About the Sound of Bananas - Anti Rules for Audio Game Design

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***Abstract*—Designing audio games is a complex challenge that differs from video game design as they feature no visual output. For this reason a number of researchers conceived specific audio game design rules geared towards working with sound. In this paper, we provide complementing audio game *anti* rules that we collated from an extensive review process involving 157 audio game prototypes by interaction design students. We argue why *anti* rules can be a powerful means in preventing common mistakes in audio game design. In more detail, we present eleven *anti* rules which when followed are likely to spoil the user experience of an audio game. Hence, the approach in this paper is *not* to state what should be done (verified design guidelines), but to inform the designer which features will probably ruin an audio game (falsify the hypothesis or probability that it will be good and enjoyable).**

***Index Terms*—anti rules, audio games, design, game design, human computer interaction, guidelines**

I. Introduction

Audio games are a special genre of computer games that are played with hearing instead of (primarily) vision as with the widely-spread genre of video games. This opens audio games to a broad audience of players. Both people with normal as well as impaired vision can enjoy the experience of playing non-visual games based on sound. Players usually enjoy audio games with their eyes closed in a relatively quiet environment to be able to immerse themselves in the experience of the game. Creating this experience can however be challenging for designers as bad design decisions can rudely disturb the player in building their mental imagery. Inappropriate sounds like, for example, the jingly of a bell representing a banana falling to the ground (we will refer back to this example in *anti* rule in Section IV-K) can distract a player in building a coherent model of the virtual surroundings. Instead of enjoying the game and focusing on the next challenge, the user might inevitably get stuck with asking themselves why the sound design of the banana was implemented in such a strange way (”Why does the banana jingle?!”). Fig. 1 illustrates this process in a vivid fashion.

To avoid such pitfalls, we collated a set of eleven issues that might be worth considering during the audio game design process. These issues were elaborated in a study involving 191 under-graduate interaction design students and 157 video game prototypes, and we formulated them as *audio game design anti rules*. This means, rather than providing design guidelines stating what to do (a concept which as been crititzied by some designers, e.g. [1]), we report design *anti* rules informing designers what to better *not* do when creating an audio game. In other words, our design *anti* rules represent (common) mistakes that – with a high probability – will not make the game any better, but worse.

Fig. 1. A grand challenge in audio game design is the sonification of objects or game elements. As many objects do not emit sound in reality, this posses questions for designers such as ”how should I sonify this object? – How does a banana sound like?” Unfortunate decisions in sound design can disrupt the game experience or game immersion drastically and lead to odd mental representations in the players’ imagination (as illustrated here in a slightly exaggerated fashion).

The large part of this paper is dedicated to detailing the eleven *anti* design rules. However, before we go on to describe them, we will explain in the following section what exactly we mean by this notion and make an argument why *anti* design rules can be a useful complement to design guidelines.

A. Design Rules vs. Anti Design Rules

Designers of video games, audio games or interactive technology in general usually seek advice in consolidating design guidelines or design rules. These guidelines constitute a compendium of *dos* that was derived from experts’ design experiences, theoretical considerations, and research in dis-

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ciplines like HCI. Don Norman, for example, recommends in his well-known book *The Design of Everyday Things* [2] to "provide a good conceptual model" in order to allow "us to predict the effects of our actions" (p.13). Hence, this recommendation increases the chance (when considered by the designers) that a systems will behave as expected by the users. This predictability is crucial for efficient and pleasant use as well as a system's learnability.

However, we argue that such design guidelines can be tricky as there is no guarantee that they will work for every context or for every (beginner) designer. In this paper, we therefore propose the alternative approach of *anti* design rules. With this idea we refer to issues or features in audio games which – should they occur – will probably *not* improve the game, but rather spoil the user experience.

