



The Effects of Visual Style on Perceived Challenge

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ABSTRACT

With a recent rise in popularity (and controversy) of *challenging games*, many have attempted to emulate their success. These games are commonly styled with dark, gritty and often surreal settings and characters. Beyond setting the tone, is there a measurable effect from these visual styles on the perception of challenge, and if so, what are those effects? This study looks at similar research and/or the fields visual style, and/or challenge in games to create a game with two distinct styles, from which as a result, a set of categories to better describe a visual style is proposed. The game is then used as an investigation into what to look for when testing for the impact of visual style on perceived challenge.

KEYWORDS

Visual Style, Challenge, Video Games, Competence, Player Experience

1 Introduction

In recent years challenging games have received a cultural, and market-, boost with ‘*git gud*’ culture, where player skill is highly valued (‘*git gud*’, a rewrite of ‘*get good*’ and is a response commonly used online to put down and/or encourage players seen as lacking in skill). As a result, more game developers have been aiming for challenging gameplay as a gimmick. This can be seen as a partial return from an age of games tailored towards smooth experiences, back into rough and sometimes even infuriating challenges. These games come in all sizes, genres and styles. But should they? What if the choice of visual style can have negative consequences?

When a developer is trying to better cater to a specific target audience, knowing whether or not the choice of visual style changes the perceived challenge, or if there are any other either unwanted or wanted effects could be very useful. Especially for independent or smaller developers, as any time spent creating assets needs to be well motivated. Smaller development teams with shorter development time tend to create fewer and more simplistic assets, and choose visual style based on a very limited

graphical budget. What if it is worth putting in that extra time and money into a visual style? Perhaps the team should go for *Super Meat Boy*'s[17] gritty style rather than *Kirby's Epic Yarn*[18] bright and colorful visuals (see Figure 1). *Dark Souls* 3[19] rather than *The Legend of Zelda: The Wind Waker*[20] (see Figure 2). Both *Super Meat Boy* and *Dark Souls* happen to be known for their difficulty, what if the visuals help support such gameplay better?



Figure 1: Kirby's Epic Yarn (left) & Super Meat Boy (right)



Figure 2: Dark Souls (left) & Zelda: Wind Waker (right)

This study is an initial look into how to create and define distinct visual styles, and how to analyse/measure the effect of visual style on perceived challenge.

The study builds on work by Gerling et al.[3] which found a notable difference in perceived *competence* in games with two different visual styles, *abstract* and *stylized*, showing initial results on the importance of choosing appropriate visual representations within games.

RQ1: *What are the effects of visual style on perceived challenge?*

RQ2: *How are two distinct visual styles produced in a structured manner?*

2 PREVIOUS WORK

2.1 Approaches To Visual Style

Depending on what the goals of research into visual style is, the results and methodology can vary notably. Due to the usability of visual style as a way to categorize and search for games, there is plenty of motivation to appeal to end-users rather than professionals or researchers [4][5][9][11]. With this study being targeted primarily at researchers and developers, the subject of visual style will also be approached as such. This approach is not without caveats, as it seems to be fairly uncommon. The subject as a whole is also difficult to approach due to an apparent lack of research on the subject in general [5][4]. It also has some variety in naming conventions and taxonomy, even setting the standard of the term *visual style* itself is a fairly recent development within the research area [5].

2.2 Definition of Visual Style

A style, on an abstract level, is a collection of similarities within a subject, which forms a coherent and identifiable pattern [6]. For visuals specifically, it has been described as “*a cohesive and unifying visual aesthetic*” [5]. As such, there is a level of expectation for conformance and consistency from the viewer. These definitions do not limit the depth of the description of the visual style, and allows for both superficial or general descriptions and in-depth descriptions of visual styles. Visual styles do not exist in a vacuum, and are difficult to disconnect from the game as a whole, and they are generally connected to an overarching theme [6].

2.3 Connection to Art

With game art still being within the confines of ‘*art*’, many of the aspects used to describe art can be used similarly for games [5][6]. Inheriting its nature, this also introduces an unwanted level of subjectivity to its research, with art generally being considered to contain an element of interpretation [5]. On a positive note, implementing certain styles into games require technical solutions, and these techniques are generally not subject to interpretation, albeit terminology may vary. There are also many cases where visual styles are borrowed from traditional media, such as paintings, movies and cartoons [6][5]. These naming conventions can be used as-is in many cases, although technical descriptions might be needed to fully explain the style, such as how the work by Donovan et al.[5] describes the visual style of the game *Okami* with the Japanese artistic style *Sumi-e* combined with *cel-shading*.

2.4 How to get the data/descriptions

There is also an issue with concept versus content analysis. Since the digitalization of media, most image-based research has been based on content analysis [4]. This could be an issue if the content of a game has a style which is difficult to process, which a conceptual look rather than an image analysis could notice [4]. In essence what this means is that a human observer is more likely to accurately identify a style and its cultural origins.

