15	29.40	8.210
CREATIVITY	8	30.13	5.489
NEW EXPERIENCE	6	29.00	2.530
RELATIONSHIPS	6	35.67	11.325
total	173	29.25	7.036

Object Sharing (Q5)	N	Mean Age	SD
"No."	66	31.55	7.521
showing in-game	45	27.91	7.876
using in-game	51	28.06	5.944
publicly displaying	27	30.30	8.241
total	189	29.56	7.456

Purch. Personalization (Q7)	N	Mean Age	SD
"No."	118	30.48	7.420
"Yes."	71	28.03	7.311
total	189	29.56	7.456

Table 4. Mean values and standard deviation of age for each group of object value, object sharing, and purchased personalization.

Factors of Influence on Player Behavior

Table 3 shows the calculated effects and significance of age in association with different player behaviors towards digital game objects. Age was found to have the following significant effects:

1. a moderate effect on the main reason for collecting digital game objects: $\eta^2 = .107$, $F(7, 165) = 2.822$, $p < .01$ (90% CI $= .016 < \eta^2 < .150$);

2. a small effect on how the participants shared their objects with others: $\eta^2 = .049$, $F(3, 185) = 3.177$, $p < .05$ (90% CI $= .003 < \eta^2 < .096$); and

3. a small effect on the participants having ever purchased personalization options for their objects: $\eta^2 = .026$, $F(1, 187) = 4.906$, $p < .05$ (90% CI $= .001 < \eta^2 < .073$).

Table 4 shows the mean values and standard deviation of age for each group of the dependent variables that were significantly affected by it: object value (Q2), object sharing (Q5), and purchased personalization (Q7). The reasons for object

DV	Gender (V)	Education Level (V)	BrainHex Class (V)
object value (Q2)	.270	.210	.258
object type (Q1, coded)	.267	.183	.228
object rarity (Q1, coded)	.153	.136	**.247** *
object sharing (Q5)	.109	.166	**.230** *
purchased object (Q6)	.099	.115	.111
purchased personalization (Q7)	.039	.093	.188

* $p < .05$.

Table 5. Effect values and significance of gender, education level, and BrainHex class in association with different player behaviors towards digital game objects.

BrainHex Class	(no modifier)	COLLECTIBLE	RARE
Achiever	1.08	0.88	0.55
Conqueror	0.91	0.85	**2.00** *
Daredevil	1.32	0.00	0.00
Mastermind	**0.92** ***	**1.31** **	1.13
Seeker	**1.18** ***	**0.34** ***	0.65
Socialiser	**0.67** *	**3.12** ***	0.00
Survivor	0.67	2.00	2.00

Note. Each cell's value represents how many times that particular combination is more probable (if value > 1.0) or less probable (if value < 1.0) to occur in our sample than it would occur on an independent distribution.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 6. Standardized probabilities of occurrence of each pair of Brain-Hex type and object rarity (Q1, coded) in comparison with an independent distribution.

BrainHex Class	"No"	using in-game	showing in-game	publicly displaying
Achiever	**0.55** ***	**1.58** ***	1.02	1.00
Conqueror	1.09	0.89	0.88	1.19
Daredevil	0.59	0.71	1.67	1.43
Mastermind	**0.88** **	1.01	**1.51** ***	**0.44** ***
Seeker	**1.44** ***	**0.61** ***	**0.55** ***	**1.41** **
Socialiser	**0.28** **	**1.85** *	0.42	3.14
Survivor	0.95	1.87	0.71	0.00

Note. Each cell's value represents how many times that particular combination is more probable (if value > 1.0) or less probable (if value < 1.0) to occur in our sample than it would occur on an independent distribution.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 7. Standardized probabilities of occurrence of each pair of Brain-Hex type and object sharing (Q5) in comparison with an independent distribution.

value that appealed to the youngest players were MEMORY and INVESTMENT, whereas those which appealed to the oldest players were UTILITY and RELATIONSHIPS. Regarding object sharing, the oldest players reported never having shared their game object(s) or having displayed them publicly, while younger players have reported showing their object(s) to others in their game or device and using the object(s) in-game with others. Although the effect is small, this could be a result of younger players being more familiar with online game playing and mobile devices. Regarding purchase of personalization features for their digital game object(s) with real currency, younger players have more frequently reported having done so than older players. This was also a small effect, but it could suggest that younger players are more open to spend real currency on their games than the older players.

