Player Expectations of Animal Incorporated Computer Games

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Abstract. Animal incorporated games were both hypothesized and shown to serve multiple desired objectives, among which improvement of animal welfare, strengthening pet-owner relations, and creating new experiences for human players. We study the expected player experience of animal incorporated games through the use of an extended survey (n = 177). Our results indicate that respondents expect (a) added unpredictability caused by animal-opponent behavior, (b) increased enjoyment when playing against animals, for a limited duration of time, and (c) that hypothetical exact simulation of animal behavior offers equally interesting opponent behavior. Furthermore, concerns of animal welfare significantly moderate the preference for computer-, exact simulated- or animal-opponents. These outcomes can be used to correct for aspects such as novelty bias, when measuring player experiences in animal incorporated type games.

Keywords: Animal-Computer Interaction · Computer games
Animal welfare · Player expectations

1 Introduction

While computer games are traditionally played against a computer or human opponent(s), either offline or over the internet, there is a recent interest in computer games which incorporate living non-human organisms. Although this is a relatively new topic, there is already quite a variety in intents and approaches towards such games. Some are developed solely for academic purposes [1] while others are commercially available [2] or artistic endeavors [3]. Some are developed for battling animal stress [4] while others incorporate living organisms for behavioral [5] or content generation [6]. Often these games receive notable media attention and since most of them are neither technically nor visually noteworthy, it seems that the inclusion of a living organism is responsible for the expressed interest.

As of yet there has been no empirical study that verifies if the addition of a non-human organism within a computer game indeed raises interest, and if so, why this is the case. By means of a survey we study people's expectations of a game which incorporates living organisms. We hope that the results of this study will give us a better understanding if these types of games are likely to stay compelling or if the

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current attention is due to a novelty factor. Furthermore we want to understand whether the participants expect such games to be less predictable and to which extent they are regarded as animal abuse. For sake of brevity, in the remainder of this text we refer to living non-human organisms simply as organisms, and we refer to digital interactive (computer) games simply as games. But first we identify several categories of games that involve animals or other organisms.

2 Animal Incorporated Computer Games

If animals play, how animals play and why animals play are questions on which a lot of research has been conducted [7, 8]. It is not our intent to contribute to these questions in this article, since our goal is to study in which way the addition of an organism within a computer game changes the player's opinion on the game. There is quite a diversity of games which incorporate organisms. We choose to divide them by the type of interaction the organism has within the game: voluntary interaction, involuntary interaction and indirect control.

2.1 Voluntary

With voluntary interaction we mean that the organism initiates the interaction or play on its own intent. Within the emerging field of ACI (Animal-Computer Interaction) [9] this freedom to engage or withdraw is a key aspect. Various games have been developed which allow pets and their owner to interact together [10–12]. Games can also be used to fight animal stress responses and resulting stereotypical behavior. Digital interactive gaming was shown to lower both behavioral and physiological (cortisol hormone) symptoms of stress in home-alone dogs [4]. A well-known game providing cognitive enrichment and physical exercise is *Pig Chase* [13], a game shared between humans and captive pigs via the internet that was proposed in 2012, but of which the current production status is undocumented. Moreover games to enrich the lives of captive orangutans are being researched [14].

There are also examples of games which could be played without human interference. *Games for Cats* [2] is meant to be solely played by cats, but the game still requires human assistance since it involves navigating through menus and the free versions includes numerous popups. Similar games exist for dogs [15], but it remains uncertain if such games are beneficial for the dog's wellbeing [16]. Animals can also interact with regular games, as illustrated by a video in which a bullfrog tries to catch and eat ants from the popular mobile game *Ant Smasher* [17].

2.2 Involuntary

With involuntary interaction we mean that the animal does not initiate the interaction or play on its own intent. With such games the organism is incorporated within the game and responds to actions of the human player. Often these are natural mechanisms of survival, where the organism steers away from unfavorable conditions or is lured by favorable conditions. An example of a game employing involuntary interaction is a

game by van Eck and Lamers [5], which is based around a modified Pac-Man game in which the opponent ghosts were controlled by living crickets inside a physical facsimile of the game level (maze). Vibrations within the physical maze stimulate the crickets to either chase the player's Pac-Man avatar or to avoid him, since for crickets vibrations indicate approaching danger from which they flee. Further examples are games for purposes of biology education [1, 18] and that embody an artistic endeavor [3]. Also the aforementioned *Ant Smasher* [17] game might be placed in this category, since it might be more likely the Bullfrog's intention is to eat, not to play.