In a figurative sense, our argument is analogous to Popper's ideas about *falsification* and the *Problem of Induction* [3]. Rather than observing features in audio games that worked well and "inferring" verified design guidelines from these observations, we take the opposite approach. – By revealing problems in audio game prototypes we are able to state that specific characteristics will most likely spoil the user experience (*anti* design rules). Thus, figuratively, we "falsify" the idea that a certain feature will make a good audio game, instead of attempting to "prove" a general recommendation.

In this way, we contribute a list of *don'ts* (as opposed to *dos*) that were derived from the analysis of 157 audio game prototypes.

II. Related Work

Before we go on to elaborate *anti* design rules, it is necessary to review existing design recommendations in the context of audio games.

There is interesting literature on the design of games in general (e.g., [4]) as well as on the design of video games (e.g., [5]). However, when it comes to *audio* game design, literature and especially audio game design literature in which design guidelines are postulated, are rare to find. In the following, we review audio game design recommendations and guidelines that are available within the scientific community [6]–[10].

Some of the very first design rules specific to audio game design were collated by Friberg & Gärdenfors [6], drawing on literature about auditory displays, auditory interfaces and film sound theories. One example of the authors' design recommendations is that the player should always know if the perceived sounds were triggered by the player's own activities/interactions or by the game autonomously. Another design rule recommends instantaneous feedback by the system when the player has made an input so that he or she knows that the command has been recognized as anticipated [6]. Interestingly, authors of audio game papers (e.g., [11]) have not mentioned design rules or recommendations before Friberg's & Gärdenfors's postulated design rules, although they might had experienced similar issues and a documentation of those would have helped other researchers and practitioners.

Rovithis and colleagues [9] collated design principles of audio games in general before discussing the application of audio games in an educational setting. They split their design principles into three categories, namely: "Organizing the Sonic Content", "Navigation & Feedback Sounds", and "Narrative Content: Two Parallel Directions Although" [9]. The authors e.g. give recommendations about how to design sounds for navigation and feedback which can be seen as expansion of existing design rules by Friberg & Gärdenfors [6].

Much additional work on audio game design guidelines was conducted from the perspective of accessibility. For example, Yuan, Folmer, and Harris [7] offer a set of "strategies for turning visuals into audio" by "replac[ing] visual feedback" [7] that make games accessible for blind people (p. 10). The authors state that "audio cues [can] use real world sounds such as the sound of wind or footsteps to provide information or hints to the player" (ibid.). While this is a valid and useful consideration, it might not be applicable to all audio game design challenges. Considering the introductory example of the banana (see Fig. 1), for instance, the recommendation still does not resolve the question about how to exactly represent this object or fruit using audio. This problem also relates to insights by Velleman and others who stated that [12] "[...] accessible does not mean 'an adapted original' but 'a re-designed original based on the essence'." (p. 260).

Garcia and de Almeida Neris [8] also presented design guidelines for audio games tailored to game accessibility. Their guidelines were elaborated by working with two blind players and by conducting a literature review. The authors provided "advice on how to present the audio in an audio game trying to achieve better accessibility" [8] (p. 231). In general, it is widely-agreed hat audio games should be designed inclusively for everyone and not just for people with visual disabilities [13]–[17].

While we appreciate the related work cited above, we argue that there should be design rules specifically for audio games, and that the community should not restrict itself in adapting video game design guidelines or translating visual cues to audio. Hence, these guidelines should go beyond aspects of accessibility. In line with [9], [10] we think that video games should not serve as templates for audio game design. Rather, audio games should be designed as audio games from scratch.

III. Study

To uncover audio game design *anti* rules, we conceived a study involving 191 students in interaction design and a rigorous peer-review process (i.e., the students gave feedback to each others' audio game prototypes). To ensure that every student had basic knowledge about audio games, we designed several exercises in which the participants gradually deepened their knowledge about audio games by (Task I) reading audio game related literature like guidelines and design rules, (Task II) playing simple and more sophisticated audio games and finally (Task III) designing and presenting their own audio game idea by means of an adapted version of video prototyping.