Table 5 shows the calculated effects and significance of gender, education level, and BrainHex class in association with different player behaviors towards digital game objects. The Fisher's exact tests showed no significant effect of gender and education level on the dependent variables. For BrainHex class, the tests showed the following significant effects:

1. a moderate effect for players valuing RARE collected digital game objects, Cramer's $V = .247$, $p < .05$ (99% CI $= .024 < p < .032$) (Fisher's exact test). Further analysis (see Table 6) revealed that Seekers are more inclined to collect no-modifier objects, whereas Masterminds and Socialisers are more inclined to collect COLLECTIBLE objects and Conquerors are more inclined to collect RARE objects.

2. a moderate effect on how the participants shared their objects with others, Cramer's $V = .230$, $p < .05$ (99% CI $= .015 < p < .022$) (Fisher's exact test). Further analysis (see Table 7) revealed that the classes more inclined to share their objects are Achievers (by using the objects in-game), Masterminds (by showing the objects in-game), and Socialisers (by using the objects in-game and possibly by also publicly displaying the objects, although the latter was not found to be significant in our data due to the sample size). Seekers appear to be less inclined to share their objects, unless it is by publicly displaying them on-line.

We also tested for the effects of each of the five traits of personality from the TIPI scale, namely extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience, in each of the dependent variables. All the ANOVA tests showed non-significant results. Therefore, we conclude that personality traits had no effect on the participants' behaviors towards collecting digital game objects.

Themes

We connect our data points to a set of themes in the data: mechanics drive value, digital game objects represent investment, social presentation is important, and collections are esoteric and guide play.

Mechanics Drive Value

Many participants attributed collection value to how objects enabled interesting decision-making or affected game mechanics. Favorite objects were categorized as either GEAR, CHARACTER, or VEHICLES in 46.0% of responses; all such objects change how the game is played, supplying rules in the form of statistics or enabling new game mechanics. While not included in this total, many elements identified as MISCELLANEOUS *may* impact gameplay (e.g., specific buildings in simulations or location-based objects in *Ingress* [G17], both observed in

our data). Further, some CRITTERS, excluded from this set, may modify game state.

When players reported their primary reason for valuing objects, UTILITY and ENJOYMENT were most frequently cited. This data, again, points to the importance of game mechanics for collected objects, suggesting that players want to make use of their objects in game, not just look at them or otherwise have the objects in their possession.

We argue that there are two main groups of players:

1. those that value their objects for their functionality and purpose, and

2. those that value their objects primarily because they bring them pleasure.

This suggestion aligns with Watkins et al.'s [36] finding that game players made more use of digital collections than other respondents.

Digital Game Objects Represent Investment

The INVESTMENT and MEMORY values accounted for 22.8% of our participants' reasons for valuing digital game objects. We expect that players' time in-game is important to them, and digital game objects serve to encapsulate these experiences.

Social Presentation is Important

Digital game objects are easily shared, and many are "shown" automatically when players go online. We observed that many participants reported having shared their digital game objects with others (65.1% did so at least once). At the same time, mechanic-oriented values were the most important; the more socially-oriented values, COMMUNICATION, RELATIONSHIPS, SOCIABILITY, and SELF-EXPRESSION, were less prevalent in the data. Our quantitative analysis also showed that participants employed different means for sharing their game objects and that this fact may have been influenced by different factors such as the player's age and style of play.

Collections are Esoteric and Guide Play

Many games offer a schema for collectible objects, such as a theme or a set of items that go together. These schemas relate to the rules of the game. However, based on our data, what players chose to collect were varied, often breaking from the originally specified schemas. A total of 10 participants reported collecting parts of specific equipment sets (GEAR). An additional three reported collecting a specific class of CRITTERS. Some collections were more esoteric; for example, P126 reported:

> I collect Teddy Bears in the *Fallout* [G2] games. The developers have put a good amount of work creating a world that feels like it was actually devastated by atomic war. I collect the bears as a kind of tribute to the massacred innocents.

P182 reported on his collection activities in *Skyrim* [G3], which functioned as a personal quest to collect unique objects:

> [...]I tracked down every item in [*Skyrim*] that could be considered unique [...]Among these was a particular[...] skull. [...]There's nothing really special about this [...]skull; it doesn't have any story significance and [...] doesn't have any utility. [...] it does have a different texture [...] more importantly there's only one of them.

