The Impact of Visual Properties on Player Habits and Game Sessions

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Abstract.
This paper aims to provide a foundation in regard to information and cause correlation for future research about player retention and game session times based on visual properties. (such as colour values) This study can later be applied within software development. An online quantitative survey about play sessions and player habits is conducted and the conduct of this research is aimed at helping art directors make conscious and deliberate choices about the art styles for products where the visuals may impact player retention and game sessions. By knowing how visual elements such as colour values, shapes and contrast impact game play intensity and player engagement, and ultimately the end time spent during play sessions, art directors can make informed decisions to help impact player behaviours and habits.

The paper includes subjects such as colour effects on humans (mental and physical), how human eye sight functions and how this should affect designs, effective use of visuals, eye fatigue, and visual communication.

This study of visual properties and play sessions concludes that visuals have a definitive impact on how the game is perceived and processed by the player, leading to situations where the same mechanics can be much more intensive if presented using specific forms of visuals.

Keywords: Colour Values, Game Retention, Visuals, Graphics, Play Sessions
**Abstrakt**

Uppsatsen är ämnad att skapa en grund för information och korrelationer mellan speltider och bibehållande spelsessioner baserat på visuella egenskaper (ex färgvalörer). En undersökning av spelsessioner och spelarvanor är utförd med sikte på att hjälpa art directors att göra medvetna och avsiktliga beslut om spelutseende för produkter där det visuella kan påverka spelsessioner. Genom att veta hur visuella element, så som färgvalörer, former och kontrast påverkar spelintensitet och spelarengagemang och slutgiltigt tiden spenderad under spelsessioner, så kan art directors göra informerade beslut för att påverka beteende och vanor.

Uppsatsen inkluderar områden såsom färgeffekter på människor (mentala och fysiska), ögonfunktioner och hur dessa borde påverka design, effektivt användande av grafik, ögontrötthet och visuell kommunikation.

Denna studie av visuella egenskaper och speltider drar slutsatsen att visuella effekter har en definitiv inverkan på hur spelet uppfattas och bearbetas av spelaren, vilket leder till situationer där samma spelmekaniker kan vara intensivare om dessa presenteras på specifika visuella sätt.

**Nyckelord:** Färgvalörer, Speltid, Grafik, Spelsessioner
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1 Introduction
Values describes how light or dark a colour is. (Doll; Baade; Andrews, 2014, p.18)
This paper aims to assist further in research about visuals and how they influence individuals in
digital visual play spaces. This paper illustrates an attempt to collect information relevant and
necessary to further explore the impacts visuals have on players and their play sessions. The
research I am conducting aims to look at visual properties such as colour values and their
correlation to players playtime habits. Will certain colour values have an impact on how long
players are willing to play a certain game experience? Will art styles containing higher colour
values cause players to play shorter sessions due to eye fatigue, or will a game with overall low
colour values cause players to play shorter sessions, perhaps due to less engagement caused by a
less intensive visual experience?
2 Background

By giving art directors access to tools that can connect player habits to the visuals and ultimately the overall design of an experience to fit the desired design goals for player time sessions, art directors can provide developers with a means of predicting and managing player behaviours. By tailoring values, saturation and contrast in a way that prevents eye fatigue, designers have a greater chance of keeping players enjoying experiences that are designed to last longer, and at the same time being able to maximize player engagement for shorter, high intensity games.

This paper is part of a two-stage project where the first stage was a literature review conducted to provide basic knowledge of colour values and visuals in video games. The literature review also touches on how research can be conducted to measure the effects visuals have on player habits in video games. This paper (stage two) is a continuation of the literature review (stage one) written last year. (2016) The Literate review in question is called: Colour Values and their impact on player habits and game sessions (Frandsen, 2016) and can be found in its entirety in Appendix B.

In order to conduct the research and analysis for this paper, I have read books on how visuals can affect us both mentally and physically, in order to properly analyse possible outcomes that can correlate to player retention. This paper tries to find common factors between already established information and the research being conducted for this paper.

The following are books listed that I have read in order to prepare for this analysis:

  This book helps us understands the basics of art, such as colour and composition.

  This book helps us understand the structure behind visuals in films and video games.

  This book provides a range of information necessary for analysing communication in our society.

  As the title suggests, this book provides universal and fundamental principles of design.

  This book uses science to create a better understanding of design.
2.1 Bright Colours
Since childhood we learn to focus on colours, especially bright colours. This in one of the first aspects of sight that lets us separate shapes from each other. “Children take in the world around them through their eyes, and bright colors are one of the first aspects of sight that help them distinguish form and categorize objects” (Pancare, 2017)

Colours are used around the world in different ways. Different colours represent different things depending on cultures and history. Colours are said to effect people on deeper levels, beyond our established cultural rules and traditions. Colours affects us both mentally and physically. In an article about colours effects on children, Rachel Pancare, Master of Science in childhood education and elementary school teacher says: “Color has also been known to affect their moods and behavior.” (Pancare, 2017) She continues, “Warmer colors like orange and yellow bring happiness and comfort.” (Pancare, 2017)

When studying colours, it is a good starting point to look at colour and its relationship with children, this way we can see the development and impact of colours in a structured way from the beginning of its effect on people and how this evolves as people evolve, physically and mentally. According to Pancare, children prefer bright colours since their eyes are not fully developed and therefore have an easier time distinguishing brighter colours. High value colours and contrasting colours stand out among the different hues of the colour spectrum. Children tend be more attracted to bright primary colours over low saturation pastel colours. Examples of this can be seen in objects and media desirable to children, such as candy, toys and children’s television programs.

