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### The development and pilot evaluation of a 'serious game' to promote positive child-animal interactions

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*Published in:*  
Human-Animal Interaction Bulletin

E-pub ahead of print: 20/08/2019

*Document Version*  
Peer reviewed version

[Link to publication on the UWS Academic Portal](#)

*Citation for published version (APA):*  
Hawkins, R. D., & Williams, J. M. (2019). The development and pilot evaluation of a 'serious game' to promote positive child-animal interactions. *Human-Animal Interaction Bulletin*, 8(2).

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1 **The Development and Pilot Evaluation of a ‘Serious Game’ to Promote Positive Child-Animal**  
2 **Interactions**

3

4 **Running head:** SERIOUS GAME TO PROMOTE POSITIVE CHILD-ANIMAL INTERACTIONS

5

6

**Abstract**

7 Animal welfare education aims to nurture compassion, respect and kindness to animals but there  
8 remains a need for more rigorous evaluations of such programmes to assess the most effective  
9 approaches. Incorporating technology into animal welfare education is a relatively novel field. This  
10 study examines the process of designing, developing, and evaluating the effectiveness of a new  
11 theoretically-driven educational computer game intervention. Pet Welfare was designed for children  
12 aged 7-12 years, to promote positive child-animal interactions. A pre-test, post-test, test-control,  
13 quasi-experimental design was used using a self-report questionnaire that children completed within  
14 class. Participants included 184 primary-school children from schools in Scotland, UK. The results  
15 indicated a positive impact on knowledge about animal welfare needs, knowledge about appropriate  
16 and safe behaviour towards pets and beliefs about pet minds. Children were also less accepting of  
17 cruelty to pets. . There was no impact on self-reported compassion. This study presents the first  
18 evaluation of a digital animal welfare ‘serious game’ for children, demonstrating the benefits of  
19 incorporating technology and game-based learning into animal cruelty prevention. The results of this  
20 study will inform future education directions for those wishing to promote positive and safe  
21 relationships between children and animals.

22

23 **Key words:** Animal Cruelty; Animal Welfare; Children; Education; Technology; Serious games

24

25

**Introduction**

26 School-based animal welfare education aims to nurture compassion, respect and kindness to animals,  
27 can facilitate empathy, humane attitudes, prosocial skills and behaviour, and can play a key role in  
28 violence prevention (Arbour, Signal & Taylor, 2009; Ascione & Weber, 1996; Faver, 2010; Nicoll,  
29 Trifone & Samuels, 2008). Such programmes can be built into existing curricula, follow school  
30 pedagogy and therefore meet educational standards by building on specific subjects (‘curriculum-  
31 blended’; Ascione, 1997). Animal welfare education programmes can also be built upon the  
32 framework of curriculum for excellence (Hawkins, Williams & Scottish SPCA, 2017a). Even though  
33 many programmes that involve direct child-animal interactions have proven to be successful (e.g.

34 Nicoll, Samuels & Trifone, 2008; Tardif-Williams & Bosacki, 2015), direct contact is neither always  
35 possible nor necessary (e.g. Ascione, 1993; Hawkins, Williams & Scottish SPCA, 2017a). Scientific  
36 evaluations of such programmes are lacking, and evaluation studies that do exist, lack methodological  
37 rigour with many not including control groups. This paves the way for new collaborations between  
38 researchers, psychologists and animal welfare organisations to develop and evaluate the effectiveness  
39 of such programmes and assess the best practices in promoting positive human-animal interactions.

40 There is a lack of research into the development and evaluation of interventions which aim to prevent  
41 animal cruelty and to promote positive child-animal interactions. Those interventions that do exist,  
42 have focused on intervention once a child has been cruel to an animal, rather than on prevention. Most  
43 research on childhood animal cruelty rarely considers cruelty within the general population, instead  
44 focusing on narrow clinical or other special populations (Ascione, 1993; Felthous & Kellert, 1987;  
45 Hawkins, Hawkins & Williams, 2017; Longobardi & Badenes-Ribera, 2018), but ideally, prevention  
46 programmes should be universal. We know from previous research (Hawkins, 2018; Hawkins,  
47 Hawkins & Williams, 2017) that most cruelty towards animals in childhood is accidental, and that  
48 education is the key to preventing unmotivated animal cruelty and promoting positive and safe child-  
49 animal interactions (Hawkins, Williams & Scottish SPCA, 2017a). We also know that dogs, cats and  
50 rabbits are not only the most common pets in the UK, but also the most common targets for pet  
51 cruelty in childhood (Scottish SPCA, 2017; PDSA, 2011). The present study examines the  
52 effectiveness of a new theoretically-driven digital educational intervention for children in the general  
53 population, focusing on dogs, cats and rabbits. Pet Welfare was designed to enhance compassion,  
54 understanding of animal sentience, animal welfare needs, appropriate and safe behaviour towards  
55 animals, and prevent animal cruelty from an early age.

56 As mentioned, childhood animal cruelty is often unintentional, and may have cognitive roots,  
57 resulting from misinterpretation of animal behaviour and welfare needs, as well as a lack of  
58 knowledge about appropriate and safe behaviour towards animals, and lack of ability to recognise  
59 emotional signals in pets (Hawkins & Williams, 2016; Lakestani, Donaldson, Verga & Waran, 2006;  
60 Meints & De Keuster, 2009). Reducing acceptance of animal cruelty (indicative of cruelty behaviour)  
61 through education is a key goal, which could be achieved through the inclusion of emotional material  
62 aimed to increase beliefs about animal minds, how to accurately identify emotional signals (Hawkins  
63 & Williams 2016; Lakestani, Donaldson & Waran, 2014; Meints, Racca & Hickey, 2010), and  
64 through examples of animal cruelty and neglect (Hawkins, Williams & Scottish SPCA, 2017a).  
65 Educational materials need to be child-friendly and ethically appropriate, without distressing images.  
66 This can be tackled through focusing on accidental and intentional animal cruelty using common  
67 everyday scenarios and behaviours (e.g. “Should you pull a cat’s whiskers?”).