Gathering descriptions of influences and the goals of the visual style(s) directly from developers would be ideal to accurately portray any game’s specific visual style [4]. There was an attempt made at such an approach by having game development students describe and categorize visual styles [4]. However, in contrast to information from developers of completed games, this does not give much insight into any specific game or description of a visual style, or what element different developers consider important to describe within a visual style. Also, studying game development does not mean that any student has significant insight into visual styles. as it would require at least an interest, or focus on visuals in some way. Whether or not this was true for the participants, is not mentioned in the source [4]. An example of a fairly complete detailed description is the *FAVR*[10] by Arsenault et al.. *FAVR* looks deeply into visual representation, and recommends a ground-up look at describing game visuals. This resulted in a robust framework which describes how a game can be presented onto the screen, or viewed. *FAVR* descriptions also include what type of data is being rendered, such as *Vector graphics*, *Polygons* etc.. Donovan et al.[5] also puts weight on the importance of describing how games are viewed and presented as an aspect of style.

2.5 Common Terms and Descriptions

Where specific styles are mentioned, three terms are fairly constant throughout the research; *Realistic*, *Stylised* and *Abstract* [6][5][3][4][8][11]. These are not always named nor implemented the same way into each framework, and have their own issues as to how they are defined. *Realism*, was found to have multiple interpretations, and in one case as the concept of *exaggerated realism* [4]. This fits well into the idea that realism can be seen as part of a spectrum rather than just a category [6]. On this spectrum, *abstract* can be seen as the opposite of *realism*, with *stylized* in the middle. Similarly Keating et al.[4] had the participants of their research place games according to style on a table, which has the advantage of not moving towards absolute values but rather the difference is measured relatively from other styles. The *Controlled Vocabulary for Visual Style* (henceforth *CVVS*) [8][7] sets up some standard terminology for general style description, and a basic yet expandable framework.

There are also styles which come from the games themselves, such as pixel art. Initially, pixel art was simply what the technological limitations at the time could produce, yet it

evolved into being considered a style of its own [5][4]. Categorizing the early pixelated games as *pixel art* is both correct and incorrect, as it might not accurately represent the developers intent or vision, yet it is technically true. This presents a further problem with defining styles, as there is a temporal and technological aspect which needs to be considered [5][4]. This makes pixel art both a technical term and a visual style, with developer intent separating the two concepts.

More recently, with the introduction of *Physically Based Shading(PBS)* and *Physically Based Rendering(PBR)* to games, the term *realism* received another visual boost, and set a new standard for what can be considered realistic. *PBS/PBR* refers to the method of more closely approximating real-life lights and materials. The ongoing move towards ray-tracing (and similar techniques) could also soon change how realism within games is perceived, and could perhaps make the current technical descriptions of realism quickly outdated. By using realistic rendering techniques, the style can be affected as well and be, in part, considered to be in the category of *realism* even with otherwise stylized visuals, such as a Lego themed game with realistic rendering [4].

2.6 Discerning different styles, description frameworks

The existing frameworks have different goals and structures, and each iteration attempts to construct or use their own framework [6][1][5][4][8]. However, each new iteration and interpretation leads to new perspectives on how to approach visual style. But as a result, there is no well tested and generally applicable framework on research into visual style. There is however a trend towards categorization of styles and the ability to use a combination of multiple terms or facets to describe a style [5][4][7][8], while some recognize the value of representing styles as spectrums [6][4].

The idea of placing visual styles on a spectrum, has seen little further support. An obvious issue with looking at visual styles on a spectrum is that a lot of stylized games that might be considered visually very different, yet have similar levels of realism and stylization, would be located in the same area. Placing styles on a spectrum might has its uses, but it seems like a 2D representation of styles as in Järvinen's work [6] is not sufficient for anything other than a superficial analysis. There might also be too many factors within a style for a spectrum-representation to be viable.

Research into visual style to this point seems predominantly focused on analysis of visual styles rather than their production, with one exception, the framework by McLaughlin et al.[1], which divides styles into *Form*, *Motion* and *Surfaces & Lights*, which has been tested in other studies[2][3]. *CVVS* [8] also provides a good start, and uses three descriptors, *style*, *color* and *mood*. Previous work, similar to this study, on player experience and visual style did not use the concept of visual style but rather

Graphical Fidelity[3] and *Visual Complexity*[2]. Technically however, they implemented *abstract* and *stylized* (or similar) as styles.

2.7 Many styles in one

Games, much like other art, are also not limited to a single style. As different elements of a game can be made with varying style, and due to the level of possible interactivity, much visual variety can exist within a single game. As such, defining a game as having a single identifiable visual style could be difficult in some cases. A game could also simply have a nondescript style, or be a border case, which can be difficult to describe or categorize [4]. Game art is however implemented with gameplay as context, and breaking of the visual style is often used to point out important information or visually separating objects. As an example, characters are often made to be of a different visual style than the environment, which helps the character stand out in the scene and increase their visibility [5] or possibly due to technological limitations, or as just a style choice[11].