As stated, colours have a clear effect both mentally and physically on people and is not just tied to cultural associations. Psychologist Susan Minamyer writes: “In addition to mental associations, there are also physical responses to color.” (Minamyer, 2017) A concrete example of this can be seen with the colour red. “Red has been known to increase the heart rate and therefore increase alertness and the appetite, while cooler colors like blue and green tend to have a calming effect.” (Pancare, 2017) Red also increases respiration and brain wave activity. (Minamyer, 2017) Effects such as these can be used for different kinds of design situations. People might use colours when designing experiences for schools, bedrooms, dental offices and prisons. In the United States, pink has been used in prisons since it has a tranquil effect on the prisoners. (Minamyer, 2017) The same tactic has been applied in the California County Probation Department when detainees were put in pink cells for acting violently. This type of pink is sometimes referred to as “Passive Pink”. (Gruson, 1982) In a psychiatric study, pink also seemed to have a certain effect on people.

“Those who gazed on blue apparently amplified their own strength by doing so, while the pink-starers seemed weakened just by gazing at pink.” (Stewart, 2013) These types of design decisions are just as applicable when it comes to game design. If a player is exposed to visual elements that encourages stress, for instance a game that relies heavily on red bright colours which in effect alter heart rates, this could for all practical purposes cause premature fatigue in contrast to a more tranquil visual experience. This design could possibly impact the amount of time spent playing, both full sessions as well as smaller sessions counting micro breaks. An experience that affects play sessions and possible pauses, alters the immersion and overall game design goals. Physical effects of visuals will be further explored in later stages of the paper.
2.2 Colour Impact
“Color, without a doubt, is the most misunderstood visual component. Probably due to the misguided color education we received as children, our knowledge of color and how it works is almost unusable” (Block, 2008, p.136) In order to better understand how colour effects the human body, we must first understand the foundations of colour.

What follows is a condensed explanation of colours from “Colour Values and their impact on player habits and game sessions”

Colour is simply light being reflected by objects whether they be organic, synthetic, alive or dead. If you cannot see an object it is because no light is being reflected from the object nor is it being absorbed by the object, or possibly if you are in situation where no light source is present. This means that for something to be invisible, the object needs to be able to let all light that is cast upon it, to be passed through it without reflecting a single ray. If there is no light present at a scene, you cannot see any objects. So what is it that determines what you see when an object is hit by light? It is determined by the amount of light that is reflected, and the light that is absorbed. This means that the colour of an object is determined by its surface. Light from the sun consists of “normal” “white” light. We call it normal light because it doesn’t seem to change the colour properties of an object.

(Frandsen, 2016, p.03)

A more detailed breakdown of individual colour aspects: Hue (H), Saturation (S), and Value (V), sometimes called HSB. (Hue, Saturation, Brightness), Contrast and Value range can be found in “Colour Values and their impact on player habits and game sessions” (Frandsen, 2016) available in Appendix B.

Humans have two types of light receptors. Rods and Cones (Ware, 2008, p.66)
-Rods are used for low light conditions. (Used to navigate during night time for instance)
-Cones are used for daylight conditions. Cones are divided into three subtypes: Short, middle and long-wavelength sensitive cones. Humans have fewer short-wavelength sensitive cones than middle and long sensitive ones. The short-wavelength sensitive cones are less sensitive to light than the others. These short-wavelength sensitive cones are sensitive to the shorter wavelengths on the hue-spectrum. (The bluer hues) And since we have fewer of these, you could say that we are therefore not as sensitive to blue colours as for instance red colours which are further up on the hue-spectrum, using high wavelengths.

“Bright colors, such as yellow, reflect more light and stimulate the eyes. Yellow is the color that the eye processes first, and is the most luminous and visible color in the spectrum.” (Minamyer, 2017) Yellow is a colour that seems to be a very bright colour because it activates both our mid and long-wavelength sensitive cones. These cones are sensitive to green and red, and when combined, yellow appears to be brighter than the other colours. Paul Van Slembrouck, internal product designer at Facebook, writes this about the colour yellow: “This is the biggest collective excitement that your cones ever have, aside from seeing pure white.” (Van Slembrouck, 2011)
2.3 Why Different Colours Affect Us in Different Ways

When looking at a screen, some objects are easier to see, even if these objects are not centred on the screen, they still stand out. Bright lights and colours on dark backgrounds, contrasting objects, shapes that differ from the surroundings, things that brake an established pattern. How should you design objects of interest that players will find and why does this kind of highlighting work? In the back of our brain is a region called “The Primary Visual Cortex” (Ware, 2008, p.25) The Primary Visual Cortex is also known as “Visual area 1” (V1). Different areas of V1 emits signals when you encounter colours, shapes, textures, motions, and stereoscopic depth. (Ware, 2008, p.25)

2.3.1 Using Visuals Effectively

“What makes an object easy to find is how easily we can direct a rapid eye movement to focus our attention of it.” (Ware, 2008, p.26) Before seeing something, we have a limited “pre-processing” which directs our attention to a certain area. “If we are looking for tomatoes, then it is as if an instruction has been issued”. (Ware, 2008, p.26) To make players able to spot something easier, a developer should tell players what they are looking for. If the player knows and has been informed to look for red round objects, it will be easier to spot those objects, than by looking for round object without knowing what colour to look for. This is thanks to the pre-processing. This process tells the body that all red-sensitive cells in the Primary Visual Cortex should “shout louder” (Ware, 2008, p.27) and that the blue and green sensitive cells should shout less loudly. This is the power of the Primary Visual Cortex and can be applied in several situations. Colours, shapes, sizes and orientations would be examples of this.

