ANIM3: ANIMated ANIMals as A Numbing Immersive Mechanic

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Figure 1: The virtual dog outing park where one can interact with the dog. The user can pick up the ball once it is released by the dog by clicking on it, and then has to aim the ball to hit the target, after which the ball is retrieved by the dog. In other moments, it can be fed a bone or drink from a bowl by clicking on that object. The interactions are created for immersive Virtual Reality, for which we foresee opportunities to distract the participant by maintaining a high level of presence in a situation of "acute pain" to lower the pain experience.

ABSTRACT

A high prevalence of "acute pain" within hospital emergency departments and side-effects of current practices calls for new additional treatment measures. Alternatives to analgesics include Animal Assisted Therapy (AAT) and Virtual Reality (VR). Whereas proven effectively separately, the combination AAT techniques and VR analgesia has received no or scant attention. In this paper we focus on exploring this field through exploring the literature from the separate approaches and show how they would fit together, conceptualized in a new VR application ANIM3. Leading in this development process, besides the extensive literature review, were stakeholder interviews. Our first user encounters gained positive responses to the prototype. As a whole, we see strong indications that "acute pain" reduction in the hospital based on AAT principles in Virtual Reality is a promising technique. We postulate that these experiences should add well timed heightened distractions, while keeping the contextual factors in mind leading to interactions of a maximum of about 15 mins, with limited or no need for explanations, and limit need of locomotion and two-hand controls. We recommend the creation of proposals to further development and research to explore these possibilities to their full potential.

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CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; *Virtual reality*; User studies.

KEYWORDS

AAT, animals, virtual animals, immersive VR, VR, acute pain

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1 INTRODUCTION

The sensation of pain is a well-known negative emotional experience [39]. Pain is functionally classified as either physiological pain: short, **acute**, and alarming, or as pathological pain: *'"maladaptive pain" [..] usually (but not always) persistent or **chronic**'* [39, p32]. We focus on a context with acute pain conditions [25].

Daily, 70% of visits to a hospital's emergency department (ED) are related to pain [4, 25], which naturally consists mostly of acute pain. Undergoing medical treatment in these emergency rooms correlates with additional pain, stress, and anxiety [31]. To limit physiologic, social, and behavioural disturbances, analgesics such

as opioids are frequently utilized [25]. However, at times opioids are administered at a maximum dose without blocking all pain for the patient. This practice can potentially cause devastating effects, such as dependency, resulting in poor health outcomes and increased mortality rates [12, 17, 34].

The current treatment approaches can be categorized into pharmacological and non-pharmacological. Non-pharmacological solutions focus on pain management techniques without the use of medications, such as various forms of distraction, as to some extent the intensity of pain a patient perceives is correlated with attention [23]. One distraction-based alternative is Animal Assisted Therapy (AAT), in which animals and certified human trainers work together in therapeutic sessions to mitigate stress and anxiety symptoms [14]. It is proven to effectively reduce pain perception due to the emotional response the patient has towards the animal [3].

Another non-pharmacological alternative for pain reduction has recently emerged through the development of mixed reality technologies. In particular, Virtual Reality (VR) interventions are used to reduce both acute and chronic pain [22]. Virtual Reality lets a user experience and manipulate a virtual environment, often through a fully immersive headset that blocks the user's view of the real world. The high acceptance levels from both patients and hospital staff is stimulating further research into the possible applications of VR as a pain mitigation strategy [10]. Whereas AAT [16] and VR [10, 18] are proven to be effective strategies separately, scientific evidence focusing on combining the approach of them is scant [19, 20], this combination provides an open opportunity for pain mitigation research.

ANIM3 follows in the footsteps of previous research from the CHI-PLAY community into playful designs and interventions that aim to help alleviate negative experiences (such as in pediatric hospitalization [24]), emotions such as anxiety (i.e. through interactive plants [30]) and chronic pain (i.e. through a virtual gardening experience [36]). There is much less work discussing the design of a virtual animals, Emmerich et al. [7] being the exception. However, their work has a strong focus on companions (of which animals are only one example) in games and draws from player experience within action and role-playing genres, while in our case the interactive animal is the core element of the intervention.

1.1 Goal, Direction, and Contribution

The combination of AAT techniques within VR will present a new approach to pain treatment. If proven effective, it could lower pain levels and may reduce pharmacological treatment, mitigating the health consequences associated with the side effects of medicine.