2.8 Challenge

A challenge is a task or a problem which is considered stimulating, which in games can be both cognitive, physical and emotional [15]. Physical challenges are based on the input for the game, while cognitive challenges are connected to problem solving, and emotional challenge is experienced through moral choices and empathy due to story elements or similar. Challenge is considered to be an essential aspect of what makes up a game [15]. One of the reasons for this is that games that are too easy or too difficult to play can result in boredom or anxiety [13].

The work by Denisova et al.[15], which covers a large amount of earlier research and more specifically usage of questionnaires to measure challenge, identifies what types of influences there can be to challenge from existing work:

- *Difficulty and Skill*
- *Learning and Mastery*
- *Flow and Immersion*
- *Uncertainty*
- *Performance Evaluation*
- *Enjoyment and Pleasure*
- *Competence*
- *Suspense and Curiosity*
- *Anticipation and Tension*
- *Success and Failure.*

According to Denisova et al. [15], *competence* is the result of *optimal challenge*, as mentioned earlier, and has the player feel able to solve the problems presented by the game. Azadvar and Canossa's *UPEQ*[12] and Gerling et al.[3] continues a trend of presenting *competence* as a psychological *need* within games. *UPEQ*[12] also shows that *competence* is an important component in measures that can predict playtime, money spent and general likeability of a game.

Difficulty, in contrast, is simply a measure of how ‘hard to do’ a task is, and challenge does not necessarily require difficulty [15], just as how *difficulty* does not automatically result in *challenge*. *Difficulty* is also often conflated with *challenge*, and the terms are often used interchangeably in both research and among the general public [15].

While *UPEQ* [12] is the most extensively tested player experience questionnaire to date, it is unfortunately not relevant to the research questions, as it is primarily useful for prediction/analysis of playtime, money spent and group play. The focus of research into player experience and challenge is often motivated by economic factors or simply making a more well-received game rather than challenge in itself [12][15]. As such, entertainment value, and positive reactions is understandably often in focus. In contrast, the aim of this study is to find if there is any further correlation between visual style and perceived challenge, and reinforcing previous results in *competence*. There currently exists no complete and tested framework for measuring all the different facets of challenge [15].

3 METHOD

This paper largely follows Peffer’s [21] design and creation methodology. As such, there were some iterative changes to both the paper and the artifacts produced, although the primary objective (RQ1) and motivation did not change throughout the process beyond wording.

Much like similar research [3][1], the problem was approached by the already tested and established method of producing a game with distinctly separate visual styles, but identical gameplay, and applying the game with user tests.

However, in the process, a gap in the research, specifically on how to make distinctly different visual styles, was found. As such, the research questions had to be updated, and an objective for the thesis was added. It also led to the design and creation of a categorization system of style (see *Table 3*).

This categorization was eventually tested by producing two distinct visual styles in the game with it as a basis. The resulting visual styles and concurrently the efficiency of the categorization were then tested on their viability for finding differences in *challenge* based on visual style, via interviews. The data was finally subjected to both a quantitative and qualitative analysis for evaluation.

3.1 Game

Initially, a small racing game was planned, but in consideration of time constraints, a simple planetary gravity-based game, similar to *frogger* like Gerling et al.[3] used, was made. The player has to guide a vessel to another planet past moving obstacles, without crashing during flight, landing or takeoff, or flying off-screen, whilst fighting against gravity. There are also

collectible points which guides/misguides the player. The game was made with Unity[16] due to its high support for short development cycles, fast iterations and multi-platform builds. Also as a progression from previous research, this game was made in 3D [3], although with gameplay still in 2D-space.

Gameplay was made to be somewhat challenging, as previous research found that more challenging games had a more notable difference in results regarding not only to *competence*, but all measurements used (*Competence, Autonomy, Relatedness, Immersion, Intuitive Control*) [1]. There are only three inputs in-game (accelerate, turn left, turn right) and no random elements, to keep the game fairly simple, and to keep the player feeling responsible for any mistakes. Each obstacle moves in a predictable linear pattern, teleporting from one side of the screen to the other, off-screen.

The game was produced using primarily basic shapes before any visual style was applied, and was worked and improved upon continuously throughout the study. Later versions included WebGL support which means the game could be run online, and also had a clickable link (for the questionnaire), and could copy gameplay results (time, score, deaths) to the clipboard, which any user then could paste into a questionnaire.

3.2 Measuring Challenge

In the beginning, a quantitative approach was attempted, using a simple and very limited questionnaire, which was quickly dismissed once tested, albeit far too late in the production of this thesis. Even when only looking at *competence* and *difficulty*, as initially done, it seemed improbable that participants could accurately perceive these. Initial results, consisting of 4 respondents, showed that whichever visual style was played last was consistently seen as easier, both in *competence* and *difficulty*, and a 5-point scale would not be sufficient without a fairly large sample size to show any relevant difference. Furthermore, due to this study looking into challenge as a general concept, which types of challenge would be present in the results would be difficult to predict. An accurate and functional questionnaire would require most relevant types of challenge present in the game to be tested for, and constructing such a questionnaire was sadly far beyond the scope of this study.