2.3 Indirect

Indirect control of a game by organisms is also a possibility and illustrated by the project *Fish plays Pokémon* [19], in which a fish navigates a game of *Pokémon* (published by Nintendo, 1996) by swimming around its fish tank. Designated areas in the tank trigger actions within the game when entered by the fish. Variations on this principle were made with the games *Tetris* (various publishers) and *Street Fighter 2* (published by Capcom, 1991). In *Lumberjacked* [20] movements of the leaves of a tree are translated into movement of virtual tree characters. Organisms can furthermore be employed for content creation within a game. For example, in-game landscapes have been evolved in real-time based on the simultaneous growth of actual fungi and bacteria cultures in Petri dishes [6].

In the remainder of this work, we focus on an involuntary animal incorporated game [5] to study the expectations that humans have of playing such games. We realize that an involuntary type game by definition does not fulfill the requirements of the very relevant field of ACI. Still, since the main focus of this research lies on player expectations, we opted for a game which received notable media attention in, among others, popular gaming magazines, and of which gameplay footage is available. As mentioned in the introduction, our aim is to study why such a game received so much attention and the influence of the animal component on the reception of the game. Further motivations for our choice are argued in Sect. 5.

Although we have talked about the broad class of organisms until here, our study pertains to species of the phylogenetic branch of animals or Metazoa, thus excluding among others bacteria, fungi, slime molds, and plants. After discussing related other studies, we define our survey and analyze its results. With a concluding discussion we aim to give insight on human expectations of playing animal incorporated games, and its future directions.

3 Prior Studies of Players' (Expected) Experience

The difference in user experience between playing against a computer or against an opponent controlled by an organism was not yet empirically studied. Lee *et al*. [18] conducted a user experience study regarding a museum installation in which museum visitors interact with living cells. It displays a microscopic view of living cells through a touchscreen interface on which users can draw. These drawings are then projected onto the microscopy field as light patterns, causing phototactic responses and in turn

motion of the cells. Various games and experiments are available to installation users requiring them to guide cells to a specific area on the screen or trap them within a virtual box. The study mainly concludes that museum visitors enjoyed interacting with the installation. Participants made positive comments about the inclusion of living cells and other aspects of the installation were praised. Since there was no comparison with a similar installation lacking a living organism we cannot identify the impact of the organisms' presence on user experience.

User reviews of commercially available animal incorporated type games could also offer insight on player experiences. In the Google Play Store and Apple's App Store numerous games are on offer which were developed to be played by cats. The abovementioned *Games for Cats* [2] allegedly has over 2 million downloads (November 2016) and numerous consumer reviews. Here we mostly read whether cats did or did not seem to like the games, roughly how long they were interested, whether the (presumed) pet owners enjoyed watching cats play, and comments on the app itself, e.g. about price and stability. Although user reviews provide potentially valuable information to assess user experiences, in this case they give us no clear comparison between games with and without opponents controlled by organisms.

Aforementioned Pac-Man study [5] that compares playing against an algorithmically controlled versus against an animal-controlled opponent created a context that enabled study of player experiences with the modified (animal incorporated) and standard (player-versus-computer) Pac-Man games, although it did not undertake such an empirical comparison.

Although not about games that incorporate organisms, a relevant study was undertaken by Weibel *et al*. [21]. It concluded that players who falsely believed they played an online game against human-controlled opponents experienced more enjoyment, presence and flow in doing so, when compared to players that were aware of the opponents' true algorithmic control. Generalizing this result from human-controlled opponents to organism-controlled opponents, one can hypothesize that similar positive change in player experience could occur—in other words, the mere idea of playing a game incorporated with living organisms may affect player experience. As a corollary, even without actual playing, the mere idea of organism-controlled opponents in a game may positively affect expected player experience.

Table 1 offers us a conceptual framework to categorize studies that investigate either player expectations or experiences given various assumed and actual opponents. With computer opponents, we mean algorithmically controlled opponents. Exact organism simulations are hypothetical algorithmically controlled opponents that exhibit perfect simulation of organism behavior. Studies wherein the actual opponent is none do not engage participants in actual game playing, but choose an alternative approach for data gathering such as surveys.