An experience where the player is made aware of things to look for, for instance by incorporating hostile and friendly objects and characters, rewards and penalties or particular patterns and shapes that impacts the game, will create a scenario where the player is subconsciously and actively looking for multiple shapes and colours through the use of pre-processing. This will effectively make for a more intensive experience by having cells “shouting” regarding different sizes and colours frequently. A game like Candy Crush Saga (2012) would be an example of this kind of setup. This is something I would like to call a high intensive experience and could possibly be mentally tiring. When playing the game, the player is constantly receiving multiple signals telling him/her “here look!” a red object, “hey look!” a round shape, “hey look!” a blue object. This is a situation where the player is constantly looking for particular items, and these items are bright and in a very high contrast from the other Items, and all of the items are desirable. This leaves little room for a tranquil experience, and I would deem it very taxing on the player, both mentally and physically since the player is not only receiving signals, but the player is physically looking at different positions on the screen and tapping the objects as fast as possible. Even If the game incorporated soothing music, no time limits or high scores, the visual structure would still activate the brain in a high intensive way and create an intensive experience. My personal experience with Candy Crush Saga are of multiple short play sessions consisting of multiple pauses. This is not to say that all puzzle games are exhausting, since many of them do not have the same impact on your eyes. A puzzle game might be black and white, and lack contrasting shapes which alleviate the eyes from some of these signals, however this might make the overall puzzle more difficult to solve since the player can’t separate puzzle pieces by colours and shapes.
If you do not tell your eyes what to look for, objects of importance are easier to miss. If you know what shape, colour, orientation etc. that you are looking for, it is easier to distinguish the object in question from its surroundings. (Ware, 2008, p.28-29) This is important information for a designer when both thinking of player reflexes as well as player retention.

If we were to compare this type of intensive experience, as I described using *Candy Crush Saga*, with a game where the game does not want you to look for different colours, that game will be a more “relaxing” experience than *Candy Crush Saga* since your body will not tell you to keep changing eye positions as often. This might refrain the player from taking as many frequent pauses and might make the overall session length longer. This will also give you better prerequisites for an overall more immersive experience.

### 2.3.2 Long Term Processing

Other than the initial inputs and the processing of your Primary Visual Cortex, as well as the physical exercise of your eye movements, there is a more long-term planning occurring while the player is looking for information.

The brain understands what the player is looking for beyond the current eye movement, based on what you have recently been looking for. This information is stored in the brain as a pattern. This pattern determines your “eye movement tendencies”. (Ware, 2008, p.37) This way the eyes are already aware of what the next logical movement is for your desired goals in terms of data searches. This is yet another function for finding information faster and it too uses brainpower - thus making the experience more intensive than if you were not looking at any specific visual structures. (Such as patterns, shapes etc.)

Another important factor to include is the position of important objects. It will require more work for the player’s body to locate and process objects further from the centre of the player’s field of view. The player will not be able to process small details at the edges of his/her vision. If there is an object of interest, the player must further scan the viewing area in order to find the relevant information, this requires extra eye movements. This is something a designer should consider when creating a gaming experience. An experience with a fixed screen will require the player to perform extra eye movements to read important information placed on the screen further away from the centre, and in experiences where the player has the option of fixing the screen placement manually, the player will use the movement input (e.g. joystick or mouse) to centre information unless the player is willing the read a bigger area of the screen, requiring more eye movement exercises. “Visual detail can only be seen via the fovea, at the very center of the visual field”. (Ware, 2008, p.5)

Eye movements usually occur between one and three times/second. (Ware, 2008, p.39) When you are looking for an object and align your eyes on a target, (which I just mentioned happens up to three times per second) your body starts performing a loop function. This function starts testing the area, looking for the desired information. Up to four different tests are executed in each of these fixations. This means that if you play a visually intensive game with several different properties such as shapes, value changes (bright, dark, and in between values) different hues, sizes, orientations, spatial groupings, motions etc., and you have game systems that depend on you
orienting these visual aspects of the game, you will have a very different impact on the player, than if you alleviate the player from these inputs since they will cause a significant amount of focus and engagement from the player’s point of view.

Visually intensive games may have a large impact on player retention and might cause players to take pauses or partake in overall shorter play sessions. This can be good or bad based on the game design systems intentions and aesthetic goals presented by the game designer. This is something that could play a major part in the visual decisions for particular game experience ambitions and intentions and should be taken into consideration by the art director.
2.4 Visual Communication

One vital part of giving information to a player is how easy that information is to read. Give the player a cryptic assignment and he/she will have to be more engaged to understand the meaning. In earlier versions of World of Warcraft (2004), the player was given missions, and in order to complete a mission the player had to engage him/herself with the text. The player had to read the text in order to understand what to do and where to do it. If the player did this, it would still not be perfectly clear where he/she needed to go in detail. In later versions of World of Warcraft, this system has been streamlined in order to more easily see what to do and where to do it. The player is automatically shown on a map where to go with pixel precision, and the goal of your assignment is presented in a highly-condensed form on the play-screen. This is part of the mechanics of the game and it affects how much effort and engagement needs to be put in by the player in order to find the objective. How can this be applied to visual communication and how do you affect the effort that a player needs to put in to understand what is happening?

Redundancy (Fiske, 1990, p.10) is a term to describe information, or in this context “readability”. Redundancy is a way of describing how much information is given to the viewer (In the case, the player). Having a high redundancy in an image, the player is given all the information he/she requires to determine what is happening on the screen, we can call this “predictability”. The opposite of Redundancy is Entropy. (Fiske, 1990, p.10) A common use of the terms can be applied in art. A photorealistic image will give a viewer much information, so much that the viewer will be able instantly see what the image is supposed to portray. This is an example of high Redundancy. A lot of this information is redundant and not very important or necessary, but it makes things very hard to misinterpret.