Based on the data collected, we hypothesize that developing personalized schemas for collecting digital game objects provides players with the emergent ability to set their own goals.

While a game may specify a set of collection-oriented ancillary goals, such as *"Legendary Cards (Ragnaros, Leroy Jenkins, etc.)"* [P82, regarding *Hearthstone* [G8]], players may specify their own, achievable goals, for which the game provides no mechanical support (e.g., *"...all the Elemental Dragons"* [P87, regarding *DragonVale* [G1]]). Such digital game objects may or may not be COLLECTIBLE (because they are outside the game's provided schemas) and may or may not be RARE (because players may set achievable goals). Digital game objects may offer additional meaning by acting as markers of player-specified goals.

DISCUSSION

In the present paper, we investigated the collection behaviors of players. We captured information on the particular digital game objects collected and social interactions around collected objects, and developed a coding manual to categorize specific, favored objects. We also explored the value players' assigned to those objects. We found that digital game objects that influence game mechanics or provide social interest were the most commonly collected digital game objects. We provide design implications for digital game object collection interfaces, to enable them to support important player values. We recommend designing interfaces that enable curation, preserve game rules and mechanics, preserve context of play, and enable sharing. We also provide evidence that collecting is influenced by both age and BrainHex class.

Designing Digital Game Object Collection Interfaces

> [...] a game should provide a cohesive method "In Game" for identifying / locating / and organizing whatever collectibles [...] the game contains. [P106]

Digital game object collection interfaces that synthesize, sort, filter, and otherwise support interaction with collected objects would be valuable to players. Further, these interfaces should retain the informational aspects of collected objects even after a specific instance of the item has been sold, expended, or lost. Prior interfaces support players in unlocking information and gathering digital game objects for use in play, yet we observe that players develop attachment to specific instances of objects, with their own in-game statistics and even names (e.g., players' Pokémon teams: *"My current level 100 battling team"* [P74], *"My main team of Pokémon"* [P160], *"My original level 100 team from middle school"* [P178]).

Our data insinuate a set of design implications that collection interfaces could use to support games, rather than other types of archives. We expect that in a basic form, like prior collection

interfaces, game collection interfaces could support INVEST-MENT, MEMORY, and CREATIVITY values. By following the proposed design implications, they could also support COM-MUNICATION, SOCIABILITY, UTILITY, ENJOYMENT, and SELF-EXPRESSION, which align with how mechanics drive value and supporting the importance of social presentation.

Enable Curation
Curation is a form of authoring and creation [17] through which the author makes meaningful decisions about what elements should be acquired, displayed, and combined. It deriving from the artistic tradition of found objects, in which the act of selection is the key artistic contribution [19]. Curation serves to support the SELF-EXPRESSION and CREATIVITY values. Our data suggest collecting, in many cases, is driven by personal interest and experiences with certain objects. The first step to building a successful collection interface is the ability to curate and customize the contents within, an activity that we observe players are already undertaking informally.

The esoteric and personal nature of players' collections supports our assertion that game interfaces should be robust enough to allow players to select what objects they curate and display to others, rather than limiting what objects players are able to display. The fact that social presentation is important suggests that players desire the ability to show others what they have acquired and curated. Doing so would enable such interfaces to support the COMMUNICATION and SOCIABILITY values.

Enabling curation is likely a challenge for game designers. Curation interfaces to select items serve a meta-game purpose. This places them at odds with a gameworld's functioning as an interface to the game [14] (and not meta-game functions). Developing curation interfaces requires a means by which players can tag or otherwise access their digital game objects. The scope of such interfaces is also open: our data suggest that, since players potentially collect *anything*, such systems must be robust. Application program interfaces, like those available in *World of Warcraft* [G6] or *Destiny* [G10] enable external programmers to access those games' digital game objects and serve as exemplars of design approaches that enable the development of curation tools.

Preserve Game Rules and Mechanics
Because mechanics drive the UTILITY and ENJOYMENT values, they need to be meaningfully preserved. Players keep items because they like to use them, which we expect in digital collections [36]. We argue in favor of preserving the game rules and mechanics that players find so important, enabling players to relive and/or recreate in-game experiences and decisions.