Within the conceptual classification framework, Weibel *et al*. [21] compare experiences from categories A and C. Although not empirically founded, van Eck and Lamers [5] compare categories A and F. In fact, the study described here compares player expectations for categories G, H and I, based on several hypotheses that are presented next.

Table 1. Conceptual classification framework for studying player expectations and experiences given various assumed and actual opponents. (*) Despite our earlier choice to reserve the term organism for non-human species, this does not apply within the context of the conceptual classification framework: here organism refers to living organisms of any species, including humans.

Actual opponent	Assumed opponent		
	Computer	Exact organism simulation (*)	Actual organism (*)
Computer	A	B	C
Actual organism (*)	D	E	F
None	G	H	I

4 Hypothesizing Players' Expectations

Our study of player expectations is formed around several hypotheses regarding player expectations about organism incorporated games. Here we state these hypotheses and their backgrounds. Some of the hypotheses are formulated as a comparative statement. For the sake of brevity, unless explicitly mentioned, we have left out the base condition to which the comparison pertains, namely that the game is alternatively played against an algorithmically controlled opponent, a.k.a. non-player character or artificial intelligence (AI). Moreover, we refer to "animals" in the plural form whereby we mean one or more animals, and all mentions of "players" (plural and single) refer to humans.

Hypothesis 1. An animal incorporated game is expected to be less predictable.
It is a challenge for game developers to achieve the same unpredictability in AI opponents as exhibited by human opponents [22]. Although animals may not come up with well-considered game tactics, their natural behavior may add unpredictability to an opponent. This was observed in the Pac-Man versus crickets study [5]: after several minutes of play it became common for the crickets to ignore the vibrations and remain still, thus effectively pausing the game, while one play session even had a cricket introduce a new game character (ghost) by shedding its skin.

Hypothesis 2. An animal incorporated game is expected to be more fun.
Pet owners traditionally engage with their pets in non-computer games for reasons of enjoyment. Transferring this aspect of traditional interspecies play into the realm of digital gaming, one can imagine people expecting this aspect to enhance enjoyment in animal incorporated games. Furthermore, interaction with animals which might be detested in real-life (e.g. cockroaches, spiders) might trigger strong emotional responses such as excitement and abhorrence.

Moreover, although animal incorporated games are gaining momentum, for many (including gamers), it is yet an unknown possibility. As such, novelty bias could influence their expected enjoyment. Lack of experience with animal incorporated games could potentially cause misconceptions about the actual experience of interacting with animals, leading to heightened expectations. Furthermore, as explained above through reference to a study by Weibel *et al*. [21], falsely perceived existence of

a human opponent enhances experienced enjoyment for players. This result could potentially transfer to both non-human opponents and expected enjoyment.

Hypothesis 3. An animal incorporated game is expected to be more interesting than a game incorporating a hypothetical exact computer simulations of such animal.
It is potentially interesting to separate the impact of people's awareness about a non-human opponent from its factual implications for gameplay. If the same behavior of animal control could be achieved through a hypothetical exact computer simulation of such animal, would people expect animal incorporated games to be more interesting nonetheless? The foundations of this hypothesis are similar to those of hypothesis 2, but it attempts to compare against behaviorally identical "traditional" opponents.

Hypothesis 4. Animal incorporated games can be considered a form of animal abuse.
Animal welfare is a major aspect of animal-computer interaction research. Firstly, such research should itself respect the well-being of animals while experimenting to build new knowledge. Secondly, it should aim not only to avoid animal cruelty but also to improve the current conditions of various animals in all situations. Just as digital technology is used in many ways to improve our own lives (a role that computer gaming embraces), so should it be employed to the benefit of our pets, livestock, wildlife, etc. [9, 23].

Although improving animal welfare is not necessarily the main objective of animal incorporated games, it is worthwhile to consider people's expectations about its role in propagating animal cruelty. Regarding animal incorporated games in which biotechnology methods are used, so-called biotic games, an in-depth ethical analysis was presented by Harvey *et al*. [24].

5 Survey

Since our aim is to study the expected experience of animal incorporated type games, there is no need for participants to actually play such a game. Instead, a survey was undertaken among a population of people who were not (in particular) expected to have experienced actually playing animal incorporated type games. Several reasons exist to opt for this approach. Firstly, studying the actual experience of playing such games may be obfuscated by prior expectations. It is our goal to identify these prior expectations, in order to create a proper context for later study of actual play experiences. Secondly, actual playing could potentially make it difficult to offer a similar experience to all participants, since animal incorporated type games were observed to be less predictable [5] and might offer quite various experiences.