An abstract piece will not have High redundancy, but instead Entropy. This encourages the viewer to think. The viewer needs to spend more time analysing the image in order to understand what he/she is looking at. In art, this is often desirable as it is commonly said to make an image “interesting” since the viewer now needs to engage the brain and spend more time trying to decode the piece.

An impressionistic piece toys between the lines or realistic and abstract and tries to give the viewer as little information as possible but at the same time remain readable to the viewer. ”Entropy as a concept is of less value for the general student of communication in that it constitutes a communication problem, whereas redundancy is a means of improving communication.” (Fiske 1990, p.12)

Entropy is not something a developer would normally strive for in a video game since this might result in the player dying because the player was trying to figure out if the object coming towards him/her was something positive (like a reward), or something negative (like an enemy). This often results in games sticking to basic stereotypes to easily communicate with the player. Angry looking objects with sharp edges is most likely an enemy whilst a round, soft green object is a most likely a reward. If a designer choses to include entropy in a game, the meaning becomes harder to see and this requires more work from the player. The overall experience will require more engagement from the player.
3 Previous work
At this point in time there has been extensive research done on the effects of visuals on the human body, however finding research on the correlations of visual effects and player retention and habits is not as widespread. In his book *Visual Thinking: for Design* (2008) Colin Ware presents the physical effects visuals have on people and why these effects take place in the human body. Colin Ware explores the human perception in ways that are of utmost relevance for understanding how players are impacted by design choices in video games.

Ware claims that almost half the brain is devoted to the visual sense. (Ware, 2008) In a game that engages the brain and presents multiple challenges while giving the player control over elements such as moving objects and characters, while at the same time presenting the player with long term goals, dangers, and puzzles and still engages a multitude of other functions of the human body, the visual aspect of this would be devoted to almost half of the processing power of the human brain. Other relevant work includes the work of Doll, M., Baade, C., and Andrews, I., in the book *Art Fundamentals*. (2014) Their book has enabled this paper to be constructed in that it has been the underlaying part in understanding the basic principles of art to properly communicate the visual areas of video games. The book details the basics of art, such as colour, composition, colour values and visual contrast.
4 Purpose
The purpose of this research is to generate data through analysing the work previously detailed in background and previous work with the data from the conducted survey and find correlations that can help structure guidelines when developing art styles for projects containing visuals that are deemed to have a substantial and possibly monetary impact on the end experience. The goal is to be able to determine what colour values and overall visual properties of the art direction of a project are best suited for a certain type of experience. A developer should be able to tailor the colour values to fit the desired goals for player habits regarding time allocation and overall session length. A movie should be able to be engaging for the full length of the experience and a game meant to be enjoyed in short player sessions should be engaging for that specific period. Knowing how values effect player retention will help this process. If the overall game design has the intention of players playing short but frequent sessions, the visual experience should cater to this, and if the experience demands a long-term dedication and relies on player engagement lasting for a greater amount time, the visuals should cater to these needs as well.
5 Method
Research will include the conduction of quantitative data collection based on player habits in video games in form of a questionnaire. This research will be used to look for correlations between visual properties (e.g. colour values) and playtime sessions.

5.1 Questionnaire
The conduction of a quantitative data collection was compiled through the use of an online global questionnaire. The questionnaire was created using Google Forms. The questionnaire is aimed at people all ages who play video games on both console (stationary) and mobile games. The questionnaire is using a self-selection sample method. The people involved in this survey have voluntarily chosen to be a part of this research. The survey is available in multiple countries to decrease sampling error and sampling bias. The questionnaire is used to examine lighting conditions for play sessions, play session lengths and average play session lengths, eye fatigue and questions about the appeal of different colour values, and finally the effects of value contrast. The questions have been selected to look for correlations between visuals in games and play session times.

The questionnaire is available in Appendix C

The questionnaire was posted 23/4-2017 and closed 27/4-2017 and had 697 participants. (A detailed list of where the questionnaire was made available can be found in Appendix E)

The websites where the questionnaire was posted have a combined subscriber count of 1,613,398. (26/04-2017)
(A breakdown of individual subscriber count per website can be found in Appendix D)

The questionnaire was answered by people from 60 different countries. (A breakdown of countries can be found in Appendix A)

The Questionnaire features several images. Following are details regarding the use of these images.

*Emblem 1, Emblem 2 and Emblem 3* are examples of Colour contrasts.

- Emblem 1 is highlighting a contrast difference of **60%**
- Emblem 2 is highlighting a contrast difference of **20%**
- Emblem 3 is highlighting a contrast difference of **20%**

This purpose of this question is aimed at determining the effects of colour contrast.

Following are the values of the emblems:
- Emblem (1) 80-20 Values [Adobe Photoshop Value panel], (Contrast difference of **60%**)
- Emblem (2) 80-60 Values [Adobe Photoshop Value panel], (Contrast difference of **20%**)
- Emblem (3) 40-20 Values [Adobe Photoshop Value panel], (Contrast difference of **20%**)

The images are available in Appendix G
Figure 18 (Screenshot from Angry Birds Season – Go Green, Get Lucky) and Figure 19 (Screenshot from Limbo) were used in the survey to make it easier for participants to separate the questions from each other since there were several questions revolving around high colour value games and low colour value games. The images were used to avoid mistakes regarding these phrases. These images were chosen since they use different visuals that make it easier to separate the questions and answers from each other.

The images are available in Appendix H

5.2 Methodological Limitations
All studies have limitations. Here are some possible limitations regarding the methods used for this paper.

- **Sample size** - The websites on which the questionnaire was made available on are a small part of the target audience consisting of people who play video games on both console (stationary) and mobile games - thus the collected data does not represent everyone in this category.

- **Anonymity** - There is a chance that people will refrain from answering truthfully.

- **Carelessness** - Respondents did perhaps misread or act carelessly when completing the survey.