Integral part to the students' learning experience and for our analysis (cf. below) was a peer-review process facilitated by the Aurora online environment [18] that was designed for peer-reviewing in university settings.

A. Participants

We had the opportunity to study the training of 191 interaction design students (female = 22, male = 169) for audio game development. This setup featured two primary advantages. Firstly, it provided access to many people dealing with audio games. This is a rather unique opportunity, considering the size of this relatively small community of developers. Secondly, we were able to look into a structured process and design critique of audio games. This enabled us to investigate the students' considerations, preferences, and ideas for audio games from a different angle and hence added an additional layer of reflections. In the discussion section (Subsection V-A), we will further elaborate why for our purpose the study of students during a reflective peer-review activity is appropriate, and we do not necessarily have to investigate professional audio game developers in their work.

The endeavor took place as part of a large under-graduate university course, and the participation in tasks A-C was voluntary and optional.

B. Tasks I-III

In the following, we detail tasks I-III as they were integral part of our study design. The students had to fulfill these task within the length of the academic semester (16 weeks).

Task I - Literature review. In the beginning, the participants had to read four papers that described characteristics of audio games as well as presented audio game related studies [9], [11], [15], [19]. These papers introduced the participants to audio games and aided their understanding of this genre. Moreover, they served as a starting point and source of inspiration for their own concepts or ideas for audio games.

Task II - Personal game experience. Subsequently, the participants played audio games on mobile phone, namely Blindscape [20] and two games from the Audio Game Hub [21]. This was meant to be an 'hands-on experience' so that the participants better understand audio games. After that, the participants played the 3D audio game Terraformers [22], in which they had the possibility to switch graphics as supplement on.

Task III - Audio game prototype. In the end, they had to design[1] an audio game based on the knowledge they gradually built and capture their game idea as a video clip. The requirement for this demonstration clip was that it should be recorded in a way so that the listener (without actually seeing the video) could understand the game and its setting or scenery. While not being able to play it on their own, the listeners should be able to experience essential elements as if they watched a game review for a conventional video game including demonstrations of the storyline, sound design, and gameplay. Besides showcasing an *audio game*, the participants were invited to also include visual footage of artifacts and development/prototyping tools in their audio game video clips for adding supplementary information to aid the understanding of the game concept and experience. In summary, the video clips served both to assist the students' in their learning and conceptualization processes as well as communicating their ideas in a vivid fashion. This again, enabled us to gain in-depth insights in their audio game prototypes for informing our analysis.

[1]Note: The students did not implement audio games in code. They captured the concept of an audio game using audio/video, hence, building a "audio"/video prototype. Actually implementing the audio game from the beginning was out of scope of this university course and not a good design process anyway, in our understanding.

C. Analysis

After 16 weeks (at the end of the semester) we collected the data of 191 students who voluntarily chose the audio game design exercise. The three authors of this paper conducted a pre-selection before analysis based on the submission's quality. Selection criteria were a) the completeness of the submission, b) that the student created a video clip for their audio game that was comprehensible and communicated well the game, and (c) that the student was able to express their thoughts in an adequate fashion (appropriate spelling and grammar, clear presentation of thoughts). After pre-selection, we analyzed the data of 157 students.

These data were primarily comprised of the textual documentation of the peer review process (feedback) and the video clips. In total, this accumulated in 3x157=471 reviews with an average length of 190 words and 157 videos with a mean duration of 211 seconds. Hence, we analyzed approximately 100 pages with feedback and 9 hours of video.

To this end, we used a qualitative data analysis tool and conducted open coding on the feedback. In addition, we watched the videos one time alone and one time as a group. During this procedure we took notes. Finally, we conducted a thematic analysis [23] on all these texts, looking for salient patterns with a particular regard to things that worked well and that did not work. In line with widely acknowledged authors in the field of qualitative research (e.g., [23]), we define the significance of these salient patterns not by pure quantitative measures; rather we believe that a finding can also be salient besides its limited number of occurrences in the text.