Whereas some existing applications feature animals as part of the environment, the possibility of having an animal as the main element is underexplored within VR analgesia. This is in contrast with commercial VR games which do feature pets more frequently and may serve as a source of inspiration [1]. For example, WABA [6] presents a virtual pet experience in which the user can perform caring interactions such as feeding it and putting it to sleep.

Within hospitals, the use of virtual pets will alleviate factors associated with regular AAT, such as health consequences and limited availability of trained pets and staff [27]. Due to the anxiety and stress relieving effects of AAT [8], the intervention may also be beneficial for non-medical settings. The findings from this paper may contribute to a further understanding of the best practices around the use of VR for non-entertainment purposes and open up space for further research into the possibilities of virtual AAT.

[1]Bogo [29], Beast Pets [2], Falcon Age [9], Stunt Corgi [32], Gary the Gull [21]

2 EXPERT INTERVIEWS, APPLYING VR IN A EMERGENCY ROOM

To start exploring this possibility we conducted expert interviews with 2 emergency nurses and the innovation manager of the Deventer Hospital. This was done to gain more insight into the current practices in the context that we also envision ANIM3 to be used, as Deventer Hospital is already implementing VR experiences for pain distraction as a pilot.

Current experiences used as distraction by the interviewed experts mainly include non-interactive 360 videos, or more game-based applications, such as Merry Snowball [11].

The experts indicated that VR is commonly applied during medical treatments such as re-positioning broken bones and treating burn wounds. They state that for a time between three and fifteen minutes, the patient should be actively engaged whilst being encouraged to remain mostly immobile (to refrain from obstructing the medical procedure). In practise, the nurses found that the type of VR application used is ideally adjusted to the interests of the patient to further stimulate engagement.

The possibilities of including animals within a VR application were also discussed. The experts agreed that animals would be suitable as distraction within a hospital setting. They would expect the interactions to be similar to real life pet interactions, and mentioned examples as petting it, feeding it, and teaching it a trick.

3 ANIM3: DESIGN OF A PROTOTYPE

In line with the interview findings presented so far, we choose to create an environment with a variety of simple point-and-click interaction possibilities leading to a relatively short experience. In this environment the user is placed at a central position which requires limited locomotion (i.e. preventing exclusion of patients with often occurring injuries and treatments). Furthermore, we target this to do three things: 1) providing a relaxing environment; 2) simplifying interaction, requiring less involvement of the nurses; 3) reducing chances for getting motion sick. Different objects can be activated through selection with the controller, see Figure 2.

3.1 Interview-Based Iterative Design Process

During an iterative design approach various types of animals, environments and interactions were considered. Besides supporting design decisions from the literature, we also actively involved potential users to give input via semi-structured interviews. We received ethical approval for these interviews and limited user encounters from our EEMCS faculty under RP 2020-101. The interviewees included a co-founder of a VR hospital entertainment system, family and friends (spanning from 15 to 60+ years, and equally across the gender spectrum), three emergency room nurses, from which one was from another hospital without VR. In total 25 people were interviewed, of which 14 were students. Besides this, we had regular meetings with an innovation manager of the involved hospital.

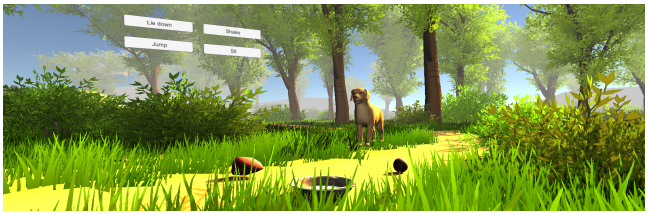

Figure 2: Desktop screenshot providing overview of the environment and its interaction possibilities, 4-item menu for triggering tricks, and object-based triggers for feeding a bone (left), giving water (center), and picking up a ball (right). The latter then changes game mode allowing to throw the ball after which the dog fetches it back. This mode can also be presented more game-like (see Figure 1).

The non-nurse participants were asked in semi-structured interviews to share what they might expect if they were a patient and given the option to experience the proposed AATxVR treatment. Four participants were unfamiliar with VR and the concept was explained. Afterwards, the expectations and initial thoughts about the VR application were shared by the participants. They were encouraged to elaborate on their ideas with follow-up questions.