- **Fluency in language** - There is a chance of misunderstanding a question if a language barrier is present. (There is a high probability of language barriers in this case, considering that the questionnaire was made available in multiple countries)

- **Questions** - Close-ended questions can be tedious in succession, this might affect carelessness. Badly formulated questions might result in poor results.
6 Result
Over the course of five days, 697 people residing in 60 different countries contributed to the results presented below. Questionnaires were collected without age restrictions, and divided into age groups.

The data collected below acts as initial research meant the take a closer look at relationships between visuals in games and the amount of time people spend playing said games. This research is not taking game mechanics, sound design or other parts into consideration but instead tries to separate the visuals from the rest of the game experience. In order to conduct conclusive research and provide definitive answers, research would require thousands of people to have the same game experience regarding games and lighting conditions and in these conditions, alterations of visual properties such as Colour Values, Contrast and Saturation could be achieved in a way that would lead up to a decisive conclusion.

This paper should be regarded as initial research, meant to spark an interest for further studies.

6.1 Data Collection - Questionnaire

Age Groups
(697 responses)

<table>
<thead>
<tr>
<th>%</th>
<th>1.4</th>
<th>&lt;15</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>28.3</td>
<td>15-20</td>
</tr>
<tr>
<td></td>
<td>52.4</td>
<td>21-30</td>
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<td></td>
<td>15.9</td>
<td>31-40</td>
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<td></td>
<td>1.7</td>
<td>41-50</td>
</tr>
<tr>
<td></td>
<td>0.3</td>
<td>&gt;50</td>
</tr>
</tbody>
</table>

Figure 1. Table over age groups (Frandsen, 2017)

Lightning Conditions for Play Sessions
(697 responses)

<table>
<thead>
<tr>
<th>%</th>
<th>19.1</th>
<th>Sunshine/Bright light</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27.5</td>
<td>Darkness</td>
</tr>
<tr>
<td></td>
<td>53.4</td>
<td>A variation of Bright and Dark</td>
</tr>
</tbody>
</table>

Figure 2. Table over lighting conditions for play sessions (Frandsen, 2017)
Longest Expected Play Session Lengths
(697 responses)

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Colour Value Games</td>
<td>11.2</td>
</tr>
<tr>
<td>High colour Value Games</td>
<td>27.3</td>
</tr>
<tr>
<td>A variation of Low and High Colour Value Games</td>
<td>61.5</td>
</tr>
</tbody>
</table>

Figure 3. Table over longest expected play sessions (Frandsen, 2017)

Having Experienced Eye Fatigue While Playing Video Games
(697 responses)

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>43.3</td>
</tr>
<tr>
<td>No</td>
<td>56.7</td>
</tr>
</tbody>
</table>

Figure 4. Table over eye fatigue (Frandsen, 2017)

Eye Fatigue Occurred With:
(302 responses)

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Colour Value Games</td>
<td>10.3</td>
</tr>
<tr>
<td>High Colour Value Games</td>
<td>44</td>
</tr>
<tr>
<td>Equal amount between High and Low Colour Value Games</td>
<td>45.7</td>
</tr>
</tbody>
</table>

Figure 5. Table over eye fatigue occurrence (Frandsen, 2017)

Most Visually Appealing Games
(697 responses)

<table>
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<tr>
<td>High Colour Value Games</td>
<td>63</td>
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Figure 6. Table over most visually appealing games (Frandsen, 2017)
Average Play Sessions
(697 responses)

<table>
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<tr>
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<th>Low Colour Value games</th>
<th>%</th>
<th>High Colour Value games</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2</td>
<td>&lt;1 Hour</td>
<td>3.9</td>
<td>&lt;1 Hour</td>
</tr>
<tr>
<td>31.7</td>
<td>1-2 Hours</td>
<td>25.5</td>
<td>1-2 Hours</td>
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<td>2-3 Hours</td>
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<td>2-3 Hours</td>
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<td>3-4 Hours</td>
<td>19.2</td>
<td>3-4 Hours</td>
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<td>4-5 Hours</td>
<td>10.5</td>
<td>4-5 Hours</td>
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<td>2.7</td>
<td>5-6 Hours</td>
<td>3.3</td>
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</tr>
<tr>
<td>5.2</td>
<td>&gt;6 Hours</td>
<td>8</td>
<td>&gt;6 Hours</td>
</tr>
</tbody>
</table>

Figure 7. Table over average play sessions (Frandsen, 2017)

![Average Play Sessions Graph](image)

Figure 8. Graph showing average play sessions (Frandsen, 2017)
**Most Captivating Emblem**  
(697 responses)

<table>
<thead>
<tr>
<th>%</th>
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</thead>
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<tr>
<td>82.2</td>
<td>Emblem 1</td>
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<tr>
<td>5</td>
<td>Emblem 2</td>
</tr>
<tr>
<td>12.8</td>
<td>Emblem 3</td>
</tr>
</tbody>
</table>

Figure 9. Table over most captivating emblem (Frandsen, 2017)

Figure 10. Emblem 1  
(Frandsen, 2017)

Figure 11. Emblem 2  
(Frandsen, 2017)

Figure 12. Emblem 3  
(Frandsen, 2017)

This question is aimed at determining the effects of contrast. Following are the colour contrast differences:

Emblem (1) 80-20 Values [Adobe Photoshop Value panel], (Contrast difference of 60%)
Emblem (2) 80-60 Values [Adobe Photoshop Value panel], (Contrast difference of 20%)
Emblem (3) 40-20 Values [Adobe Photoshop Value panel], (Contrast difference of 20%)
7 Analysis
What follows is an analysis of the data of the conducted survey in correlation to contextual information and analysis presented under the segment background.