68 Considering unmotivated animal cruelty and neglect, children also seem to lack detailed animal  
69 welfare knowledge (Jamieson et al., 2012; Muldoon et al., 2009; Wells & Hepper, 1995), leading to  
70 inadequate animal care (Batson, 2008) and animal welfare issues such as irresponsible pet ownership  
71 (Buckland et al., 2014). Research shows that even adult pet owners lack knowledge about pet welfare  
72 and social needs, especially concerning rabbits (Edgar & Mullan, 2011). Teaching children about the  
73 complex welfare needs of animals, their natural behaviours and social needs, is important to promote  
74 positive pet-owner relationships and prevent accidental cruelty and neglect (D'ovidio, Pierantoni,  
75 Noviello & Pirrone, 2016). Moreover, evidence-based educational interventions that target these  
76 cognitive factors may have the potential for promoting responsible pet care, optimal pet welfare, and  
77 for the prevention of cruelty and neglect (Buckland et al., 2014; Tardif-Williams & Bosacki, 2015).

78 Computer games for educational purposes (i.e. 'game-based learning' or 'serious games'), have been  
79 found to be more effective at increasing learning and retention, and cognitive outcomes than  
80 traditional teaching methods (Vogel et al., 2006; Wouters, Van Nimwegen, Van Oostendorp & Van  
81 Der Spek, 2013). Computer games can be built upon the science or 'pillars' of learning, ensuring high  
82 quality education, and can target both cognitive and affective aspects of learning and have been  
83 shown to promote helping behaviour and reduce aggressive cognitions (Ewoldsen et al., 2012;  
84 Schmierbach, 2010; Chi, 2009; Hirsh-Pasek et al., 2015; Alfieri et al., 2011; Darling-Hammond,  
85 2008; Fisher et al., 2011; James & Swain, 2011). Moreover, technology can be utilised to create  
86 emotionally engaging experiences for children which fosters interest in animals, promotes a sense of  
87 emotional connection to another species, and subsequently elicits cognitive and affective empathy for  
88 animals (Webber et al., 2017). The use of photos can stimulate positive responses towards animals  
89 (Myers, Saunders & Bexell, 2009). There is therefore exciting potential for new educational computer  
90 games to be developed and evaluated which aim to promote positive child-animal interactions.

91

## 92 **The Present Study**

93 The aim of this study was to evaluate the effectiveness of a new 'serious game' named Pet Welfare.  
94 This study aimed to answer the following research question: Does the Pet Welfare game intervention  
95 have a significant impact on children's beliefs about pet minds, knowledge about animal welfare  
96 needs, knowledge about appropriate and safe behaviour towards pets, compassion towards animals  
97 and acceptance of cruelty to pets? It was hypothesised that there would be a significant pre- to post-  
98 test change for all target outcomes for the intervention group but not the control group.

99

100

## **Method**

101

102 **Development of Pet Welfare**

103 Pet Welfare was developed using Articulate Storyline 2 (www.articulate.com), an e-learning tool that  
104 allows interactive educational material to be developed for online or offline use. A series of  
105 interactive levels were developed for the three types of pets (dogs, cats and rabbits) incorporating text,  
106 images and sound. Three levels were developed per animal to provide variety and different  
107 interactivity. Children received feedback throughout the game and viewed their scores. All images  
108 were either provided by the Scottish SPCA or purchased from photo stock websites. Once developed,  
109 the game was downloaded and played offline through the Articulate Storyline Mobile App player on  
110 iPads in class (also available on other devices).

111 Based on a literature review, key target outcomes were decided before the development of the game,  
112 feeding into decisions made regarding content, and therefore were the focus of the evaluation  
113 procedure. A logic model based on the Evidence Based Practice Unit (EBPU) Logic Model (Wolpert  
114 et al., 2016) was created to inform the development of the game (Figure 1). Based on the logic model,  
115 an evaluation questionnaire was developed. This included measures to test the key target outcomes of  
116 the game (knowledge, beliefs about pet minds, compassion and acceptance of cruelty to pets). All  
117 content and feedback were based on current scientific research into animal sentience, behaviour and  
118 welfare and confirmed by animal behaviour experts to ensure accuracy and to avoid misinformation.  
119 Images were also sent to three animal behaviour experts for validation during the development phase  
120 to ensure accuracy of the emotions displayed. All three behaviour experts had expertise in identifying  
121 and recognising behaviour stills and agreed accuracy of all images.

122

123 [Figure 1 about here]

124

125 **Level 1: Sentience and Belief in Animals Minds**

126 Level 1 targeted children’s beliefs about pet minds. The aim of this level was to teach children that pet  
127 animals are sentient and to facilitate their beliefs about pet minds using the most up-to-date research  
128 on animal emotion and cognition. The questions focused on the items from the Children’s Beliefs  
129 about Animal Minds measure (Hawkins & Williams, 2016), happiness, sadness, fear, pain and  
130 intelligence. In this level, an image was presented on the screen (e.g., a scared dog) with the question  
131 “how is this dog/cat/rabbit feeling?”. Children had to choose a correct answer from four options  
132 (happy/sad/scared/in pain). One image per emotion (happy/sad/scared) was provided per animal.  
133 Where no suitable image was available, children were shown a neutral image of an animal and asked  
134 “can dogs/cats/rabbits feel pain?” and “are dogs/cats/rabbits clever?” and subjects had to click yes or  
135 no on the screen. Feedback was provided about information on animal behaviour relating to those

136 emotions (e.g. “This dog is frightened. A frightened dog might crouch down or whimper”). The  
137 feedback was made short, simple and child-friendly. For correct answers, children were congratulated  
138 and provided with feedback, for incorrect answers, “oops that was incorrect” was displayed and  
139 children were given another chance. All emotion images had a plain white background to prevent  
140 children from looking for visual cues in the background of images.