Instead, focus was shifted onto getting insight into what players specifically found different between the two styles in regards to challenge. This turned the project towards a more qualitative analysis, consisting of interviews and reactions to challenge during gameplay. The reason for this was that this method guarantees that if there are any results, they are likely relevant, and can give insight into what perhaps future research should focus on. Furthermore, it did not require the construction of an expansive questionnaire, which itself would also require testing.

At this point, however, the game had already been designed with portability and performance in mind, for a quantitative method,

including online access through WebGL, which had in part taken up a needless amount of time.

3.3 Interviews

Interviews and tests were primarily done in a classroom with students at computers. The remainder (2), were initial tests, which were conducted in a private setting. Participants were interviewed one at a time, at their own pace. The different styles, akin to previous research [3][2], were played in varied order to avoid bias towards the first or last game played. The participants were asked to speak out loud and any relevant exclamations or responses regarding challenge were recorded after playing the first game. Participants were encouraged to switch between games to confirm their reactions/responses. The interviewer and the participant were seated next to each other, with the participant at a computer, playing the game, and interviewer taking notes on challenging events and their context, and instructing the participant where needed. Instructions were primarily gameplay assistance, and which game to play. Participants were asked to only play as much as they wanted, but to at least play both games to a similar extent. The primary questions asked were the following:

- “Does this/either game seem easier / more difficult / challenging?”
- “If so why?”

If the participant found any difference after playing, and switching between games where needed, the fact that the two games are in fact identical in gameplay is then revealed to see if this changes the perception of any difference. The answers were then finally compared with the different aspects of *challenge* to find which type of challenge the participant found differed between the two games, and any trends analysed.

4 VISUAL STYLES CATEGORIZATION

Producing visual styles by applying existing research and definitions in mind had proven itself to be an issue due to the lack of production-focused visual style descriptions.

Initially, frameworks by McLaughlin et al.[1] and *CVVS*[8] were tested. Both proved to be insufficient to describe the complete style of a game due to a lack of technical overlap to describe any actual implementation. However, for defining dissimilar styles from general descriptors *CVVS* was very useful as a first step. As the purpose of this paper was not a deep analysis into style, a full in-depth description of everything in detail (such as *FAVR*[10]) was also highly unnecessary. At this point a mid-point between a general description and an in-deep description was needed. As a basis for the creation of varied styles with a level of distinctiveness, a structure that can show what technical elements should be used/differ when making separate styles at this point seemed practical. Existing frameworks are neither particularly complete, nor made with

this in mind, with the exception of McLaughlin et al.’s work [1], which was used as a basis. As a result a set of visual categories were discovered:

View, Lighting, Models, Materials, Textures, Animation, Effects, Environment, UI/HUD (see Table 3).

The categories are based on a combination of previous research, common game asset categorization grouping and technical descriptions. The categorization is both an explorative extension of how McLaughlin et al.[1] categorizes assets, but also largely based on general asset categories in games. After initial grouping, the categorization was further improved upon iteratively by testing if it was possible to place a wide variety of technical and style terminology within the categorization. At the point where the categories were deemed enough to describe multiple stylistic and technical choices, as few notably different descriptions were left, focus was shifted onto defining the two visual styles needed and their production.

4.1 Making of Visual Styles

The styles were defined by choosing opposing or “distant” concepts in each category where applicable (and producible within time limits), based on initial general descriptions; *bright stylized* and *dark realistic* (see Tables 1 & 2, Figures 3 & 4). The two styles were initially based on the three styles *realistic*, *stylized* and *abstract* as a basis, since those are the three most common and easily distinguishable descriptors as they have been tested in previous research to some extent [1][3]. They were then expanded upon using *CVVS*[8] with *dark* and *bright* as identifiers, then further with the dark realistic game getting less saturated colors while the bright stylized game got stronger vibrant colors. For the game, some categories, or only partially used, in cases where no specific style or technique was planned to be applied.

Some effects are also used in both games, to enhance visuals, or support gameplay. Vignette (darkening around edges) was used in both versions, although slightly differently to focus the player onto the center of the screen. Bloom was also used in both styles to make it so that bright objects stand out. Notably the bloom stands out more in the darker variant (see Figure 4), while the bloom also makes the scene look softer in *Style 1* (see Figure 3), resulting in different stylistic effects.

As to avoid making one of the games *technically* more difficult, the styles require gameplay elements to be similarly visible and distinguishable. There are also no differences in any camera aspects during gameplay, to keep them gameplay-wise as close as possible. Also, while orthogonal/perspective views can be seen as a style choice, the flat perspective could potentially change how difficult gameplay information is to perceive, and was as such kept the same. Going a bit further than previous research, the visual styles also were set in different themes.