7.1 Eye Fatigue
There are many different types of games on the market with different art styles and Visual themes. It is hard to tell definitively what type of visuals will ultimately engage players for the longest play sessions without further extensive research, but it is easy to see that different visuals will have different effects on the player. So what effect will a game like *The Unfinished Swan* (2012) have on players? This is a game containing High contrast visuals. The player starts off, experiencing two set of values, light and dark, and nothing in between. The player is later introduced to more colours, but overall very contrasting ones with few tones in between. There is a struggle between physical strains and engagement in this case. On one side, the visuals can be demanding to look at, but on the other hand, engaging and attractive.

The survey conducted for this paper shows that 63 percent of participants think High colour value games are more appealing to look at. The research also shows that 82 percent of participants were most drawn to the High contrast emblem among the choices available. This can mean that players will initially be more drawn towards a game like *The Unfinished Swan*, an important part of marketing and initial impressions; however, the play session length and the habits of a player might differ if the art direction would be structured in a less contrasting visual manor.

High contrast will be more apparent to a player, bright red and yellow colours will be more intensive since the player’s eyes will be more sensitive to the wavelengths of the light, bright red colours can cause the player pulse to increase, as well as affect respiration. This is all important to determining how the player will use the game and could be detrimental to longer sessions. A less intensive (visually) experience might be less taxing on the body, and could possibly provide a more tranquil experience but it will not be as physically “interesting” to look at. A player might be able to physically play the game longer, but he/she might not want to.

Another thing to factor in is the contrast of the complete experience. A player may choose to play a low colour value game with low visual contrast, but choose to do so in a bright environment, and through this, still experience a high contrast visual setting. The conducted survey shows that 19.1 percent of participants play games in a **bright** environment and 27.5 percent play games in a **dark** environment. The remaining 53.4 percentages were not prone to any particular setting, but rather a mix of settings. The question of video game surroundings is something that will be made easier to disregard when virtual reality games are involved as they shield the player from many distractions outside the game itself.

Another part to factor in is the fact that some monitors do not have truly “dark” visuals since even a black pixel is sometimes still a lit pixel. This means that you would have to completely turn off the pixel on the monitor for it to not affect the player. Liquid crystals needs to be turned off when playing on an LCD monitor for this to not have an impact, but the pixel can still be affected by backlight. Some monitors offer solutions to this. (e.g. Organic light-emitting diode displays). Other factors may include reflections on the screen. From the survey conducted, 43.3 percent of the
participants have experienced eye fatigue from playing video games. Of the people that have experienced eye fatigue, 44 percent of the eye fatigue occurred while playing High colour value games whereas 10.3 percent experienced eye fatigue with Low colour value games. The remaining 45.7 percent stated that they have experienced eye fatigue in equal amounts between high and low colour value games.

Humans are sensitive to bright colours. (see section on colour impact about cones and rods) I personally use a software that makes the computer monitor orange when I read and write documents since I feel orange causes less strain on my eyes. The orange colour forms less contrast between the orange and black(text) than what would occur with black text on a white background.

As previously established. The colour red can create an intensive experience - attracting the attention of a viewer. The colour red is used in many instances to attract attention, one example is the Hellobar. (An example image of the Hellobar is available in Appendix F) The tool is meant to draw the attention of a viewer and it uses a bright and colourful red hue to do so. This particular colour uses ≈80 percent saturation and ≈90 percent brightness. (Using the colour panel in the Adobe Photoshop software)

Because red is intensive to look at, the colour is effective for this specific purpose. Yellow might be perceived as a brighter colour, but given that webpages are often white, the contrast is lower and the overall impact will be less desirable than red in this case. The purpose of attracting the eye to read a bar is a high intensive way of attracting attention, but the intended duration of this exercise is not very long. A designer should define the desired duration for specific parts of a game in order to properly understand the visual impact of high intensive graphics.

Disclaimer: This colour of the Hellobar can be adjusted by the user to match the specific intentions of the bar for any website.
7.2 Play Sessions
In “Colour Values and their impact on player habits and game sessions” (Frandsen, 2016) I detail a survey conducted on Giant bomb (CBS Interactive Inc., 2013) (This can be accessed in Appendix B with further details on the extent of the research) of average gaming sessions. This research was not specifically related to visuals in games but to game sessions in general. The result showed as follows:

<table>
<thead>
<tr>
<th>Percentage (%)</th>
<th>Immaterial Value games - 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>&lt;1 Hour</td>
</tr>
<tr>
<td>40</td>
<td>1-2 Hours</td>
</tr>
<tr>
<td>28</td>
<td>2-3 Hours</td>
</tr>
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<td>13</td>
<td>3-4 Hours</td>
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<td>6</td>
<td>4-5 Hours</td>
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<tr>
<td>2</td>
<td>5-6 Hours</td>
</tr>
<tr>
<td>3</td>
<td>&gt;6 Hours</td>
</tr>
</tbody>
</table>

Figure 13. Table of immaterial value games (Frandsen, 2017)

Following is a combined assembly of the data in addition to the findings of my data collection. I cannot from this information find a conclusive correlation to the 2013 data.

Figure 14. Graph showing average play sessions including immaterial value (Frandsen, 2017)
In 2014, Nielsen (The Nielsen Company, 2014) posted research regarding gaming habits of U.S Gamers 13+. According to their statistics, the average weekly playtime for a gamer was in 2013: 6.3 hours. The research is not involving individual play sessions, but establishes a combined average amount of play time in an unknown number of play sessions over the course of a week. This data was collected based on a survey of 2000+ U.S consumers (Across multiple devices)

According to the survey conducted for this paper, only 10.3 percent of the participants experience eye fatigue with Low colour value games as described in the section “Eye-Fatigue”. This could mean that High colour value games will create more eye fatigue, due to the eyes being more sensitive to bright colours.
This could also be further enhanced by playing these High colour value games in a dark environment, something that is supported by the survey.
The survey data shows that 27.5 percent of players are playing games in darkness where as 19.1 percent play games in Sunshine/Bright light. The remaining 53.4% play games in a variation of the two conditions.