The interviews made clear that from a participant's perspective there should be enough elaborate content to immediately grasp the attention [2] Interactive objects used within the scene should fit naturally, forming a coherent whole with the environment, so that their presence makes sense to the user. Similarly, as participants were asked to discuss the type of animal they would deem appropriate, familiar "common" animals were preferred over mythical creatures.

One interviewee pointed out that fantasy animals could confuse some patients or evoke negative associations based on their cultural (or religious) heritage: "Especially with mystical animals the 'good' versus 'bad' is more prominent as they have different meanings for various cultures".

Fitting the earlier mentioned differences in interest, not all participants indicated an urge to interact. The more passive user would be satisfied to simply observe the animal from a safe distance, of whom some would still be interested to have simple interactions with non-alive objects in the scene.

Building on this and the related work, in the subsequent parts of the design process we use three elements of Schell's [33] tetrad to describe the game-environment decisions regarding Technology, Aesthetics [3], and Mechanics. The story element is not explicitly discussed as it was deliberately beyond the first steps of development of this prototype.

3.2 Technology: HMD

Regarding the *technology*, for this prototype we used Unity 3D, the HTC Vive (v2016) with SteamVR. This is mostly for availability reasons and flexibility (i.e. allowing for 6 degrees of freedom if needed).

[2]In line with Schell [33] one might say, there should be an emphasis on providing a good hook in the interest curve of the game, especially as it is only to be played once or a few times.

[3]Aesthetics are linked to the public understanding of aesthetics, regarding look & feel, not the more experience oriented of the MDA model [13]

In the participating hospital setting, from personal communication we know a stand-alone product without calibration and including external controls is strongly preferred. Currently the Oculus GO is used by the Deventer Hospital, however for cost, availability, HMD-integrated buttons, and maintenance reasons the Pico G2 is currently the preferred device. However, we think the Oculus Quest could also be a good candidate if bed-dependent calibration can be skipped and if including hand tracking would turn out to be essential in such a context. Regarding other commercially applied materials, for efficiency and quality reasons we used various models from the Unity Asset Store. We implemented the system such that they would also be playable in seated or lying down position, needing one controller.

3.3 Aesthetics: Common Dog and Calming Park

For the *Aesthetics* we took into account the importance of the appearance of an animal [19] and carefully chose the asset based on the interviewees. In these interviews a dog was often brought up. This was due to a preference for more common, easily identifiable pets, and the mostly positive associations they have with dogs. As part of the selection process for the proper dog model, three suitable animated dog assets were selected. We asked 7 of the interviewees to give their preference, and six of them preferred the Golden Retriever. Their choice seemed influenced by the familiarity of the dog type as well as the realistic appearance. In a similar fashion we presented three nature environment asset sets (this time filtered on those that were free). We hope this nature feel will provide additional calming effects, and asked the same 7 interviewees. They preferred the *'Nature starter kit 2'* over two others. However, based on their input we made it more open and lighter to further try to emphasize the positive look & feel, see Figure 2.

3.4 Mechanics: Simple and Various Elements

Regarding *Mechanics*, a few key elements to include in ANIM3 were identified. In line with suggestions of our interviewees, namely that some users would want to sit and watch whereas others would want to actively engage with the environment, De Valk et al. [5] suggest to include both reactive and active behaviour. For example, having a set of idle animations for the dog (and animals like birds flying around in the scene) that request attention, provides a simple way to encourage *less pro-active players* to also involve themselves in more energetic interactions without requiring this. Furthermore, we introduced simple interactions such as pointing at an object to trigger an animation, including birds and butterflies flying away and sitting still on objects. Whereas playing with the dog would give *enthusiastic players* the satisfaction they seek for, which we do mostly via a throw and catch game that tracks score inspired by Merry Snowball [11]. In this throw and catch 'game' mode a target was worth 1 point, and a bonus of 10 points was awarded for pointing at balloons that were one-by-one temporarily introduced for 8 seconds with set random intervals (3-10s) between them [4] The inclusion of multiple objects that can influence each other and

[4]This was included as a prototype research tool in the form of a Detection-Response Task to measure level (cf [35]). Given the only preliminary evaluation so far, we do not report further on this

respond differently is suitable for the immersion state of De Valk [5], in which the player can develop game rules and goals for themselves. In our game this is most prominent in the interaction between user, dog, ball, and targets, and to some extent with the ability to scare of birds and butterflies from certain objects. Importantly to make use of the emotional attachment to (virtual) pets, we included several interactions with the animal [19]. The dog shows some form of cooperation and helping out to catch the ball, and we provide a playful experience also related to nurturing [1], via feeding a bone and giving it water.