141

## 142 **Level 2: Knowledge of Animal Welfare Needs**

143 The goal of level 2 was to tackle potential inaccurate knowledge and promote new knowledge around  
144 the welfare needs of animals and highlight the five freedoms. This level focused on what pet animals  
145 need to be ‘happy and healthy’ through a ‘drag and drop’ game. For each animal, children had options  
146 of care items (e.g. water) and distractors (e.g. chocolate) to move on the screen and were asked “what  
147 does a dog/cat/rabbit need to be happy and healthy?”. Correct items had to be moved onto a target  
148 animal icon and incorrect items onto a bin icon. Incorrect answers ‘bounced back’ and so children had  
149 to keep trying until all items were on the correct location. Once finished, feedback was provided about  
150 the five freedoms for each animal to reinforce learning and provide context to the items.

151

## 152 **Level 3: Appropriate Behaviour**

153 Level 3 focused on children’s interactions with pets, which is important for preventing accidental  
154 animal cruelty (Buckland et al., 2014; Shen et al., 2016). This level involved a quiz where children  
155 had to respond to questions by pressing ‘yes’ or ‘no’. The questions related to animal welfare  
156 knowledge (e.g. “Should you give a dog chocolate?”), accidental animal cruelty (e.g. “Should you  
157 hold a rabbit upside down like a baby?”), motivated animal cruelty (e.g. “Should you kick a cat?”),  
158 animal neglect (e.g. “Should you leave a cat alone for a few days without feeding it?”) and safe  
159 behaviour towards animals (e.g. “Should you approach a dog you don’t know?”), two questions per  
160 theme and ten questions per animal. Feedback reinforcing key messages was provided after each  
161 question (e.g. “Rabbits do not like this, they become stressed. It slows their heartbeat and puts them in  
162 a trance like state which can be harmful”).

163

## 164 **Evaluation Method**

165

### 166 **Participants**

167 Participants included 184 primary school children, 92 test and 92 control (53% boys, 47% girls) from  
168 three schools in West Lothian, Scotland, UK. Randomisation was not possible for this study and so a  
169 quasi-experimental design was used. Two schools made up the test group and one school made up the  
170 control group. Children were aged between 7-years and 12-years (M=10, SD=1) and from two age  
171 classes, 7-9-years (42%) and 10-12-years (58%). The control group was from a separate school and  
172 age-matched to the test group. Most children had pets (63%). The types of pets owned were: dogs  
173 (40%), cats (20%), rabbits (1%), other small mammals (8%), horse/donkey/pony (2%), birds (4%),  
174 fish (11%), and reptiles/amphibians (4%).

175

## 176 **Design**

177 A quasi-experimental, mixed factorial design was used to evaluate the intervention. One variable was  
178 phase of testing (time), a repeated-measures variable with two conditions: pre-tests (day before  
179 intervention) and post-tests (two days after intervention). The between-subjects variable was the  
180 intervention condition (game intervention vs. control).

181

## 182 **Procedure**

183 The ethical guidelines of the British Psychological Society, specifically relating to research with  
184 children, were adopted for this research, and ethical consent was granted from an internal review  
185 board at the host university. Permission was granted from the local authority before schools were  
186 contacted via email and telephone. Head teachers and class teachers were provided with information  
187 regarding the study and participation was at their discretion. Parents/guardians were provided with a  
188 covering letter and project information sheet at least a week ahead of the study. Opt-out forms were  
189 provided to complete and return to the school if a parent/guardian wished not to give their consent for  
190 their child to participate in the research project. Only one parent opted their child out from the study.  
191 Child consent was also obtained with child-friendly consent forms.

192 The pre-test, intervention, and post-test conditions were conducted over three school days. Children  
193 completed the pre-test questionnaire on the first day (Monday), played the game intervention on the  
194 second day (Tuesday) and then completed the post-test questionnaire two days later (Thursday). The  
195 control group followed a similar pattern whereby they completed the pre-test questionnaire on the first  
196 day (Monday), went about usual class activities on the second day (Tuesday), and completed the post-  
197 test questionnaire two days later (Thursday). The control group were able to play the game  
198 immediately following the completion of the post-test questionnaire. On the intervention day, children  
199 took turns individually playing the game at their school desk. The game took each child  
200 approximately 15 minutes to complete.

201

## 202 **Pre- and Post-test Questionnaire**

203 A self-report questionnaire was developed as the evaluation tool and administered during class time.  
204 The questionnaire comprised of a range of validated child-animal measures described below, each  
205 checked for reliability using Cronbachs Alpha. The questionnaire took each child approximately 15  
206 minutes to complete and they could ask the researcher or their teacher for help if needed. The  
207 researcher and teachers could only help the children read or understand a question and did not provide  
208 the child with any answers. Demographic questions including gender, age and pet ownership (yes/no)  
209 were incorporated. Other measures included: beliefs about pet minds, knowledge about the five  
210 freedoms, knowledge about appropriate and safe behaviour, compassion, and acceptance of cruelty to  
211 animals.