As previously mentioned, these scenarios where players are prone to eye fatigue due to visual circumstances can possibly result in an increase of pauses and ultimately shorter overall sessions. Other established factors already discussed are impacts such as heart rates, respiration and overall brain activity. The survey conducted in conjunction with the information gathered from the background reading supports the claims that intensive visuals will affect player retention, what is not yet established is to what extent. In the grand scheme of things, the effect could potentially be less than vital to the game systems design goals for the experience, but more research must be done to understand the extent of the end consequences.
7.3 Visuals in Different Stages

Different types of visuals can be useful for different stages of a video game’s development and use. The following excerpt is from “Colour Values and their impact on player habits and game sessions”

One factor when it comes to game retention is the initial impressions of the game. The intensity of a game experience might differ greatly if you compare the first hour of gameplay to the 20th hour of the same game. According to DeltaDNA:

“One of the core challenges of free-to-play (F2P) is how to on-board and engage players as quickly and easily as possible to ensure they will stick around.” (DeltaDNA, 2016)

According to their statistics, most F2P games will lose 20% of installs within two minutes from first ever launching the application. You need to take this into account when measuring game sessions since a game might deliberately be more engaging, causing longer play sessions within the first hours of a game.

DeltaDNA used a sample of 275 (F2P) “comparable games selected from the DeltaDNA platform” to conduct research and according to their statistics regarding these games, “90% of games have a median first session length of less than 20 minutes.” (Frandsen, 2016, p.06)

Game developers will often focus on making extra intensive game experiences for the early stages of a game in order to captivate players early on, and visuals play a big part in making this happen. Just like visuals have an importance in captivating players early, visuals also play a big role in the acquisition of a product. According to Jill Morton, President of Colorcom, 92.6 percent of people put visuals as the most important factor when acquiring a product. (Morton, 2010) “When asked to approximate the importance of color when buying products, 84.7 percent of the total respondents think that color accounts for more than half among the various factors important for choosing products.” (Morton, 2010) Jill continues: “Research reveals people make a subconscious judgment about a person, environment, or product within 90 seconds of initial viewing and that between 62% and 90% of that assessment is based on color alone.” (Morton, 2010) “Research by the Henley Centre suggests 73% of purchasing decisions are now made in-store. Consequently, catching the shopper's eye and conveying information effectively are critical to successful sales.”

(Morton, 2010)

If a developer has chosen to use less intensive visuals for the play experience itself, it might still be a good idea to separate the art direction between in game, early game, box art and overall visual marketing strategies. You can have different visual goals between the game and the marketing of the game. So far, we have covered the effects visuals have on the player’s experience, such as how the body reacts to the way players are interacting with different visuals, and this all effects the designer’s intentions. Games have different ambitions and goals and where as some games want the players to play short but frequent play sessions, some games aim at immersing players in long sessions with as few interruptions as possible. What these statistics show, is just how important visuals are at different stages in producing a game. As previously stated, the goal for a tranquil overall experience of a game might be the complete opposite of what the marketing campaign needs to address. This is still very much achievable as long as the overall art direction adapts to this challenge. The marketing of a product might be visually “explosive” on posters and commercials, while the play experience is of a different nature with both intensive and less intensive sections. This is something that can for instance be seen in commercials directed by publishers. The aesthetic goals of a trailer can be very different from the game experience, even if the footage used is straight
from the game. By condensing intensive moments into one trailer, you can achieve a certain visual goal and create a specific atmosphere and this way push the marketing campaign in a specific direction.

Bright bold colours might not fit the desired design goals for the majority of the game, but high value, heavily saturated colour properties might be useful for quickly captivation a player in a particularly intensive visual experience for the first hour of the game. This strategy extends to the experience a customer may encounter in a store where an aggressive visual statement might convince a customer to make a purchase.
8 Conclusion
This study of visual properties of game artefacts and play sessions concludes that visuals have a definite impact on how the game is perceived and processed by the player, leading to situations where the same mechanics can be much more intensive if presented using specific forms of visuals.

As previously stated under result, this research is far from extensive enough for a definitive conclusion to the exact visual impact on play sessions, however it is evident that visual properties have a large impact on the physical and mental experience of the player. My goal with this research was to establish an interest of the factors that tie visuals and player retention together outside of traditional game systems, and that I with this research have created a continued interest in the subject for further, more extensive research to be conducted.

At this stage, it is hard to tell to what extent visuals have an impact on play sessions, only that the connection has been established. Values, contrast, colours, shapes all impact the brain in different ways and cause different visual effect on the player. It is up to future research to determine the severeness of the impact on play sessions, given that game systems themselves have a large influence on how long players are willing to interact with them.

Understanding how visual elements work and the effects they have on people is key to making the visuals of the experience a developer is creating, work to his/her advantage. Art directors are dependent on the development team understanding these principles in order to create a consistent experience that can be controlled and adjusted from start to finish in accordance with the initial design intent. By understanding the importance of colour theory and visual impact, art directors should make it imperative for the art team to understand the impact of visuals in connection to player habits. This way, creating visuals will give a more effective and less wasteful trial and error approach to establishing visual cues for specific situations and laying out plans for longer sections dependant on a shift of intensiveness of the visuals throughout the game.