Instead of presenting our respondents with a general overview of animal incorporated type of games, we chose the abovementioned study of cricket-controlled Pac-Man ghosts [5] as a case example for our survey. This offers respondents a clear example of the topic instead of a potentially overwhelming summary. Moreover, since Pac-Man is an iconic game we expect respondents to have a basic understanding of the game's rules and how the algorithmically controlled ghosts in the standard game behave (for example that they have roughly constant speed). This enables respondents to compare the animal incorporated and standard versions of the game.

Alternative animal incorporated games such as *Playing with Pigs* [13] and *Cat Cat Revolution* [10] present new game concepts designed especially for animal incorporated gaming. As such they would (a) lack an implementation with computationally controlled opponents for comparison, (b) require explanation of the game rules, and (c) potentially direct respondents' focus towards the novel game concepts instead on the possible presence of animal opponents. A fictional animal incorporated type game could be used as the presented case example, but its lack of actual gameplay footage would make it more difficult for the respondents to imagine concrete gameplay.

Before being presented with survey questions, participants were shown a short introduction video that uses footage from the abovementioned study of cricket-controlled Pac-Man ghosts as an example game (98 s. total duration, of which 44 s. explanation about the game through on-screen text and images and 54 s. of gameplay footage accompanied by on-screen text).

After viewing the video, participants were asked to answer 16 questions. The first two questions verify whether the participants know the standard Pac-Man game and question how much they like it, while the third question asks if they ever heard of games in which humans interact with a living animal. Next we ask if they would prefer the standard Pac-Man game or the version in which one plays against an animal controlled opponent. Then we ask whether they think the animal controlled Pac-Man game will be less predictable than the standard game, whether they would prefer this added unpredictability, and whether using crickets to control the in game adversaries is considered animal abuse. We conclude the game related questions by asking whether they would prefer to play against either real crickets or an exact simulation of real cricket behavior, and again check which of the three variations (regular, animal controlled, simulation) they would prefer. Basic demographic information (age, gender, nationality, education, gaming experience) was queried and an opportunity for providing comments to the survey was given. The language of the survey and introductory video was English. The original survey and video materials can be viewed online[1].

5.1 Respondents

We collected results from 177 respondents. The majority of these (n = 146, 82%) were collected from bachelor students at The Hague University of Applied Sciences during various lectures within the Faculty of IT & Design. The authors of this work were not involved in these lectures. Another 26 (15%) were collected from bachelor and master students of various faculties at Leiden University during a public lecture organized by a student council, and given by one of the authors of this work. It should be noted that the lecture topics were unrelated to animal incorporated games and gaming in general. During break times or after lecture completion, attending students were shown the introductory video after which they were asked to answer the survey questions. The remaining 5 responses (3%) were collected via a public Google Forms site distributed via gaming forums.

[1] http://goo.gl/forms/5Zy5nachA5.

Of the collected results none were discarded, leaving us 177 data for analysis. A brief summary of respondent characteristics is presented in Table 2. Although we queried the respondents' level of education and nationality we choose to leave these out of the results. We afterwards realized that the surveys usage of the American educational system is probably confusing for the mostly European group of respondents, possibly resulting in incorrect answers. We discarded the results on nationality since part of the respondents selected multiple answers, probably their original nationality and current residency.

Table 2. Brief summary of respondent characteristics based on self-report.

Topic	*Options*	*n*	*Fraction*
Age	12–17	2	1%
	18–24	147	83%
	25–34	24	14%
	35–44	3	2%
	Unreported	1	1%
Gender	Female	60	34%
	Male	114	64%
	Unreported	3	2%
Gamer	Yes	102	58%
	No	74	42%
	Unreported	1	1%
Play games	Never	14	8%
	Once a year	13	7%
	Once a month	24	14%
	Once a week	24	14%
	Some days per week	63	36%
	Every day	36	20%
	Unreported	3	2%

5.2 Results

Almost all respondents (n = 175, 99%) were familiar with the standard Pac-Man game and the majority either liked it "very much" (n = 28, 16%), "a bit" (n = 115, 65%) or "not so much" (n = 28, 16%). Eighty-five percent (n = 151) of the respondents had not yet heard of computer games which you play against animals. Table 3 presents the main questions and results of this survey.