As we focus on design pitfalls in this paper, we go on to present the results in the following section formulated as design *anti* rules.

IV. Results

This section presents eleven audio game design pitfalls collated as design *anti* rules. As stated earlier, they are formulated in an exaggerated, and slightly polemic fashion to emphasize their core concerns, to make them catchy, and to make them easy to remember. They contain interventions that exactly should *not* be implemented. Still, we expressed them as ironic imperatives, also for the sake of memorability

and to stress their nature as *anti* design rules in contrast to widely-used design recommendations.

Please note, that the participants came up with many intelligent, original, and enjoyable audio game design concepts. We chose the titles of the design *anti* rules by no means to be disrespectful. Neither is our intention to indicate that the students' submissions were of low quality; on the contrary. Most *anti* rules are based on only a few observations, worked out by thematic analysis [23], and were exaggerated for the reasons explained above.

A. Use Excruciatingly Painful Sounds!

Since audio is the only mandatory channel in audio games, it is the primary modality a designer has to take care of. Audio in audio games are – considered in analogy – the graphics of video games. When a player watches the screen while playing video games, he or she perceives the visuals as the output from the game which the player reacts to with his or her user inputs. If players face a situation where the visuals are unpleasant or even "painful to watch", they can close their eyes physically using their eye lids or just turn away by focusing on something else and therefore escape the visual images. However, the human body does not have similar physical means for covering the ears or other ways of avoiding a unpleasant sound (in a similar fast fashion).

We therefore argue that players of audio games are more vulnerable than players of video games, if the game makes use of sounds in an unpleasant or even painful way. The players cannot escape physically nor by focusing on some other sounds, like they could in video games if they would not want to experience the game's content. It is open to debate if graphics can cause physical pain, however, there is painful audio. This observation also relates to the following *anti* design rule.

B. Punish Failure with Loud and Bad Sound!

A game usually rewards players when they succeed in the game and also punishes them, if they fail in a certain task (e.g., by adding or subtracting game credits). Depending on the design of the game, the degree of designed punishment is used in different ways, ranging from mild punishments (e.g., losing a 'life') to more severe ones (e.g., losing the game) [4]. The visual content itself is usually not part of the reward or punishment systematic. However, in our observations, the interaction design students employed loud or annoying sound as a punishment. As this strategy occurred in several audio game prototypes and can be problematic due to ethical implications, we capture *sound as punishment* here as an *anti* design rule to encourage discussions by the community about this approach as a game mechanic.

C. Use Stock Sounds!

Stock sounds are similar to their visual pendant: stock images/video footage. They are easy to acquire, do not require professional sound equipment per se and, are often less expensive than producing the sounds by oneself. The downside

Fig. 2. Illustration of a well-coordinated and mastered sound design resulting in a consistent sound scenery and mental imagery. The player perceives and understands the sounds in harmony, thus producing an image in the player's mind that the player can enjoy.

of stock sounds are licence fees, their non-exclusiveness, as they can be used or bought by others too and their generic characteristic, which may not perfectly fit a scene or intended experience. For the study on hand, stock sounds were appropriate due to the nature of prototyping, however, we found several examples in which the stock sounds limited the participants in expressing their intentions and in offering a rich and diverse spectrum of player experience.

D. Do Not Use Sound Fitting the Ingame Context!

Sounds in audio games shape the virtual scene through auditory information. Therefore, the primary elements of the game shaping the experience is all information in the game that is represented via composed snippets and tracks of sounds. A different selection of sounds, even if they are very similar, could reshape the imaginary scene unintentionally and influence the experience dramatically. Depending on the scenery to convey, the sounds should have relations to that scene and therefore fit the context (see Fig. 2 for an illustration of a consistent scene created by good sound design). In our analysis, we found in several instances how inappropriate sound snippets spoiled the mental imagery of the players. This also relates to the *anti* design rule of Section IV-J, and the illustration in Fig. 3 visualizes possible consequences of inappropriate sound mastering.