212

### 213 **Children’s Beliefs about Pet Minds**

214 An adapted version of the Children’s Beliefs about Animal Minds measure (Hawkins & Williams,  
215 2016; Menor-Campos, Hawkins & Williams, 2018) was created for the purpose of this evaluation,  
216 named Children’s Beliefs about Pet Minds. Each scale (e.g., “Do you think the following animals are  
217 ...?”) relates to a specific sentence item (clever/pain/happiness/sadness/fear). These questions were  
218 asked in relation to dogs, cats and rabbits. Each item is scored on a 5-point Likert scale (“Strongly  
219 disagree” to “Strongly agree”). Total scores were calculated for each species (score range 5-25) as  
220 well as an overall Child-BAM score across all species (score range 15-75) where a high score  
221 indicates high Child-BAM. The measure demonstrated high reliability within the current sample ( $\alpha =$   
222 0.91).

223

### 224 **Children’s Knowledge about the Five Freedoms for Pets**

225 This knowledge question asked, “What do dogs/cats/rabbits need to be happy and healthy?”. An  
226 image of each animal was provided with space around the image for children to write freely. Answers  
227 were coded according to the five animal freedoms. For example, mentioning food, water and hay for  
228 rabbits would score the child three points for ‘freedom from thirst, hunger and malnutrition’. Total  
229 scores for each species were calculated as well as a total knowledge score across species. The measure  
230 demonstrated very good reliability within the current sample ( $\alpha = 0.76$ ). There was no maximum total  
231 score.

232



233 **Children’s Knowledge about Appropriate and Safe Behaviour towards Pets**

234 This measure was developed specifically for this study to test elements of the intervention around  
235 appropriate and safe behaviour. The measure asked, “Should you do the following...?” for 12 items.  
236 Four questions per species were included and the questions were taken directly from those included in  
237 the game intervention. One question per species was asked for welfare knowledge (e.g. “Give cats  
238 toys such as a scratching post?”), one question per animal for cruelty (e.g. “Shout or scream at a  
239 dog?”), one question per species for neglect (e.g. “Leave a cat for a few days without feeding it?”) and  
240 one question per species for safe behaviour towards animals (e.g. “Touch a rabbit when it is showing  
241 its teeth or stomping its feet?”). Total scores for each species were calculated (score range 4-20) as  
242 well as a total knowledge score across all species (score range 12-60) where a high score indicated  
243 high knowledge. The measure demonstrated very good reliability within the current sample ( $\alpha= 0.74$ ).

244

245 **Children’s Compassion towards Animals**

246 The Children’s Compassion towards Animals measure (CCA; Hawkins, Williams & Scottish SPCA,  
247 2017b) was included for this evaluation. This measure uses a one 5-item scale asking “What do you  
248 think about animals?” with five statements (e.g., “When I see an animal that is hurt or upset I feel  
249 upset” and “When I see an animal that is hurt or upset I want to help it”). The measure was scored on  
250 a 5-point Likert scale (“Strongly disagree” to “Strongly agree”). Total scores were calculated (range  
251 5-25). This measure demonstrated good reliability within the current sample ( $\alpha= 0.61$ ).

252

253 **Children’s Acceptance of Cruelty towards Pets (CACP)**

254 A new measure was developed for the purpose of this study named Children’s Acceptance of Cruelty  
255 to Pets (CACP). This measure included three 9-item scales with the question “Do you think it is  
256 alright to..?” with nine statements (e.g. “make a cat scared?”). The measure was based on pet  
257 sentience (e.g. “make a dog sad?” and “injure a rabbit”) and pet welfare needs (e.g. “not give a rabbit  
258 food or water?”). The measure comprised of three separate scales, one for each pet species  
259 (dogs/cats/rabbits). Each item was scored on a 5-point Likert scale (“Strongly disagree” to “Strongly  
260 agree”). Total scores were calculated for each species (score range 9-45) as well as an overall cruelty  
261 score across all species (score range 27-135) where high scores indicate high acceptance of animal  
262 cruelty. This measure showed high reliability within the current sample ( $\alpha= 0.85$ ).

263

264 **Analysis**

265 Total scores were added for each key variable for each individual at each sample point and data were  
266 analysed at the individual level using the Statistical package for the Social Sciences Statistics 24  
267 (SPSS Inc.), with a two-tailed significance of  $p < .05$ . Initially the data was checked for outliers,  
268 normal distribution, homogeneity of variances and sphericity, and outliers were removed from  
269 analysis. A two-way repeated measures ANOVA using time (phase of testing: pre-test, post-test) as  
270 the within-subject variable and group (two conditions: test, control) as the between-subject variable,  
271 tested main and interaction effects. The focus of the results reported below are the interaction effects  
272 which show a difference in performance for the intervention group but not the control. Significant  
273 interactions were analysed using simple main effects analysis of time within the treatment condition,  
274 this indicated whether there was a significant change from pre-test to post-test in the test group, but  
275 not in the control group. Where there was no statistically significant interaction, main effects were  
276 reported. ANCOVA was used to examine whether the interaction remained significant once adjusting  
277 for pre-test scores, age, gender and pet ownership.

278

## 279 **Results**

280

### 281 **Beliefs about pet minds**

282 Pet Welfare significantly improved total beliefs about pet minds scores; there was a statistically  
283 significant interaction between the intervention condition and time (Table 1, 2). The intervention  
284 group significantly improved at post-test whereas the control group did not. The difference between  
285 game intervention and control at post-test remained significant when adjusting for pre-test scores and  
286 demographics using ANCOVA (Table 3). A significant effect of the intervention was also found in  
287 the scores given to each species' minds, these effects remained significant when adjusting for pre-test  
288 scores and demographics using ANCOVA (Table 1, 2, 3).