Twenty-three participants left a comment. Comments ranged from compliments (e.g. "Very interesting field of research!", "Fun experiment!", "Brilliant concept"), encouragements (e.g. "Good luck!", "Keep it up!"), suggestions (e.g. "Mice would be fun too", "I'd use something else than bugs. And make it very clear the animals are not being harmed") and personal statements (e.g. "I don't like insects to be fair").

Table 3. Main questions of the survey and their results (n = 177).

	n	*Fraction*
A. *Would you prefer to play the standard Pac-Man game or Pac-Man against an animal controlled opponent?*		
Standard Pac-Man	60	34%
Pac-Man versus an animal controlled opponent	76	43%
I don't know	41	23%
Unreported	0	0%
B. *Do you expect playing Pac-Man against an animal controlled opponent will be more fun on the long term?*		
I expect standard Pac-Man would always be more fun to play	23	13%
It would be more fun for a couple of times	86	49%
It would be more fun for a week	13	7%
It would be more fun for a month	7	4%
It would be more fun for a year	1	1%
I expect an animal controlled opponent is always more fun	20	11%
I don't know	26	15%
Unreported	1	1%
C. *Do you think the animal controlled Pac-Man game will be less predictable?*		
Yes	133	75%
No	29	16%
I don't know	15	8%
Unreported	0	0%
D. *If yes, would you prefer this added unpredictability?*		
Yes	110	62%
No	23	13%
I don't know	20	11%
Unreported	24	14%
E. *If it was possible to exactly simulate the behavior of the crickets, would you prefer this above playing against real crickets?*		
Yes	65	37%
No	59	33%
I don't know	52	29%
Unreported	1	1%
F. *Which Pac-Man variant would you prefer?*		
Standard Pac-Man game	55	31%
Pac-Man versus real crickets	51	29%
Pac-Man versus computer simulated behavior of crickets	51	29%
I don't know	20	11%
Unreported	0	0%
G. *Do you consider playing Pac-Man against crickets animal abuse?*		
Strongly agree	10	6%
Agree	20	11%

(*continued*)

Table 3. (*continued*)

	n	*Fraction*
Neutral	66	37%
Disagree	49	28%
Strongly disagree	30	17%
Unreported	2	1%

6 Discussion

We studied the expected experience of animal incorporated games, through the use of a survey. Respondents were asked to consider expected differences between games with animal-controlled opponents, algorithmically controlled opponents, and opponents who are exact computer simulations of animal behavior. Focus was placed on aspects of expected predictability of behavior, expected fun when playing, and potential animal abuse. The results can be used to create a proper context for later study of player experiences regarding this type of games, and in particular to assess aspects such as novelty bias regarding animal incorporated games.

Results indicate that respondents firmly expect that animal-controlled opponents add unpredictability to the gameplay (Table 3C). Moreover, the added unpredictability appears appealing, given that 62% of respondents indicated to prefer it (Table 3D). This confirms the first stated hypothesis that an animal incorporated game is expected to be less predictable.

When asked about expected enjoyment or fun (Table 3B), respondents appear somewhat dichotomous in their expectations. Expected duration of enjoyment shows a general skewed bell-shaped distribution, with a maximum at the qualitative notion of "a couple of times" (49%). Extending from this point in both directions along the spectrum of duration (towards "never" ("prefer standard game") in one direction (13%), and towards "for a year" (1%) in the other), the distribution decreases monotonously. However, beyond the qualitative duration "for a year", at the indeterminate notion of "always more fun" there is a sharp increase (11%). This appears to indicate that the expected duration of added enjoyment for the majority group of respondents (n = 130, 73%) is distributed roughly bell-shaped, yet that a smaller mutually exclusive group of respondents (11%) expects animal-controlled opponents to always offer more enjoyment than computationally controlled opponents. The remaining respondents indicated not to have an expectation of enjoyment duration (15%), or did not answer the question (1%).

In light of hypothesis 2 which states that an animal incorporated game is expected to be more fun, we conclude that in general respondents expect animal incorporated games to be "more fun" than playing against common algorithmically controlled opponents. However, overall the added enjoyment is expected to be of limited duration (Table 3B), with the exception of a smaller group of respondents expecting sustained added enjoyment. These results can be interpreted as an indication that for the majority of respondents (73%) the expected added fun is caused by a "novelty effect", whereas a much smaller group (11%) expect more sustained factors to cause added enjoyment.