E. Explanation of Game Rules Must Take Up to 5 Minutes & Must be Separated from the Playing Itself!

Games in general are complex systems in which the player has to be able to understand the relationship between his or her actions and the system's reaction or outcome. In video games, interactive tutorials offer an excellent way to introduce the player to his or her gameplay options. Often, these tutorials are embedded into the game experience, however, they also can be

presented separately from the game itself. In such games, visual tutorials have the advantage that they can simultaneously visualize information or render text to the screen, supporting understanding. However, we argue that this does not apply in the same way to audio games. The explanation of game rules or interactions are not as easily included into the game in an unobtrusive way as we found in our analysis. They can either break immersion easily and thus feel not like part of the game, or they are introduced before the game starts, which can be lengthy and tedious (also because the player has to memorize and use this information at later points in the game).

F. Music or Ambient Sound has to be Distracting!

The human hearing system can differentiate between several different sounds playing at the same time (i.e., it can distinguish a limited number of different sound sources) [24]. In daily life, communication is even possible in noisy environments as exemplified by the Cocktail Party Effect [25] that allows focusing on relevant sound while virtually lowering and suppressing other sounds. This is of special interest in audio games as well in contrast to visual games where several visual effects can be perceived in parallel. When the players focus on essential sounds in an audio game, distracting music or sounds are disturbing the player in the experience, which can break immersion or cover up important auditive game information.

G. Voice Samples must be Incomprehensible!

The quality of voice and sound samples in audio games define one aspect of the game's quality, similar to the realism of graphics in video games. Voice samples can be computer-generated or human-recorded, depending on the choice of the designer. Computer-generated voices are relatively easy to generate, since there are several text-to-speech programs available. Furthermore, they only require the text for generating the samples. The downsides of computer-generated voices are their unrealistic pronunciations and robot-like voices. Human-recorded sounds are more complex and costly in production, since they require professional sound recording equipment, post-processing and – if possible – professional voice actors. Therefore, they can be produced in a more tailored fashion than computer-generated voices.

In our study, we repeatedly found that computer-generated or voice recordings of low quality can have significant negative effects on the user experiences of a game. Moreover, "low quality voices" can make the audio game prototypes appear quite cheap and low in fidelity which might only be appropriate for prototypes at certain early stages.

H. Have No Reference Point at all!

Visual computer games are conveying perceptions of depth and distances in a comprehensible way. 3D games for example calculate perspective in order to recreate realistic experiences in the game. The player is able to estimate distances because of gathered experiences from the real world but also comparable virtual spaces. However, when relying on auditive information it is harder to estimate distances to sound sources. The audio game prototypes of our sample lacked in reference points providing convenient orientation for estimating, for example, the distance between the player and the sound of a fireplace.

Fig. 3. An illustration of an unnatural or confusing experience, caused by random volumes and unexpected behaviour that "completely" destroys the imagined scenery that the player has built up in Fig. 2.

I. Mix Descriptive Narration with Experiential Narration to Break Immersion Effectively!

On the one hand, audio games may convey their content in form of narration, making use of a story teller voicing a story. The narration is therefore used to convey the contents of the story and/or the interactive gaming experience. On the other hand, voice was often effectively used in the audio game prototypes to communicate instructions or technical information on interactions, menus and GUI-elements. Unfortunately, when presenting these two kinds of narrations simultaneously, it may distract the player from enjoying the content immersively, as the instructional part interferes with the game-content.

J. Use Random Sound Volumes!

The participants clearly underestimated the need for sound mastering. The volumes between different sound sources differed drastically in some of the audio game prototypes. Sound sources were played simultaneously covering each other up or playing at volumes not fitting in comparison (e.g., in one game foot steps were really loud, while at the same time cars were relatively quiet) resulting in an unnatural and confusing experience. In Fig. 3 we illustrate in a vivid fashion how the mental imagery has built up within Fig. 2 is being destroyed for the player by inappropriate sound mastering.