We identify three potential implementation approaches to preserve game rules and mechanics: captured video, produced video, and simulation. The proposed methods are primarily in service to UTILITY and ENJOYMENT, but, to a lesser degree, they also support MEMORY and INVESTMENT.

Captured Video: Mechanics could be preserved by capturing video of object use. The digital game could automate this: capturing instances of use that, according to metrics defined

by the designers, are exceptional and, thus, likely to be worthy of preservation (e.g., using a favored sword to defeat 100 foes). Contemporary consoles do this for the purpose of sharing (social presentation)[1] when a player performs an exceptional act or reaches certain milestones. Captured video recordings could also be triggered manually, which is the nascent state of the ability to record and share video from modern game consoles. Voice interfaces, like on Xbox One with Kinect, are ideal for this, which enable the player to capture video clips without interrupting play.

Captured video serves to preserve exact instances of play that a player has actually experienced. It provides the player with little flexibility for experimentation, however, and, depending on camera-control algorithms, the resulting video may not highlight the digital game object well (e.g., the player's avatar might obscure a favored sword by being in front of the gameworld camera).

Produced Video: Video can also be produced in-engine, rather than captured, showing a digital game object in some pre-determined context that highlights its important aspects. This offers the opportunity to record what makes the digital game object important, in terms of game mechanics, but may lack the personal experience a player desires.

An illustrative example of this is the tech-tree interface of the single-player campaign in *Starcraft 2* [G7]. While not a collection interface, a player is shown a video of each potential upgrade in a particular context that highlights its value, showing the difference it will make in gameplay.

Simulation: An alternative to video records is simulation, where a player can, through the collection interface, see multiple scenarios using a collected object. A deeper interface might even enable interactive simulation, where the player can play out (or even replay) various scenarios with one or more digital game objects, observing differences in gameplay. While simulation enables deeper interaction with objects, it has the downside of failing to capture specific contexts of use (see next section).

Preserve Context of Play
Since digital game objects represent investment by players, retaining contextual information about how or when the player collected or played with the object would be beneficial. Capturing context could be challenging, since curation likely happens after an item has been acquired or used. The need to curate the item may come much later in the game, after long-term play.

While there are many elements of context that could be automatically generated, players may also wish to attach custom, personal meaning to curated objects. This suggests the need for interfaces to customize metadata about digital game objects.

Some existing games provide the opportunity for players to add meaning to their in-game objects. For example, *Dota*

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[1]Microsoft's Xbox One automatically records clips of exceptional gameplay, but there is no documentation of this feature. Both the Xbox One and Sony's Playstation 4 enable players to easily record and share gameplay clips.

2 [G19] provides Name Tags, tools that allow players to give their objects a customized names, and Description Tags, tools that let players write a brief description of an item. In the case of the Pokémon [G13] series, each individual CRITTER includes context details: the name of the original trainer (in case the CRITTER was traded), location in the gameworld the CRITTER was caught, ribbons acquired as rewards for gameworld contests, etc. [4].

Enable Sharing
Due to the importance of social presentation, our data imply an interest in sharing digital game object collections with others, which is an activity commonly performed by curators of other collections, digital or otherwise [8, 17, 20, 21, 28]. Enabling sharing of curated collections supports the values of COMMUNICATION and SOCIALITY.

Being digital and networked, games offer easy means to do this. Indeed, much of the infrastructure to share game moments already exists in current platforms. However, our data suggest that players might have different preferences regarding collection sharing, which can be affected by their age and personality. Future work aimed at understanding these differences could contribute to suggest more personalized options for digital game objects sharing, which could potentially appeal to a broader range of different players.

Points of Caution and Limitations
While we generally argue in favor of preserving digital game objects, doing so could have negative consequences for current collecting practices. If mechanics are preserved beyond when players have an object in their possession, this may undermine the game's mechanics overall, which could reduce the perceived INVESTMENT and UTILITY of collected digital game objects. In games where players have a limited inventory and expressly balance inventory management to preserve objects, enabling players to capture and preserve the mechanics in an archive could reduce ENJOYMENT. At the same time, the opposite may be true: players may find relief in no longer needing to manage inventory.