Although such sustained factors were not all specifically hypothesized, candidate factors are expected unpredictability of animal behavior, psychological effects caused by awareness of animal opponents, and expected engagement within play by animals.

Regarding the hypothetical possibility of implementing exact simulations of animal behavior as a substitute for using real animals, preferences expressed in Table 3E were roughly uniformly distributed over the three offered alternatives: preference for real animals (37%), preference for exact simulation (33%), explicitly stating not to know the preference (29%). Interestingly, both the roughly equal fractions of stated preferences, and the relatively large fraction of respondents unknowing of their preference point towards an overall equal split between the two alternative approaches.

With regards to hypothesis 3 which states that game played against animals is expected to be more interesting than when played against exact computer simulations of animals, it is interesting to consider what expectations could lead to the three alternative answers in Table 3E. Firstly, one could assume that both a preference for exact behavioral simulation (Table 3E, "yes") and an unknown preference towards either of the stated approaches (Table 3E, "don't know") indicate that respondents expect animal incorporated games to impact only behavior of opponents, and not provide other benefits, such as added player enjoyment caused by awareness of animal opponents. Alternatively, a preference for animal opponents (Table 3E, "no") could indicate the opposite: that besides potential behavioral effects, animal incorporated games offer other benefits. Secondly, preference for exact behavioral simulation (Table 3E, "yes") could point at having negative connotations towards the use of animals in gaming.

The survey questions shown in Table 3F and E overlap in content. Table 4 illustrates how these two questions are co-answered by respondents. As expected, the following co-answers occur frequently: Table 3E "yes" and Table 3F "simulation", Table 3E "no" and Table 3F "crickets", Table 3E "don't know" and Table 3F "don't know". This illustrated consistency in cross-question answering.

Table 4. Co-answering matrix for survey questions regarding preference for either simulation or animal opponents.

Prefer simulation above crickets? (Table 3E)	*Which Pac-Man variant would you prefer?* (Table 3F)				
	Standard	Simulation	Crickets	I don't know	*Unreported*
Yes	15	36	10	4	0
I don't know	19	8	12	13	0
No	21	6	29	3	0
Unreported	0	1	0	0	0

Pearson's Chi-square test was applied on the data of Table 4, excluding the "unreported" row and column. Results ($n = 176$, $p < 0.0001$) indicate that co-occurring answers deviate with statistical significance from their expected values under a null-hypothesis of no correlation. This outcome supports the a-priori expectation that the abovementioned answers strongly co-occur.

With respect to hypothesis 4, which states that an animal incorporated game can be considered a form of animal abuse, clearly opinions are divided, but not polarized (Table 3G). As mentioned earlier in regards to hypothesis 3, a preference for exact behavioral simulation over animal opponents could point at having negative connotations towards the use of animals in gaming. Table 5 illustrates the co-occurrence of such preferences (Table 3E) with answers regarding animal abuse (Table 3G). If leaving the "unreported" answers outside consideration, one could a-priori expect a co-occurrence pattern that appears stronger in the top-left, middle section and bottom-right of the co-answering matrix. Generally, this pattern is confirmed, with the exception of co-answers within the column "strongly agree". Oddly, respondents who agree strongly with the abuse-statement (Table 3G), would overall prefer playing against animals over simulated opponents when given this choice. An explanation for this seemingly contradictory aspect of otherwise logical answer co-occurrences in Table 5 is provided by the following statistical analysis.

Table 5. Co-answering matrix for survey questions Table 3E and G.

Prefer simulation above crickets? (Table 3E)	*Do you consider playing Pac-Man against crickets animal abuse?* (Table 3G)					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	*Unreported*
Yes	1	12	30	15	6	1
I don't know	3	3	15	19	11	1
No	6	5	21	14	13	0
Unreported	0	0	0	1	0	0

Pearson's Chi-square test applied to Table 5, excluding the "unreported" row and column, indicates that co-occurring answers deviate with minor statistical significance from a pattern of no correlation ($n = 174$, $p < 0.05$). However, a common underlying assumption of the test, namely that all expected values under the null-hypothesis exceed 4, is not met for the top three cells in column "strongly agree", but is met for all other expected co-occurrences. This indicates that the odd results for said column are caused by underrepresentation in the sample data, whereas the a-priori expected distribution of co-occurring answers is met with statistical significance. Statistical significance ($n = 164$, $p < 0.05$) and the underlying assumptions are upheld when applying the same test excluding also column "strongly agree". This affirms our observation that preference for a simulated over real animal opponent is correlated and potentially modulated by considerations of animal welfare.