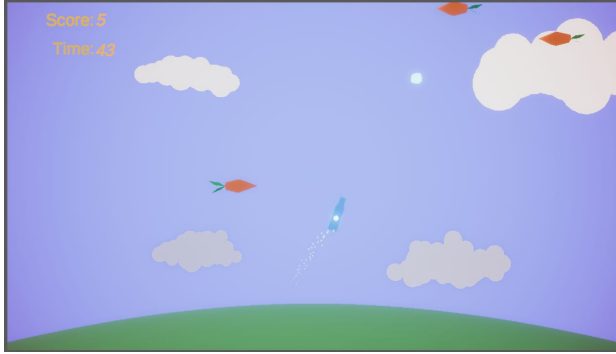


Figure 3: Style 1 - Stylized Bright Saturated



Figure 4: Style 2 - Realistic Dark Desaturated

View	
Projection:	3D, Low Field-Of-View
Viewpoint:	3rd Person, Vertical Follow
Technical:	Bloom, Vignette
Lighting	
Technical:	Flat Lighting/High Ambient, Sunlight
Style:	Cartoony, Simplistic, Bright, Colorful
Models	
Technical:	Low-Poly, Vegetables, Bottle, Water
Style:	Abstract-Stylized
Materials	
Technical:	Flat
Style:	Flat, Pastel Colors
Textures	
Style:	Cartoony, Simplistic
Effects	
Technical:	Particle Effects
Style:	Abstract-Stylized
Environment	
Technical:	Planet, Clouds
Style:	Abstract-Stylized, Simplistic

Table 1: Style 1 Description

The realistic game was set in space, with an actual rocket as the player model, collecting 'orbs' and avoiding flying saucers (see Figure 4). The stylized version had a glass bottle collecting 'water' while avoiding carrots, possibly intent on getting the water in the bottle (see Figure 3). Although the visuals of the player and enemies are different in the styles, their colliders are the same, and they had to be designed to visually fit a similar space.

The most important aspects such as the player and enemies were made as custom models, with custom textures, while the rest are basic shapes such as spheres and cubes. The realistic version

View	
Projection:	3D, Low Field-Of-View
Viewpoint:	3rd Person, Vertical Follow
Technical:	Bloom, Vignette
Lighting	
Technical:	Skylight & Moonlight, Low Ambient
Style:	Stylized Realism, Dark, Desaturated
Models	
Technical:	Mid-Poly, Spaceship, UFO
Style:	Stylized Realism, Sci-Fi
Materials	
Technical:	Physically Based
Style:	Realistic, Sci-Fi
Textures	
Technical:	Physically Based
Style:	Realistic
Effects	
Technical:	Particle Effects
Style:	Stylized Realism
Environment	
Technical:	Planet, Clouds, Space
Style:	Stylized Realism, Sci-Fi

Table 2: Style 2 Description

required a slightly more visually advanced landing/takeoff platform as well, which was produced, while the space background, and goal-planet textures were freely available assets. Both versions have custom cloud textures as well. While producing assets, and reproducing the visual styles there was a notable amount of artistic licence being applied, but while making sure to stay within the bounds of the descriptions.

5 RESULTS & ANALYSIS

5.1 Game Visual Style Production Categorization Proposition

The following describes the propositioned categorization (see Table 3), how it is used and from what it was constructed. While an example of a fairly complete framework, and with *FAVR*[10] being more than sufficient for describing how the game is presented on a screen, the inclusion of what content is being rendered breaks the possibility of categorization into “view-related”. But with the slight modification of moving the “*Graphics materials*” section to another category, *FAVR* could indeed be used for a detailed and full description of how a game is projected onto a screen. Putting the practical aspect in focus, these aspects were put into the term *View*, which describes how the camera is set up and used within a game. Although a bit simplified from *FAVR*, it is only a category, and a full *FAVR* based description could be applied, if needed for analysis.

Camera-related effects such as vignette, depth of field and color correction fell into this category due to their image-based nature. Slow-motion was also placed in this category as it too is part of perception, and can be a stylistic choice as well as a gameplay feature.

A combination of *color* and *mood* from *CVVS*[8], and connecting to the technical counterpart, *Lighting* as a category describes all lighting effects, post-processing that affects lighting, usage of light sources, as well as color and mood-choices. *Lighting* also includes some post-processing effects, such as *SSAO* (*Screen-Space Ambient Occlusion*), which although being screen-space, has an effect on the lighting in the world, rather than on the screen..

Models refers to how objects and characters are visually represented within the game. This is where *FAVR*’s *graphical materials*[10] is now located, and McLaughlin et al.’s *form*[1]. This includes not only 3D-models, but any form, such as sprite-representation. The naming, while less accurate than *form*, is a commonly used term.

The category *materials* refer to how lights affect surfaces, or how similar effects are simulated. Unlike McLaughlin et al.[1], who combines materials and lights as a general group, *materials* were put into its own category, separate from both textures and lights. Like how Keating et al.[4] describes, a game can be both realistically rendered *and* stylized at the same time, especially when considering the availability of *PBS/PBR*(*Physically Based Shading/Rendering*), the need to look at materials separately becomes obvious. Materials could in some cases be considered to be dependent on models, and as such have the same, or similar descriptions in regards to style.