K. Relate Sounds and Ingame Actions that Together Do Not Make Sense!

Game elements in audio games should emit sounds that players would expect, for example, a bell should sound like a bell. Nevertheless, we found several examples in the data where the sound used had no natural relation to the game object.

One notable audio game prototype included a voice providing a descriptive introduction on how the player should expect a banana in the game to sound like. "A banana sounds like ...", followed by a jingling of a bell and a piano tune. In other words, in some instances objects were assigned by the students with unfitting sound samples, for example, a usually silent object like a banana was assigned with a fictional sound. Unfortunately, in this example, it was not clear how the chosen bell and piano tune were supporting the perception of banana-related game interactions effectively as well as credibly (cf. Fig. 1). This example illustrates that it is difficult to encode pure visual information into an auditive experience. Here, bad audio design and mapping decision can also lead to negative effects in audio games.

V. Discussion

In the previous section, we described eleven *anti* design rules for audio games in detail. In this discussion, we want to elaborate two aspects of our research that are located on a more fundamental or analytical (meta-)level. (A) For one thing, we return to the *Problem of Induction* and our sample of audio game prototypes from interaction design students. (B) Then again, we conduct further analytical steps and divide the *anti* design rules in three categories (*Signal*, *Mapping*, and *Game*) in order to establish a set of different design lenses as a meta tool.

A. Black Swans and Bananas in Audio Game Design

We stated in the introduction that we observed problems in audio game prototypes in order to elaborate *don'ts*, instead of observing features in audio games that worked well and "inferring" verified design guidelines from these observations (*dos*). This enabled us to state that specific characteristics will most likely ruin a game and to formulate *anti* design rules.

While verifying proper design guidelines takes many observations and years of experience, "falsifying" or identifying bad design ideas take only a few or even just one occurrence. This brings the advantage that the empirical data for establishing *anti* design rules doesn't necessarily have to stem from professional audio games. Instead, we argue that we can also draw on audio game prototypes from less experienced interaction designers.

We elaborate this idea by returning to our analogy with *The Problem of Induction*. In line with Popper, this classic problem states that observing one counterexample can be enough to falsify a theory, however, collecting an apparent endless number of positive examples cannot suffice to finally 'prove' a theory. To illustrate the problem, the classic example in epistemology is the occurrence of one *black swan* that is sufficient to falsify the theory that "all swans are white". Similarly, we argue that observing the occurrence of one bad strategy in audio games, for example the use of stock audio samples, can falsify the idea that using stock audio samples is generally a good decision in audio game design. – The occurrence of one black swan in the shape of an unfortunate design decision (in this example, the use of stock audio samples that spoiled the user experience) is enough to reject the idea to generally employ this feature in future designs to improve products. In this context, we argue, it does not matter whether this unfortunate design decision (a badly sonified banana can serve as another example; cf. Fig. 1) was made by professional designers, beginners or amateurs.

B. Three Design Lenses for Audio Game Design

In this subsection, we discuss the eleven proposed *anti* rules and what they have in common. Some *anti* rules share similar features or origins which we use to categorize them into three categories for the sake of this discussion: the *Signal*, the *Game*, and the *Mapping* category.

These categories are not mutually exclusive but overlap to a certain extent. To this end, they are to be understood as non-exclusive lenses, which can be employed to interpret the *anti* rules according to their specific focus.