A similar co-answering matrix is presented in Table 6, correlating answers regarding animal abuse with preference between algorithmic opponent and animal opponent. Leaving the "unreported" answers outside consideration, here too we find the expected pattern of strong co-occurrence in top-left, middle section and bottom-right of the co-answering matrix. As in Table 5, expected values under the Chi-square test's null hypothesis of no correlation are too low in column "strongly agree", violating one of the test's underlying assumptions. Excluding said column, the

sample data meet all underlying assumptions of the test. Applying Pearson's Chi-square test as above, both including and excluding column "strongly agree", yields results that are statistically significant (resp. $n = 175$, $p < 0.005$, and $n = 165$, $p < 0.05$). As in Table 5 also, these data and statistical test results indicate that preference for potential animal opponents is significantly correlated and potentially modulated by considerations of animal welfare.

Table 6. Co-answering matrix for survey questions Table 3A and G.

Standard Pac-Man or versus crickets? (Table 3A)	*Do you consider playing Pac-Man against crickets animal abuse?* (Table 3G)					
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	*Unreported*
Standard Pac-Man	8	13	19	14	6	0
I don't know	1	2	18	13	5	2
Versus crickets	1	5	29	22	19	0
Unreported	0	0	0	0	0	0

Having discussed the results in relation to the four hypotheses stated, it is time to reflect on the meaning of it all. Animal incorporated type of games are strongly expected to add unpredictability to opponent behavior, and respondents expect that this unpredictability is a preferable. Furthermore, they are generally expected to be "more fun" than playing against algorithmically controlled opponents, although the added enjoyment is expected to be of limited duration. This hints at a novelty effect in expected player enjoyment. Naturally, this result does not consider animal enjoyment, or other aspects of animal well-being. Although considerations of animal abuse are difficult to quantify exactly from the data, it is clearly a present factor of concern. Moreover, we do find multiple quantitative and statistically significant indications that willingness to play animal incorporated games, instead of common computer opponents or hypothetical exact simulations of animals, is moderated by animal welfare concerns.

Naturally, our study does not cover all the possible aspects to consider in understanding player preferences for animal incorporated type of games. It is an initial venture into the study of acceptance of such games. To complete the picture, alternative aspects such as animal volition to play, regards of animal species, animal roles (wildlife, livestock, pets) and many more, should be studied.

With regards to methodological implications we recognize and accept the limitations. A potentially striking choice is the selection of a specific example case (crickets and Pac-Man) upon which to base the survey introduction and questions. Naturally, the approach chosen could influence the results, and we have explained our reasoning for this choice extensively in Sect. 4. Nonetheless, the fact that the crickets did not partake voluntarily and were stimulated with vibrations could affect respondents' emotions and

answers[2], potentially affecting results regarding three of the four stated hypotheses. More general methodological implications include the gathering of data through self-report, and the possibility that respondents did not correctly understand the meaning of hypothetical "exact simulation" of animal behavior.

Results should be considered with respect to their correct scoping. In particular, expectations are not experiences. We have indicated at the onset of this work that it deals with player expectation, which may be different from actual (future) experiences. Naturally, a sample of generally Dutch students is not representative for the diversity of culture, age, experience, personal situation, etcetera of a general population. Logistic constraints have contributed to these scoping boundaries.

To better understand the player's experience, our next step will be to conduct a study on the *actual* player experience using an animal incorporated type game developed solely for this purpose. The findings of this article will support us in making more informed decisions regarding both our game design and our experiment design.

We are confident to have presented a valuable initial venture into studying the acceptance of animal incorporated type of games. As this work deals with expectations, we expect that this challenging topic will be further unraveled by us and others.