289

### 290 **Children's knowledge about the Five Freedoms**

291 Pet Welfare significantly improved total knowledge about the five freedoms scores; there was a  
292 statistically significant interaction between the intervention condition and time (Table 1, 2). The  
293 intervention group significantly improved at post-test whereas the control group did not. The  
294 difference between game intervention and control at post-test remained significant when adjusting for  
295 pre-test scores and demographics using ANCOVA (Table 3). A significant effect of the intervention  
296 was also found for dog, cat and rabbit welfare knowledge, these effects remained significant when  
297 adjusting for pre-test scores and demographics using ANCOVA (Table 1, 2, 3).

298

299 **Knowledge about Appropriate and Safe Behaviour towards Pets**

300 Pet Welfare significantly improved total knowledge about appropriate and safe behaviour towards  
301 pets scores. There was a statistically significant interaction between the intervention condition and  
302 time (Table 1, 2). The intervention group significantly improved at post-test whereas the control  
303 group did not. The difference between game intervention and control at post-test remained significant  
304 when adjusting for pre-test scores and demographics using ANCOVA (Table 3). A significant effect  
305 of the intervention was also found for dog and rabbit behaviour knowledge. These effects remained  
306 significant when adjusting for pre-test scores and demographics using ANCOVA (Table 1, 2, 3). No  
307 significant effect of the intervention was found for knowledge about appropriate and safe behaviour  
308 towards cats, although a significant difference was found after adjusting for pre-test scores and  
309 demographics using ANCOVA (Table 1, 2).

310

311 **Compassion towards Animals**

312 Pet Welfare did not significantly improve children's scores for compassion towards animals. No  
313 statistically significant interaction between the intervention condition and time was found (Table 1, 4).  
314 This result remained nonsignificant when adjusting for pre-test scores and demographics using  
315 ANCOVA (Table 2).

316

317 **Children's acceptance of cruelty to pets**

318 Pet Welfare did not significantly improve scores for total attitudes towards cruelty to pets, no  
319 statistically significant interaction between the intervention condition and time was found (Table 1, 4).  
320 However, a significant difference was found when adjusting for pre-test scores and demographics  
321 using ANCOVA (Table 2). No significant effect of Pet Welfare was found for cruelty to dogs or cats,  
322 these results remained nonsignificant when adjusting for pre-test scores and demographics using  
323 ANCOVA (Table 1, 2, 4). There was a significant effect of Pet Welfare for cruelty to rabbits, this  
324 remained significant when adjusting for pre-test scores and demographics using ANCOVA (Table 1,  
325 2, ).

326

327 [Tables 1-4 about here]

328

329

**Discussion**

330

331 The purpose of this study was to evaluate a novel animal welfare ‘serious game’ named Pet Welfare.  
332 The game was designed to impact the cognitive and affective dimensions of child-animal interactions,  
333 with the overarching goal of preventing unintentional animal cruelty and neglect and to promote  
334 positive child-pet interactions. The aim was to modernise and maximise the learning and teaching of  
335 animal welfare education by utilising technology, thereby making animal welfare education more  
336 interactive and engaging. A key question was whether the Pet Welfare game intervention would have  
337 a significant impact on children’s beliefs about pet minds, knowledge about animal welfare needs,  
338 knowledge about appropriate and safe behaviour towards pets, compassion towards animals and  
339 acceptance of cruelty towards pets.

340 Firstly, it was promising that despite relatively high pre-test scores (average score 65.2 out of 75, 58%  
341 scored above the mean), Pet Welfare was successful at increasing children’s beliefs about pet minds.  
342 Total scores as well as scores for each animal, increased at post-test. These findings suggest that  
343 teaching children about pet sentience will increase their understanding of animal minds.  
344 Anthropomorphic attributions of emotions and cognition to other species, or holding a belief that  
345 animals are sentient, is arguably at the core of human-animal relationships (Urquiza-haas &  
346 Kotrschal, 2015). Such abilities facilitate social interactions, social bonds, but are also prerequisites  
347 for empathy development and moral concern (Baron-Cohen, Tager-Flusberg & Lombardo, 2013;  
348 Eisenberg, Huerta & Edwards, 2012). Believing that animals cannot feel emotions and lack sentience  
349 (low beliefs about animal minds) is related to negative child-animal interactions (low compassion,  
350 low humane behaviour, negative attitudes and higher acceptance of animal cruelty; Hawkins &  
351 Williams, 2016) as well as aggressive beliefs and behaviour (Randour & Gupta, 2013; Sprinkle,  
352 2008).

353 In recent years, there has been a movement towards focusing on positive welfare (increasing well-  
354 being)., This movement involves education about increasing animal’s happiness such as opportunities  
355 for enrichment and positive social interactions (Mellor & Beausoleil, 2015). In Pet Welfare  
356 information was provided about what children can do to make their animals ‘happy and healthy’ in  
357 line with animal welfare needs (The Animal Welfare Act, 2006; Animal Health and Welfare  
358 (Scotland) Act, 2006). Pet Welfare was successful at increasing children’s knowledge about animal  
359 welfare needs, this included total scores as well as scores for each pet type. These results are  
360 promising when considering that teaching children how to interpret animal welfare needs will  
361 facilitate positive child-animal interactions such as caring behaviour, and lead to better care (Muldoon  
362 et al., 2009). Such caring behaviour may also foster a child-pet attachment which, as known from  
363 previous studies, has developmental benefits (Muldoon, Williams & Lawrence, 2016, Hawkins,  
364 Williams & Scottish SPCA, 2017b).