Another key point of caution: we expect that part of the reason that collections are meaningful are because they represent achievement in a game. This notion is backed by the observation that digital game objects represent investment; while there were not a great number of RARE items, their presence also suggests that there is importance in the challenge of acquiring certain digital game objects. A concern, then, is that poorly designed collection interfaces may enable players to collect items that they have not *earned* (undermining INVESTMENT).

Quantitative data analysis suggested that players' behaviors towards collecting digital game objects may be influenced by their age and preferred style of interacting with games, as denoted by their BrainHex class. However, there a few limitations that need to be considered. First, our analysis was mainly exploratory. In addition, all answers were self-reported and without any specific experience in mind, so they may be imprecise. Finally, some of the observed significant effects were small. For these reasons, these results must only be considered as indicators of possible effects worth investigating in the future. However, our work provides interesting clues to direct future research.

Finally, the present research reports on data from a survey of gamers who collect digital game objects. All advertisement specifically targeted gamers who have a predisposition toward collecting. Thus, while we provide insights into collection behavior, our survey tells us little about how prevalent collecting behaviors are in digital games.

Future Work
Further research is needed to identify and reduce any deleterious effects of collection interfaces, as well as confirm their potential worth to players. Future work will continue to explore the digital game objects that players collect and identify their worth. In particular, we intend to conduct focused user studies to investigate in more detail the possible effects of player age and play style in collecting behaviors that were suggested by our quantitative analysis. We also aim to understand the prevalence of collecting behaviors.

CONCLUSION
In this paper, we provide a strong argument for the advantages of digital game object collection interfaces, and how these interfaces can foster meaning-making within games. These benefits could enhance players' value attributions for collections of game objects, and contribute to the overall play experience.

Our study shows that players are interested in collecting digital game objects with mechanics, not just meta-game rewards (which function much like catalogs of a player's successes). Ideally we would see collection interfaces rise to a meta-game level, similar to the way that meta-game rewards (e.g., Xbox Achievements, Playstation Trophies) are organized intra-platform. We would, overall, argue for a unified system to accumulate player-curated collections across games. As a starting point, we recommend that individual games support collections in way that are meaningful to players in accordance with the design implications of enabling curation, preserving rules and mechanics, preserving context of play, and enabling sharing.

We expect digital game object collection interfaces to be of benefit to individuals designing games, gamified applications, and educational software. We expect such interfaces to deepen player investment and engagement, providing a means for players to make explicit behaviors they presently undertake without support.

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The appendix includes the digital game objects survey used to collect data for the paper. The survey page includes markers (Q#) to indicate specific questions referenced in the paper. Note that in the survey we used the term "virtual objects", which was changed to "digital game objects" in the paper.

Please indicate whether or not you are 18 or older and assent to continue the survey. [select one]
Only participants age 18 and older can participate in this research project. If you are younger than 18, thank you for your interest.

○ I am 18 or older and assent to participating in this survey.
○ I am less than 18 years old or do not assent to participating in this survey.

Demographics
What is your age? [free numerical response]

What is your gender? [select one]
○ Prefer not to say.
○ Female.
○ Male.
○ Non-binary / other.

What is your highest level of education? [select one]
○ No response.
○ High school or equivalent.
○ Bachelor's degree or equivalent.
○ Master's degree or equivalent.
○ Graduate degree or equivalent.

Initial Experience
Have you collected digital objects in one or more games that you value? [select one]
For this and all future questions, an "object" might be an actual object, such as items in your inventory or worn by your character, but could also be characters/teammates, upgrades, other virtual objects, etc.

○ Yes.
○ No.

Q6. Have you purchased digital objects in one or more games with real-world currencies? [select one]
○ Yes.
○ No.

Do you enjoy unlocking achievements / trophies / etc.? [select one]
○ Yes.
○ No.
○ I am not familiar with achievements / trophies / etc.

Virtual Object Collection
In this section, we are interested in how you value virtual objects. Some reasons people value virtual objects are listed below, although they may not be exhaustive.

- Utility: the virtual object is valuable because of what it can do.
- Investment: the virtual object represented your time, effort, and achievements.
- Communication: the virtual object's appearance communicates something useful to your social group.
- Memory: the virtual object is a collection of your memories.
- Enjoyment: the virtual object is simply fun to use in game.
- Relationships: the virtual object represents relationships with other players or groups.
- New experience: the virtual object enabled new experiences.
- Creativity: the virtual object was a platform on which you could create aesthetically pleasing forms.
- Sociability: the virtual object allowed you to engage in activities with friends.
- Self-expression: the virtual object allowed you to express a wide variety of personal attributes or beliefs.