The *texture* category refers to the *texture* or *surface*, and while depending on the underlying material, as mentioned above, the

View	
Projection:	2D/3D/Orthographic/Mixed
Viewpoint:	3rd/1st person, static, follow, scroller, virtual reality
Technical:	Vignette, Lens Flare, DOF, Motion Blur, Bloom, HDR, Chromatic Aberration, Slow-Motion
Style:	Real Camera, Amorphic Camera, The Matrix
Lighting	
Technical:	Fog, Volumetric Lighting, Baked Lighting, SSAO
Style:	Dark, Bright, Scary, Horror, Fantasy, Realistic
Models	
Technical:	Low-Poly, High-Poly, Mid-Poly, PCG, Voxel, 2D, 3D, Sprites, Raster, Vector
Style:	Abstract, Realistic, Stylized, Retro, Mario, Low-Poly, Silhouette, Cats & Dogs
Materials	
Technical:	Phong/Lambert/Cel-Shading, Hard Edges, Pre-Rendered, Vertex Lighting, Flat, PBS
Style:	Anime, Cartoon, Old Games, Realistic
Textures	
Technical:	Checkers, Kaleidoscope, Truchet
Style:	Abstract, Realistic, Stylized, Sumi-e
Animation	
Technical:	IK, Physics Based, Motion-Capture
Style:	Abstract, Realistic, Stylized, Goofy
Effects	
Technical:	GPU-Particles, Volumetric Smoke/Clouds
Style:	Stylized, Abstract, Realistic
Environment	
Technical:	PCG, Terrain, Open World
Style:	Earth, Cartoony, Large UI, Silhouette
HUD/UI	
Technical:	Projected, In-World Integrated
Style:	Abstract, Realistic, Stylized, Retro, Mario, Minimalistic, Large

Table 3: Visual Style Categorization

stylistic descriptions don’t need to be the same. This is where traditional artistic styles can be used directly, and shader techniques which affect textures.

Animation is fairly self-explanatory (movement of characters/environment etc) and is a technical renaming of McLaughlin et al.’s *motion*[1]. Having animations as a separate category allows for animation techniques and styles, which are unique to animation, to be properly represented.

Effects refers to primarily particle effects, which due to their particular nature does not fit in any other category. Any similar techniques also belong here.

Environment is how the world is presented, and its important components and themes.

UI/HUD is the *UI* and *HUD* or *GUI*, the parts of the game made for conveying information (generally) in a way disconnected from the actual game world.

While the categories may seem obvious at first, there were quite a few iterations, and which concepts and technical solutions belong to which category was/is not always apparent. An example is *textures*. Textures are where two-dimensional concepts of visual styles from classic media can be directly applied, but within the realm of games, texture representation is limited to the functionality of a shader. Conceptually differentiating textures from materials is as such easy, yet for describing a visual style, they are difficult to separate due to their interwoven state.

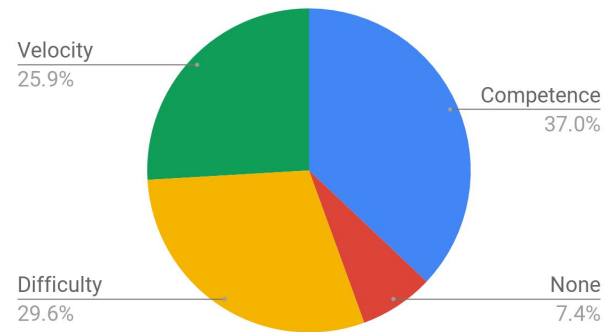
Similarly, in its current state, characters are technically nested within a set of categories. This means that a description of a character might be split over multiple categories. Alternatively, characters can be described separately, using the same categories, but only describing the character. Similarly, post-processing effects are split up into world-affecting and screen/lens-affecting, putting it part in *lighting*, part in *view*. Technical aspects need to be separated based on which part of the game world they have an effect on.

5.2 Interviews

The 22 participants were aged between 20 and 50, with the majority of participants in the range of 20-25. All but two participants were male. Out of the 22 participants, only 2 found no difference between visual styles while the rest found minor to notable perceived differences. While 2 participants had previous knowledge of the fact that the games were gameplay-wise identical, both participants did register differences between the two styles. All but 2 participants had experience with game development, to various extents. Most interviews/gameplay sessions took between 5-15 minutes. The 2 where no difference was found took the least amount of time. Participants also sometimes wanted to finish the whole game, making the sessions take longer.