3.5 First User Encounters

A first, limited user 'evaluation' (n=4[5]) of the prototype was conducted. Participants gave written consent, after which a one minute explanation was given about the application and VR controller. Participants were stimulated to think aloud, to help determine their expectations, thoughts, and feelings, as well as identify any aspects that were confusing.

There were some indications that the participants developed an *emotional connection* with the pet. P2 said *"Good job!"* to the dog when it retrieved the ball, and P3 asked whether the dog had a name, and if not, whether they could name the dog. P4 wanted to pet the dog, however this was not supported. Two participants started already in a pet selection screen : *"Hello there! You're cute!"*, illustrating that verbal communication can happen as part of the interaction as well.

After roughly three minutes, participants started to ask if there was anything else that they could do, or whether there was a goal for them to accomplish, as they had tried every interaction and seemingly nothing new would occur. Some interesting additional mechanics were already suggested by the participants. P2 said they expected to be able to pick up the bone after the dog has eaten it, and throw it. Alternatively, the dog could find a spot in the environment and bury it. Additionally, it was suggested that different objects in the scene should affect each other, for instance interaction between the dog and birds. P3 wondered whether they could instruct the dog to walk to a certain spot in the scene, especially to get a closer look of the dog.

None of the participants simply watched the objects and entities in the scene, but actively tested what interactions they could engage in. The catch and throw target mode allowed players to challenge themselves. P3 indicated that they created the goal to hit the balloons as fast as they could and not miss any. This suggests that the ball game with both targets and balloons would be suitable for open-ended play designs.

4 DISCUSSION

These preliminary observations of users interacting with our prototype are encouraging. Users were able to engage in an interaction with our system that reflected the design intention of an encounter featuring a bonding-like experience akin to a real first pet encounter.

Our current prototype still misses some features such as with proper sound effects and soundscapes - a common feature brought up by interviewees. Calming music seemed appealing to some, whereas others, depending on the environment, would prefer nature sounds. Indeed, the presence in immersive VR can be heightened with congruent soundscapes and sound effects [15].

Another obvious improvement is to be made to the prototype's user interface, including menus and the interaction with the animal, and offering different animals to interact with. Following the reasoning of van Delden et al. [37, 38], we would like to provide a suite-of-games offering interaction with different animals, and have experts be able to alter certain settings or timings. Currently we have different kind of dogs and cats as placeholder start menu items. We also envision that users like to adapt the environment. One interviewee for instance, mentioned they would prefer to have a safer feeling, closed environment such as a living room.

Next, there are a number of design aspects to explore in the context of interactive games for pain reduction in general. One idea is to tie the intensity level of the experience meaningfully to intense moments in the medical procedure. For example, in the case of VR interventions for burn wound treatments (such as [12]), a particularly salient moment in the VR experience could be created for those moments where the patient feels severe pain beyond "resting pain" during wound care. Medical staff would have a way to *announce* to the system that such a moment arrives, and the system could plan the animal's behaviour so that a high intensity moment will occur in the near future, i.e. a display of a trick or a strong emotion, thus overshadowing the increased pain.

Interactions with virtual pets seem affected by user's previous interactions with similar pets in real life [19], so the animal should (also) respond to gestures and cues in other modalities than the handheld controllers. Most notably, non-verbal affective speech is an interesting modality to include. Even though such a feature wasn't included yet, participants talked to the virtual pet in our prototype.

Supporting user input through speech can further aid in establishing an emotional bond between the patient and the pet. Similarly, the use of biofeedback and eye tracking as a research tool or for interesting interactions could be explored [26]. This is not only interesting from a in-play perspective, but allowing the system to respond to cues from different modalities also helps the system to accommodate to the user context better, as patients might often find themselves limited in some way.

This is related to investigating the extent to which varying degrees of user input in the different modalities can have effect on the user's pain experience. This is made more complex - but also more interesting - when considering the design space of animal behavior driven by user activity, where we could model mimicry and synchronicity-like relationships between the user and virtual animal. Studies related to dog-human play behaviour may further identify which interactions are suitable [28].

Concluding, through a context analysis and first design iterations, ANIM3 shows potential for an animal-based VR intervention for pain mitigation through distraction.

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[5] A more extensive evaluation was not yet possible due to the COVID-19 circumstances. Only university students already in direct contact with the first author were included.

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