365 Pet Welfare aimed to encourage children to think about an animal's perspective and encourage  
366 children to behave in ways that will not be harmful to an animal. Although evidence is limited, recent  
367 findings demonstrate the potential of education at promoting such beliefs and knowledge (Angantyr et  
368 al., 2016; Coleman, Hall & Hay, 2008; Fonseca et al., 2011). In line with these previous findings, it  
369 was promising that Pet Welfare was successful in increasing children's knowledge about appropriate  
370 and safe behaviour towards pets. Children improved on total scores and for each pet type. Given the  
371 range of positive psychological, emotional and physiological health outcomes of pets for children  
372 (Purewal et al., 2017), facilitating positive and safe child-pet interactions has important implications  
373 that are often overlooked in research. Increasing such knowledge, as demonstrated through Pet  
374 Welfare, is also important for preventing injuries to children, as well as preventing distress to pets  
375 (Shen et al., 2016), yet children lack this knowledge. One consequence of children's lack of  
376 understanding, is dog bites which remains a public health problem. With better knowledge, perhaps  
377 children would learn better ways to interact with dogs, reducing the likelihood of being bitten  
378 (Lakestani & Donaldson, 2015; Westgarth, Brooke & Christley, 2018). Future studies may wish to  
379 include other common 'high-risk' situations such as safe child-dog interactions (Dixon, Mahabee-  
380 Gittens, Hart & Lindsell, 2012) including touching or removing a food bowl when a dog is eating as  
381 resource guarding is a common cause of dog bites (Reisner, Shofer & Nance, 2007). Also, safe  
382 handling of animals may be important for preventing accidental injury to pets and injuries to children  
383 (Dickman, 2013). This study supports previous research that found knowledge is the most susceptible  
384 to change through intervention (Reisner, Shofer & Nance, 2007; Mariti et al., 2011; Vermeulen &  
385 Odendaal, 1993).

386 A key aim of animal welfare education is to prevent violence towards animals, and it was anticipated  
387 that Pet Welfare would decrease children's acceptance of cruelty. However, a significant reduction  
388 was found only for rabbits, a common target of cruelty and neglect. A lack of change overall may be  
389 due to the measure itself, low acceptance of cruelty at baseline, or that the intervention did not have a  
390 strong focus on animal cruelty. It is important to prevent childhood cruelty to animals given the  
391 complex relationship between animal-directed and human-directed violence, low cognitive empathy,  
392 behavioural problems and that cruelty attitudes and behaviour are related (Monsalve, Ferreira &  
393 Garcia, 2017; Trentham, Hensley & Policastro, 2017; Hartman et al., 2016; Hawkins et al., 2017).  
394 Further research is therefore required to examine how to successfully address animal cruelty in  
395 childhood education, and address how attitudes towards animal cruelty, translate to long-term  
396 behaviour. It was positive though that children in our study were generally unaccepting of cruelty at  
397 baseline (scoring an average of 31.2 out of 135, where a high score indicates high acceptance). This  
398 was especially true for dogs, and items relating to intentional cruelty. Future educational programmes  
399 should be aimed at those children 'at risk' for violence.

400 Another key aim of animal welfare education is to promote compassion and kindness towards  
401 animals. However, Pet Welfare was not successful at increasing children's self-reported compassion  
402 towards animals. This suggests that it may not be possible to intervene at the affective level through a  
403 short classroom-based digital educational intervention. Pet Welfare was designed to prevent  
404 unmotivated, or accidental animal cruelty and neglect, and so it may not be effective for children who  
405 lack compassion and empathy (Decety et al., 2016). Children in the current study also demonstrated  
406 high compassion at baseline (average score of 20.8 out of 25), leaving little room for improvement. It  
407 could be the measure used, or it could be argued that no change was observed due to Pet Welfare  
408 being a one-off, short intervention. However, no impact on compassion was found in a longer-term (6  
409 week) follow-up of a short intervention (Hawkins, Williams & Scottish SPCA, 2017a). It may be that  
410 compassion is resistant to change through interventions that do not include direct contact with  
411 animals, given that caring behaviour towards pets promotes attachment and compassion (Hawkins,  
412 Williams & Scottish SPCA, 2017b). However, we cannot make conclusions about this given the lack  
413 of evidence. Previous research has shown that direct contact with animals is important for developing  
414 compassion, moral concern, species-specific knowledge of animal care, understanding of appropriate  
415 about pet care and needs, and promoting human-animal bonds (Melson, 2003; Kurdek, 2008; Serpell,  
416 2004; Yoyama, Lee & Muto, 1997). However, involving animals in education raises welfare concerns  
417 and the impact on the animals themselves who are involved in animal welfare education is very much  
418 an under researched (Fine & Huss, 2017). There is no legislation in the UK to enforce these types of  
419 activities. The question of whether the affective domains of child-animal interactions can be promoted  
420 through humane educational remains.

421 Kellert (1985) recommended focusing educational efforts for 6-10-year-olds on children's  
422 affective reactions to animals and building on children's positive orientations to animals. This is due  
423 to this age range being characterised by a major increase in emotional concern and affection for  
424 animals. A dramatic improvement in factual and cognitive understanding of biology and animals is  
425 seen between 7-14 years (Binnie & Williams, 2002; Myant & Williams, 2005). As Pet Welfare was  
426 aimed at children aged 7-12-years old, both affective and cognitive domains were targeted, and  
427 potential age differences were considered, as recommended by Arbour, Signal and Taylor (2009).  
428 Middle childhood is an important time for educational intervention due to a peak in pet ownership  
429 (Paul & Serpell, 1993), receptivity to animal welfare education (Melson, 2003), as well as important  
430 changes in cognitive development including increases in prosocial moral reasoning and empathetic  
431 moral concerns (Eisenberg-Berg, 1979; Flavell, 2004). Furthermore, childhood is a key time for the  
432 development of attitudes and related behaviours, reinforcing the importance of encouraging humane  
433 orientations to animals early on (Borgi & Cirulli, 2015).