One of the participants in early local testing said that the *realistic* styled spaceship had what felt like sharper(better) controls, even with no technical differences. Similarly, another participant found the bottle version of the player less 'natural' to control. In continued testing, another 8 participants felt that the ship version of the player was easier to control to some extent, although with no notable player performance increase. Rather, it was more common that, at realization, participants often performed worse. There was one case where the bottle version

Figure 5: Perceived Differences



was seen as easier to control, but after further comparison, the participant noted no differences. In most cases the difference was perceived as slight, but three participants found the ship notably easier to control, even after switching between games. The bottle, when negatively rated, was often seen as 'floaty', and at the same time more prone to lose control (and as such, potentially crash). 5/10 participants who found the ship easier to control played the stylized game first, 4/10 played the realistic game first, and one played both versions extensively.

Conclusively 10 out of 22 participants noted increased perceived *competence* in the realistic version to some extent, with no participants who perceived themselves as more competent in the stylized version. Which style was played first seemed to have little to no impact.

In the stylized game, gravity was seen as lower than in the realistic style by three participants, and as such slightly easier. Two participants argued that it could be due to the planets in the realistic version being dark, and as such seemed larger. One participant found the stylized version more difficult due to depth and velocity perception. One participant found the enemies harder to see in the stylized version in comparison to the realistic style. Another participant found the realistic style easier, but wasn't sure as to why. One participant found the stylized enemies looking faster, while another found the realistic enemies faster. 8/22 found some difference in *difficulty* between the two styles with an even split between which one was more difficult.

The ship was also seen as faster by four participants, with all but one starting with the ship at first. Three participants found the bottle faster, all started playing with the bottle first. Although varied results, 7/22 perceived some difference in player velocity, with this perception seeming being largely due to which game was played first.

There were also vague results, such as one participant who felt that the vessels 'turned in' differently when landing, and one who felt the bottle looking flat in comparison to the ship could affect challenge somehow due to depth-perception differences.

Similar to what previous similar research [3] showed, *competence* seems to be a major factor in perceived challenge differences between visual styles.

6 DISCUSSION

6.1 Perceived Challenge

Based on the results, most of the perceived differences seem to stem from the player-controlled vessel, rather than the environment. This does not necessarily mean that the environment did not affect this in some manner, as environmental differences in perception were noted, such as gravity or distances seeming different. Although the results on perceived *difficulty* are mixed, they are still a significant portion, and all have to do with the relationship between player vessel and environment.

But what are the implications of these results? For one, it further shows that the choice of visual style on its own seems to have an impact on perceived challenge, more specifically *competence*. This means that choosing the right style when developing a game, can be especially important when the game is challenging, and less so for easy games. But due to competence being such an important measure, this is perhaps something that should be considered for all games, no matter the type.

Like previous results on *competence* and visual style showed that *stylized* visuals were perceived as better over *abstract*, this study shows *realistic* visuals being seen as better than *stylized*. This points to that applying realistic visuals might have a positive effect on perceived competence.

One issue with the study is that the participants are asked if there is a difference in challenge, and that might result in them believing that there actually is some difference, and as such constructing one. This means that the results could be somewhat exaggerated. But, keeping the fact that the games are identical hidden was seemingly not always needed, as even after this revelation, participants didn't change their minds. Even in initial testing, and one other case where the participant was completely aware that they were playing the same game, there were perceived differences.

Measuring perceived challenge seemed most efficient if the participants switched between games rather than just playing each style once. While the questions asked were functional, and helped getting participants into the right mindset, they were not always sure of what the difference was, just that there was some difference. Having the question open-ended resulted in more detailed descriptions of challenge differences, and due to the somewhat high participation, quantifiable results, although only on a small test-group. With this result, having a short questionnaire on *competence* (1-5 scale) to better connect to previous work would have been an improvement. The initial focus on *difficulty* and *competence*, although based on perceived

importance from the author, showed to be accurate in the case of this study. As such, including *difficulty* in the potential questionnaire might have been useful.

If time allowed, a few things could have been improved for the data acquisition. Taking notes with only one interviewer showed to be slightly lacking, and having a separate member taking notes would be far more efficient, or even better, a complete recording of the events.

6.2 Game

The game was perhaps a little bit too challenging, although keeping it in the spirit of challenge was a point in the study, the effect might have been a slight bit exaggerated. The game seemed to, especially to non-gamers, be a bit too much to handle and very few (3) participants actually finished the whole game. One major reason for the difficulty level was due to how gravity was implemented (somewhat realistically), resulting in the beginning of the game being the most difficult. The end is to a lesser extent difficult, due to the final planet being smaller and thus having lower gravity, but the player also has to land what is seen as upside-down, with 'reversed' gravity, from the players perspective on the planet. Although measurements for more challenging games have shown to probably be more notable, this feature might also make producing research into challenge itself more challenging, and perhaps in a not entertaining manner. Nevertheless, the game was fairly well-received by plenty of the participants of the study. For similar research, a challenging game might be useful, but with the goal of a larger quantitative analysis, there might be some risk involved with doing testing on challenging games.

Producing the game itself was a fairly linear process once the basic design was completed. The biggest issue was accommodating the two different styles within a single game, which required some planning and testing. This was especially important as the visual styles could not differ in gameplay in any way, and was solved by using prefabs for all interchangeable elements.