References

1. Riedel-Kruse, I.H., Chung, A.M., Dura, B., Hamilton, A.L., Lee, B.C.: Design, engineering and utility of biotic games. Lab Chip **11**(1), 14–22 (2011). https://doi.org/10.1039/C0LC00399A
2. Purina Friskies: Games for Cats (2011). https://www.gamesforcats.com
3. Wilson, S.: Protozoa Games (2003). http://userwww.sfsu.edu/swilson/art/protozoagames/protogames10.html
4. Geurtsen, A., Lamers, M.H., Schaaf, M.J.M.: Interactive digital gameplay can lower stress hormone levels in home alone dogs—a case for animal welfare informatics. In: Chorianopoulos, K., Divitini, M., Hauge, J.B., Jaccheri, L., Malaka, R. (eds.) ICEC 2015. LNCS, vol. 9353, pp. 238–251. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-24589-8_18
5. van Eck, W., Lamers, M.H.: Animal controlled computer games: playing Pac-Man against real crickets. In: Harper, R., Rauterberg, M., Combetto, M. (eds.) ICEC 2006. LNCS, vol. 4161, pp. 31–36. Springer, Heidelberg (2006). https://doi.org/10.1007/11872320_4
6. van Eck, W., Lamers, M.H.: Biological content generation: evolving game terrains through living organisms. In: Johnson, C., Carballal, A., Correia, J. (eds.) EvoMUSART 2015. LNCS, vol. 9027, pp. 224–235. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-16498-4_20
7. Fagen, R.: Animal Play Behaviour. Oxford University Press, New York (1981)
8. Smith, P.K.: Play in Animals and Humans. Blackwell Pub, Oxford (1986)
9. Mancini, C.: Animal-computer interaction: a manifesto. Interactions **18**(4), 69–73 (2011). https://doi.org/10.1145/1978822.1978836

[2] As one respondent indicated on the survey, "*I do not like crickets!*".

10. Noz, F., An, J.: Cat cat revolution: an interspecies gaming experience. In: Proceedings of SIGCHI Conference on Human Factors in Computing Systems, pp. 2661–2664 (2011). https://doi.org/10.1145/1978942.1979331
11. Tan, R.T.K.C., Cheok, A.D., Peiris, R., Todorovic, V., Loi, H.C., Loh, C.W., Derek, T.B.S.: Metazoa ludens: mixed reality interactions and play for small pets and humans. Leonardo **41** (3), 308–309 (2008). https://doi.org/10.1162/leon.2008.41.3.308
12. Westerlaken, M., Stefano G.: Felino: the philosophical practice of making an interspecies videogame. In: The Philosophy of Computer Games Conference, pp. 1–12 (2014)
13. Alfrink, K., van Peer, I., Lagerweij, H., Driessen, C., Bracke, M.: Playing with Pigs (2012). http://www.playingwithpigs.nl
14. Wirman, H.: Games for/with strangers-captive orangutan (pongo pygmaeus) touch screen play. Antennae **30**, 105–115 (2014)
15. Extra Pop.: Games for dogs (2015). http://www.bicshare.com
16. Baskin, S., Zamansky, A., Kononova, V.: Exploring human perceptions of dog tablet playful interactions. In: Proceedings of Third International Conference on Animal-Computer Interaction (2016). https://doi.org/10.1145/2995257.3012023
17. Youtube: African Bull Frog ant crusher (2011). youtu.be/WlEzvdlYRes
18. Lee, S.A., Bumbacher, E., Chung, A.M., Cira, N., Walker, B., Park, J.Y., Starr, B., Blikstein, P., Riedel-Kruse, I.H.: Trap it!: a playful human-biology interaction for a museum installation. In: Proceedings of 33rd Annual ACM Conference on Human Factors in Computing Systems (2015). https://doi.org/10.1145/2702123.2702220
19. Youtube: Fish plays Pokemon: pallet town syndrome (2014). youtu.be/48-qOC4fCdk
20. Young, D.: Lumberjacked (2005). http://classic.rhizome.org/artbase/artwork/35526
21. Weibel, D., Wissmath, B., Habegger, S., Steiner, Y., Groner, R.: Playing online games against computer- vs. human-controlled opponents: effects on presence, flow, and enjoyment. Comput. Hum. Behav. **24**(5), 2274–2291 (2008). https://doi.org/10.1016/j.chb.2007.11.002
22. Rouse, R.: Game Design: Theory and Practice, 2nd edn. Jones and Barlett Publishers, Sudbury (2005)
23. Mancini, C., Zamansky, A.: Charting unconquered territories: intelligent systems for animal welfare. In: 40th Annual Convention of the Society for the Study of Artificial Intelligence and the Simulation of Behaviour, pp. 181–182 (2014)
24. Harvey, H., Havard, M., Magnus, D., Cho, M.K., Riedel-Kruse, I.H.: Innocent fun or 'microslavery'. Hastings Cent. Rep. **44**(6), 38–46 (2014). https://doi.org/10.1002/hast.386