434 Although this study displays promising findings, longer-term evaluation is required with a larger  
435 population to test the reliability of findings and suitability of the intervention for other cultural

436 contexts. This research was conducted within three primary schools within West Lothian in Scotland  
437 and so the results should be generalised with caution. Conclusions can only be drawn about the short-  
438 term effects of the programme and it is not known how knowledge gained through this programme  
439 will generalise to other animals and translate long term. However, feedback from the children was  
440 extremely positive (scoring an average of 4.5/5), and the children reported that they wanted more  
441 animals and more levels to play. It is recommended that a longer, more complex game with more  
442 animal types and varied levels is developed.

443

#### 444 **Conclusion**

445 This study highlights the potential of promoting positive child-animal interactions and preventing  
446 accidental animal cruelty and neglect through the use of a fun, reward-based, interactive child-friendly  
447 digital game. This study is the first evaluation of an animal welfare education computer game for  
448 children and the results are promising with the game having a significant impact on knowledge,  
449 attitudes and belief in animal minds. Future work in this area may include the development of more  
450 varied and complex games, and different methods of delivering games. Through education, children  
451 learn kindness, and how to become responsible animal citizens in their communities, which will in  
452 turn have wider, long-term implications for a humane society and the prevention of violence.

453

#### 454 **Acknowledgements**

455 We thank the schools, teachers and children who were involved for their invaluable time and  
456 collaboration.

457

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681 **Table 1**

682 *Descriptive statistics.*

	Test				Control			
	Pre-test		Post-test		Pre-test		Post-test	
	M	SD	M	SD	M	SD	M	SD
<b>Beliefs about pet minds</b>								
Total beliefs about pet minds	65.56	8	72.31	7	64.77	10	66.28	11
Dog minds	22.27	2.9	24.37	1.8	21.83	3	22.65	3
Cat minds	21.78	3	24.04	2.7	21.43	4	21.98	4
Rabbit minds	21.53	3	23.87	3	21.42	4	21.49	4
<b>Knowledge about animal welfare needs</b>								
Total knowledge	24.03	8.5	25.55	10	19.04	6.7	17.23	7.9
Dog welfare	8.33	3	8.6	3.6	6.86	2.7	5.84	2.7
Cat welfare	7.32	2.8	8.16	3.4	5.85	2.5	5.56	2.8
Rabbit welfare	8.26	3.3	8.6	3.6	6.37	2.4	5.84	2.7
<b>Knowledge about appropriate and safe behaviour towards pets</b>								
Total knowledge	55.77	3	59.01	1.9	56	5.5	56.57	3.3
Dog knowledge	18.68	1.3	19.70	.81	18.71	2	18.81	1.3
Cat knowledge	18.99	1.4	19.80	.74	18.95	2	19.25	1.4
Rabbit knowledge	18.10	1.6	19.51	1.1	18.34	2.2	18.95	2
<b>Compassion towards animals</b>								
Total compassion	20.48	2.4	20.99	2.4	21.04	3.2	21.58	2.9
<b>Acceptance of cruelty to pets</b>								
Total acceptance of cruelty to pets	31.57	6.6	28.41	3.3	30.92	8.3	29.99	6
Cruelty to dogs	10.42	2.3	9.58	1.3	10.53	4	9.93	2
Cruelty to cats	10.68	3.3	9.46	1.3	10.22	3	9.91	2
Cruelty to rabbits	10.70	2.97	9.47	1.3	10.21	2.4	10.15	2.2

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692 **Table 2**

	Interaction effects from two-way repeated measures ANOVA	Controlling for demographics and baseline scores using ANCOVA
<b>Beliefs about pet minds</b>		
Total beliefs	F(1,166)=27.6, p=.0001, $\eta^2=.14$	F(1,168)=33.84, p=.0001, $\eta^2=.17$
Dog minds	F(1,170)=15.05, p=.0001, $\eta^2=.08$	F(1,172)=24.8, p=.0001, $\eta^2=.13$
Cat minds	F(1,168)=18.43, p=.0001, $\eta^2=.10$	F(1,170)=22.5, p=.0001, $\eta^2=.12$
Rabbit minds	F(1,168)=26.5, p=.0001, $\eta^2=.14$	F(1,170)=31.2, p=.0001, $\eta^2=.16$
<b>Knowledge about welfare needs</b>		
Total knowledge	F(1,167)=15.2, p=.0001, $\eta^2=.084$	F(1,169)=23, p=.0001, $\eta^2=.123$
Dog welfare	F(1,169)=15.2, p=.0001, $\eta^2=.08$	F(1,171)=25.4, p=.0001, $\eta^2=.13$
Cat welfare	F(1,167)=11.8, p=.001, $\eta^2=.07$	F(1,169)=24, p=.0001, $\eta^2=.13$
Rabbit welfare	F(1,169)=7.72, p=.006, $\eta^2=.044$	F(1,171)=18.5, p=.0001, $\eta^2=.1$
<b>Knowledge about appropriate and safe behaviour towards pets</b>		
Total knowledge	F(1,165)=12.7, p=.0001, $\eta^2=.072$	F(1,167)=36.3, p=.0001, $\eta^2=.18$
Dog knowledge	F(1,165)=11.06, p=.001, $\eta^2=.06$	F(1,167)=28.2, p=.0001, $\eta^2=.15$
Cat knowledge	F(1,166)=3.9, p=.05, $\eta^2=.023$	F(1,168)=11.6, p=.001, $\eta^2=.07$
Rabbit knowledge	F(1,165)=11.06, p=.001, $\eta^2=.06$	F(1,167)=22.4, p=.0001, $\eta^2=.12$
<b>Compassion towards animals</b>		
Total compassion	F(1,171)=.09, p=.77, $\eta^2=.001$	F(1,173)=2.2, p=.14, $\eta^2=.013$
<b>Acceptance of cruelty to pets</b>		
Total acceptance of cruelty to pets	F(1,166)=3.12, p=.079, $\eta^2=.02$	F(1,168)=33.84, p=.0001, $\eta^2=.17$
Cruelty to dogs	F(1,169)=.09, p=.077, $\eta^2=.001$	F(1,171)=1.21, p=.27, $\eta^2=.01$
Cruelty to cats	F(1,168)=1.9, p=.174, $\eta^2=.011$	F(1,170)=2.1, p=.058, $\eta^2=.022$
Cruelty to rabbits	F(1,167)=8.8, p=.004, $\eta^2=.05$	F(1,169)=9.5, p=.002, $\eta^2=.001$