6.3 Visual Style

From the perspective of a developer, the subject of *visual style* seems to have been mostly approached backwards, by going from broad descriptions to specifics, and focusing on overarching terminology and abstraction [4][5][6][7][8][11]. However, with style being a general concept, and through being initially approached as a primarily *art* subject, this was perhaps inevitable. But games, unlike what could be considered pure art, which can potentially be just 'expression', are in part a technical system, which requires planning and functional implementation. On the other hand, fully detailed descriptions such as *FAVR*[10] are probably excessive for shorter development projects, such as independent games or smaller research games. With all that in mind, perhaps visual style simply needs different levels of analysis and descriptions/abstractions depending on research

goals, such as the mid-level descriptive categorization in this paper. On the topic of usage error, although the work by Cho et al.[11] uses *CVVS* [8] as a basis, it somehow manages to define desaturated as *dark* and saturated as *light*, which is not necessarily true, nor accurate synonyms.

The categorization (see *Table 3*) itself is only a temporary solution for bridging the gap between in-depth and generalized descriptions, or at least an attempt to bridge the gap, and provide some level of reproducibility to the style development. The categories for the games were only tested within the limits of this study, which was to produce a fairly simple game, and as such might be lacking in perspective and flexibility. Visual style is in part vague by its nature, but by categorizing assets this effect should hopefully be decreased. Also by including technical descriptors in the categories, the issue of technical solutions turning into styles would be a non-issue. It is by no means a complete set, or final categorization, but it was very useful for the development of the two styles as it manages to describe both their technical needs, visual themes and elements. If it, or something similar, existed to begin with, no doubt more focus could have been put on challenge and its measurement.

As the two visual styles managed to produce some results, both the visual styles and the categorization have to some extent shown to be useful. Although visually, both styles might be seen as a bit lacking, they seem to have been well suited to this study. However, if a different artist, using the same game and the same descriptions, were to attempt creating the styles, it could undoubtedly look fairly different, yet hopefully still be fully functional for similar research. One other issue is that both games were accidentally produced with a blue hue. Extending the more general description (esp. *CVVS*[8]) with *color tone* (or similar) could be very useful, as it can strongly change the atmosphere of any visual style.

Whilst producing the two styles showed itself to be largely straight-forward, there were some engine-specific issues. These were things such as a lack of pre-made fitting shaders for the more stylized game, and a bug with lighting (*Unity 2019.2.11f1*), causing lights to flicker. The bug required either adopting a notably far earlier version of the engine (*Unity 2018.2.13f1*), or a later beta version (*Unity 2019.3.0b12*). The bug was not widely known, and as such was difficult to avoid. In this case, the beta proved to work without issues, and the older version wasn't tested. However, if an older, more tested version was chosen to begin with, this issue could have possibly been avoided completely. As such, choosing not only an appropriate engine, but also the correct build/version of the chosen engine was shown to be important. Although there is no guarantee with any game engine that unsolved issues that might not affect any project negatively.

6.4 Future Work

Further research into *challenge*, and similarly with *visual style* is needed, at multiple fronts. There is a lot of varied terminology, and some level of solidification of the subjects would be helpful for future studies.

Due to the categorization being produced due to necessity, and as such incidental, it can no doubt be further improved, and the concepts worked into better named and more formal categories. Further research into specific visual style categories/elements similarly to *FAVR*[10] could help with solidifying any category.

Although this study, like previous similar[3], shows primarily a difference in *competence*, different types of games might yield completely different results, and still needs to be tested. Also what would have happened if the game was easier? Would there be similar results? What if the stylized game was dark, and the realistic game was bright? There are many paths of inquiry that are still unexplored. When it comes to research into the *effect of visual styles* in general, there is a need for more games and types of games tested, more types of player experience, and more styles tested. As much of the perceived differences were on the player-controlled vessel, the effects of player visuals could also be an interesting venue to explore. Research into visual styles and their effects is still in the very early stages, and there is much to explore.

The attempts at making the game both perform well on most systems and have high portability might have proven a loss for this study. However, as better measurements and questionnaires are produced, having games and questionnaires available online could be a significant resource for better sampling size in future work, especially for researchers with a large social and/or professional network.

7 CONCLUSION

This study further shows that visual style can have an effect on perceived challenge. More specifically *competence* is seen as increased to a notable degree, moving from least at *abstract*, more so in *stylized*, to most at *realistic* styles. Although, more styles and more games still need to be looked at to confirm this thesis. The study also expands on the field of visual style, by taking some early steps into categorization of visual elements based on a combination of visual style descriptions, and technical descriptions. The categorization and technical description combination proved to be useful during the production, and in the defining of the two different visual styles. However, general descriptions, especially *CVVS* [8], were still very useful, or even perhaps needed as a starting point, or *sketch*, of the visual styles. The categorization, based on results in perceived competence, also showed itself to be functional as a tool in assisting the creation of distinctly different visual styles that can affect perception of *challenge*.

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