Q3. In what games did you collect objects that you value? [free response]

Q4. Out of the games above, which contains your favorite object or collection of objects? [free response]
You will use this answer as the basis for your answers to later questions.

Q1. What is your favorite object (or collection of objects)? [free response]

Why is your favorite virtual object(s) valuable to you? [check all that apply]
☐ Utility
☐ Investment
☐ Communication
☐ Memory
☐ Enjoyment
☐ Relationships
☐ New experience
☐ Creativity
☐ Sociability
☐ Self-expression
☐ Other:

Q2. What is the main reason that you value your favorite virtual object(s)? [select one]
○ Utility
○ Investment
○ Communication
○ Memory
○ Enjoyment
○ Relationships
○ New experience
○ Creativity

○ Sociability
○ Self-expression
○ Other:

For how long did you use the object(s)? [select one]
○ For a part of the game.
○ For the remainder of the game after acquiring it.
○ Beyond the game in which it was acquired and into one other game (via trading, save game transfer, etc.).
○ Beyond the game in which it was acquired and into multiple games (via trading, save game transfer, etc.).

Q5. Have you shared the object(s) with others? [select one]
○ No.
○ Yes, by showing the object(s) to other people in my game on my device.
○ Yes, by using the object(s) in a game online with others.
○ Yes, by publicly displaying the object(s) online.

What else would you like to tell us about your experiences with collecting virtual objects? [free response]

Personalization of Virtual Objects
The following questions are in regards to your personalization or customization of virtual objects.

Which of the following personalization features do you consider most important for the digital objects you have collected? [check one]
○ None
○ Dyes or color-changing features
○ Naming or name-changing features
○ Physical placement adjustments
○ Other:

Which of the following personalization features have you used for digital objects you have collected? [check all that apply]
□ None
□ Dyes or color-changing features
□ Naming or name-changing features
□ Physical placement adjustments
□ Other:

Q7. Have you ever purchased a personalization feature with real-world currencies? [check one]
○ Yes.
○ No.

What else would you like to tell us about personalization features for virtual objects? [free response]

Personality

Here are a number of personality traits that may or may not apply to you. Please select a value next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

I see myself as: [mark one entry per row]

	disagree strongly	disagree moderately	disagree a little	neither agree nor disagree	agree a little	agree moderately	agree strongly
Extraverted, enthusiastic.	○	○	○	○	○	○	○
Critical, quarrelsome.	○	○	○	○	○	○	○
Dependable, self-disciplined.	○	○	○	○	○	○	○
Anxious, easily upset.	○	○	○	○	○	○	○
Open to new experiences, complex.	○	○	○	○	○	○	○
Reserved, quiet.	○	○	○	○	○	○	○
Sympathetic, warm.	○	○	○	○	○	○	○
Disorganized, careless.	○	○	○	○	○	○	○
Calm, emotionally stable.	○	○	○	○	○	○	○
Conventional, uncreative.	○	○	○	○	○	○	○

Brainhex Questionnaire

For each experience, choose "I love it!", "I hate it!", or "It's okay". [mark one entry per row]

	I love it.	It's okay.	I hate it.
Exploring to see what you can find.	○	○	○
Looking around just to enjoy the scenery.	○	○	○
Wondering what's behind a locked door.	○	○	○
Running away from a dangerous foe.	○	○	○
Feeling terrified.	○	○	○
Feeling relief when you escape to a safe area.	○	○	○
Feeling excited.	○	○	○
Being in control at high speed.	○	○	○
Hanging from a high ledge.	○	○	○
Cracking a challenging puzzle.	○	○	○
Devising a promising strategy.	○	○	○
Working out what to do on your own.	○	○	○
Eventually defeating a difficult boss.	○	○	○
Taking on a strong opponent in a versus match.	○	○	○
Completing a punishing challenge after failing many times.	○	○	○
Talking to non-player characters.	○	○	○
Talking to other players.	○	○	○
Co-operating with strangers.	○	○	○
Picking up every single collectible in an area.	○	○	○
Finding an item you need to complete a collection.	○	○	○
Getting 100%.	○	○	○