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704 **Table 3**

705 *Results for main simple effects following significant interactions.*



Test x Control at Pre-test				Test x Control at Post-test			
df	F	p	$\eta^2$	df	F	p	$\eta^2$
Beliefs about pet minds							
Total beliefs about pet minds							
1,180	.331	.57	.002	1,171	20.2	.0001	.11
Dog minds							
1,182	.893	.346	.005	1,173	18.2	.0001	.096
Cat minds							
1,182	.52	.472	.003	1,172	16.6	.0001	.09
Rabbit minds							
1,182	.042	.837	.0001	1,172	20.1	.0001	.11
Knowledge about animal welfare needs							
Total knowledge about animal welfare needs							
1,181	19.2	.0001	.097	1,170	35.7	.0001	.18
Dog welfare							
1,181	11.8	.001	.061	1,172	32.2	.0001	.16
Cat welfare							
1,181	13.9	.0001	.072	1,170	29.6	.0001	.15
Rabbit welfare							
1,183	20.2	.0001	.1	1,172	32.2	.0001	.16
Knowledge about appropriate and safe behaviour towards pets							
Total knowledge about appropriate and safe behaviour							
1,181	.12	.73	.001	1,167	36.04	.0001	.18
Dog knowledge							
1,181	.021	.89	.0001	1,167	28.9	.0001	.15
Rabbit knowledge							
1,181	.691	.407	.004	1,167	20.1	.0001	.11

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715 **Table 4.**

716 *Results from main effects analysis for each intervention following insignificant interactions.*

Main effect of time				Main effect of group			
df	F	p	$\eta^2$	df	F	p	$\eta^2$

Compassion towards animals							
1,171	9.99	.002	.06	1,171	2.7	.15	.012
Total attitudes towards cruelty to pets							
1,166	16.32	.0001	.09	1,166	.322	.57	.002
Attitudes towards cruelty to dogs							
1,169	11.31	.001	.063	1,169	.632	.428	.004
Attitudes towards cruelty to cats							
1,168	13.61	.0001	.08	1,168	.015	.904	.000
Knowledge about appropriate and safe behaviour towards cats							
1,166	13.1	.0001	.073	1,166	2.2	.145	.013

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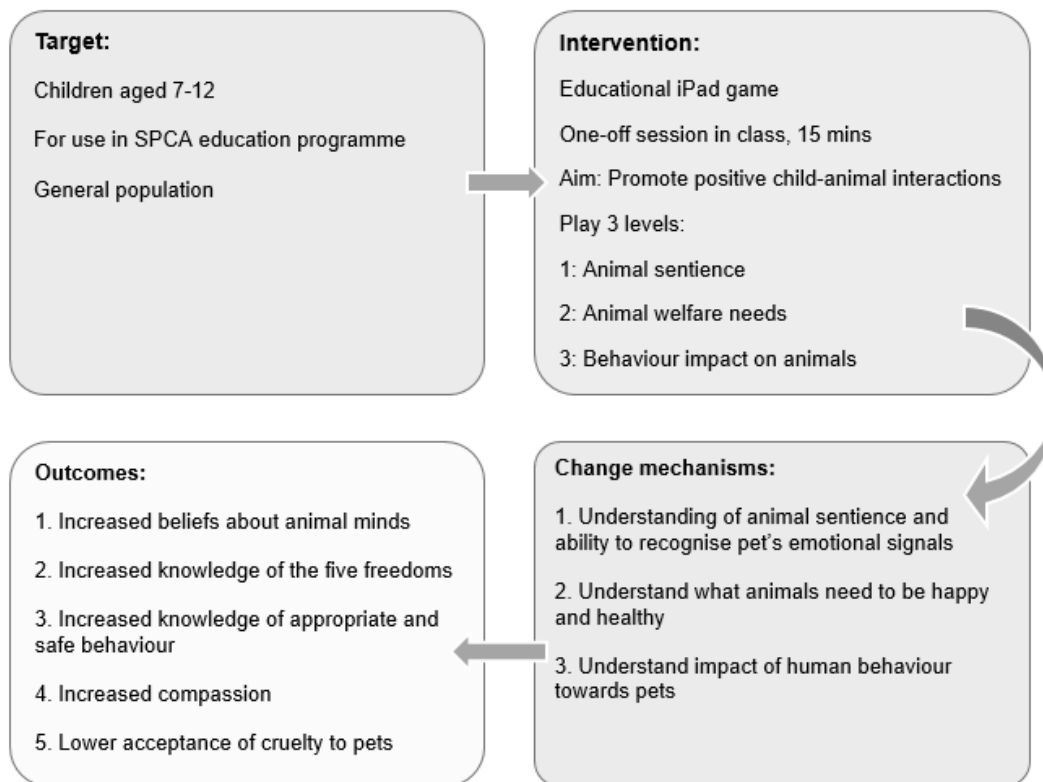
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735 **Figure 1.** Logic model for Pet Welfare.

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