The *Signal* category is enclosing properties of sound itself e.g., volume or frequency. Several *anti* rules are illustrating on some occasions how the properties of the audio signal can cause different kinds of effects. On one hand, volume (see *anti* rule in Section IV-J) is used to make objects in games more dominant ("visible"), to convey a certain closeness to the sound source or to make the objects appear more important to the player. However, volume or frequency are also used to create "painful" effects (see *anti* rule in Section IV-A) or to punish players (see *anti* rule in Section IV-B) during the game. Also, sound is a signal which is usually processed in a more serial fashion than visual stimuli. If certain sounds are played simultaneously, the player may lose direction or get distracted from the sounds which are guiding him or her (see *anti* rule in Section IV-F). Environmental sounds may cover up important information, which should be perceivable to the player. It may also be distracting if the sound samples used for representing the game-element or object are not fitting/not appropriate.

Hence, the *Signal* category collated aspects in audio game design that related directly to the nature of sound. In the following *Mapping* category we deal with experiential components of audio elements and the designer's intention behind creating such an experience.

On one side, the imaginary component of sound might pose a potent tool for conveying powerful experiences (see Scary Shadow Syndrome [26]). There is one illustrative quotation from the American producer of radio programs Himan Brown who had been interviewed by Bob Morgan: "There's nothing bloodier than the blood you see in your imagination" [27]. On the downside, it is easy to choose unfitting or inappropriate sounds by accident for representing game-elements, which may end up being confusing (see *anti* rule in Section IV-D). In order to convey the meaning of the ingame contents and offered interactions often explanations were used in the audio game prototypes. Those explanations were sometimes introduced in the beginning of the game or during the course of it (see *anti* rule in Section IV-I). Both ways having their pro's and con's (see *anti* rule in Section IV-E). The excessive use of explanation and tutorials may be connected to the

circumstance that sound is more open to interpretation and some "rules" need to be explained beforehand. This becomes apparent when looking at audio game prototypes introducing sounds without providing any reference points, such as described by *anti* rule in Section IV-H. You can never tell how far you are from an airplane if you do not know how loud this kind of plane is. It becomes even more difficult if designers need to introduce sounds for game-elements which make no sound in real life. On the one hand, this offers extensive freedom in choosing mappings and conveying meaning in artistic ways, on the other hand it can easily make no sense for the player at all, up to a point where assigning sounds becomes arbitrary, for example, assigning a banana the sound of a piano tune (see *anti* rule in Section IV-K).

The categories *Signal* and *Mapping* are both harboring pitfalls but also opportunities for game design. Some of the design interventions have a strong impact on maintaining or breaking immersion. In order to convey certain aesthetics and a personal tone in games, designers are usually producing an extensive inventory regarding textures, 3D objects, animations, etc. We argue that the same applies to sound and even more focused in audio games. The extensive use of stock sounds in the audio game prototypes and robotic voices may lead to mundane and boring content (see *anti* rules in Sections IV-C and IV-G).

Some of the *anti* rules show potential for developing audio game mechanics as well. This aspect we summarize in the following as the *Game* category. Although we defined *Use Excruciatingly Painful Sounds* as *anti* rule for audio game design, it could be valuable as game mechanic. As discussed above, painful sounds are potentially inevitable for the player, when compared to visual stimuli. When used as game mechanic, it offers an option to punish players through painful/unpleasant sounds replacing or extending more traditional game mechanics e.g. losing life when failing in the game. This however raises significant ethical issues for game design in audio games. For instance, how careful must a game designer consider his or her design decisions, when implementing auditive game mechanics (in order to avoid temporary, permanent or felt harm)? Many audio game prototypes showed, that such effects can easily be achieved by accident, not purposefully harming the player.

VI. Conclusion

In this paper, we presented eleven *anti* rules for audio game design that emerged from an analysis of 157 audio game prototypes. They represent a list of *don'ts* that audio game designers should consider when designing audio games to avoid common pitfalls. We clustered the *anti* rules into the three categories of *Signal*, *Mapping*, and *Game* that can be seen as non-exclusive lenses through which the rules can be interpreted and seen differently. We want to encourage the community to propose additional *anti* rules to complement conventional design guidelines since we believe that "falsification" (*anti* rules; *don'ts*) can be equally powerful in preventing bad designs like "verification" (guidelines; *dos*).

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