It is important that we understand and separate visual differences driven by game systems and their impact in player engagement, this is why examining visuals driven by the same systems are important to eliminate outside factors that can trigger specific play time changes.
A suggestion for future research in accordance with this method would be to examine differences between greyscale Tetris (1984) and Tetris using colours. This way, you can examine overall playtime, intermediate play sessions and micro pauses triggered by the different visual elements, while keeping the mechanics equal. Will the increased intensity of the input on the player be more taxing, resulting in pauses and different playtimes? Will the player perform better on one version? Or perhaps the visuals alone will make the experience less interesting and thus making players fail to fully engage themselves with the greyscale game?

The Visuals of a game is a complicated matter, and beyond marketing, visuals contribute to almost every aspect of a game whether it be readability and predictability, intensity and engagement or tranquillity and stress – These are all important factors that heavily impact design decisions.
References


**Gameography**

*Candy Crush Saga*. King, 2012.


Appendix

(697 responses)

<table>
<thead>
<tr>
<th>%</th>
<th>Country</th>
<th>%</th>
<th>Country</th>
</tr>
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<td>Vietnam</td>
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</table>

Figure 15. Table of represented countries (Frandsen, 2017)

B. Frandsen, F., 2016. “Colour Values and their impact on player habits and game sessions”
docdroid [online] Available at: <https://www.docdroid.net/QJMjs2i/colour-values-literature-review.pdf.html> [Accessed 8 January 2017]
Colour Values and their impact on player habits and game sessions

Literature Review
**Abstract.** This paper aims to provide a critical review of current research and information about Colour Values and their impact on player game sessions. The information reviewed in this paper creates a baseline of knowledge that enables the reader to understand what Colour and Colour Values are and how they can be applied within software development. The information gathered is meant to help in future research about player retention and game session times. Surveys about player game sessions are reviewed in order to act as a baseline for future research about correlations between Values and play session length. The conduction of this research is aimed at helping art directors to make conscious and deliberate choices about the art styles for products where the visuals may impact player retention and game sessions. By knowing how Colour Values impact game play intensity and player engagement, and ultimately the end time spent during play sessions, art directors can make informed decisions to help impact player behaviours and habits.

1. **Introduction**

Values describes how light or dark a colour is. (Doll; Baade; Andrews; 2014, p.18)

This paper aims to assist further in research about Values and how they influence individuals in digital visual play spaces. This paper illustrates an attempt to collect information relevant and necessary to further explore the impacts Values have on players and their play sessions. This paper will be used as the base for further examination and data collection later this year. (2017)

The purpose of this research is to generate data that can help structure guidelines when developing art styles for projects containing visuals that are deemed to have a substantial and possibly monetary impact on the end experience. The goal is to be able to determine what Values are best suited for a certain type of experience. A developer should be able to tailor the Values to fit the desired goals for player habits regarding time allocation and overall session length. A movie should be able to be engaging for the full length of the experience and a game meant to be enjoyed in short player sessions should be engaging for that specific period. Knowing how Values effect player retention will help this process. If the overall game design has the intention of players playing short but frequent sessions, the visual experience should cater to this, and if the experience demands a long-term dedication and relies on player engagement lasting a for a greater amount time, the visuals should cater to these needs as well. This research might extend further to surrounding factors where correlations occur that impacts Values such as Colour Saturation and Value Contrast. This will be taken into consideration when reviewing literature in preparation of the data collection.

I believe that art directors should have access to tools that can connect player habits to the visuals and ultimately the overall design of an experience to fit the desired design goals for player time sessions. This will ultimately give developers a means of predicting and managing player behaviours. By tailoring Values, Saturation and Contrast in a way that prevents eye fatigue, designers have a greater
chance of keeping players enjoying experiences that are designed to last longer, and at the same time being able to maximize player engagement for shorter, high intensity games.

Later research will include the conduction of both quantitative and qualitative data collection based on player habits in video games, however this paper is strictly a review of relevant literature.

2. Colours

“Color, without a doubt, is the most misunderstood visual component. Probably due to the misguided color education we received as children, our knowledge of color and how it works is almost unusable” (Block, 2008, p.136)

Before we get into Colour values, we need to understand what Colours are. Colour is simply light being reflected by objects whether they be organic, synthetic, alive or dead. If you cannot see an object it is because no light is being reflected from the object nor is it being absorbed by the object, or possibly if you are in situation where no light source is present. This means that for something to be invisible, the object needs to be able to let all light that is cast upon it, to be passed through it without reflecting a single ray. If there is no light present at a scene, you cannot see any objects. So what is it that determines what you see when an object is hit by light? It is determined by the amount of light that is reflected, and the light that is absorbed. This means that the colour of an object is determined by its surface. Light from the sun consists of “normal” “white” light. We call it normal light because it doesn’t seem to change the colour properties of an object. “A white car parked outside in the sun still looks white, so sunlight is not reddish, greenish, or blueish.” (Block, 2008, p.136)

There are millions of colours (Doll; Baade; Andrews; 2014, p.17) so instead of naming every single colour, you can instead define them by looking at three different aspects: Hue (H), Saturation (S) and Value (V), sometimes called HSB. (Hue, Saturation, Brightness)

2.1 Hue

The hue is the aspect which some people might simply call “Colour”. There are seven families of hues in total: Blue, Violet, Red, Orange, Yellow, Green, Brown (and greys). (Doll; Baade; Andrews; 2014, p.17) Disclaimer: I don’t fully agree with this statement and would personally not count brown as a hue, but instead cyan. (There are several conflicting sources on this subject and they tend to use different phrases for describing the grouping of hues)

If you instead interpret the aforementioned information not as hues, but as a grouping of hues (due to the use of the word “families”) where for instance cyan is part of the blue or green group the information can still be applied in accordance to the information provided in “The visual Story” by Bruce Block. According to Block, there are eight hues. “Hue is the position of a color on the color wheel: red, orange, yellow, green, cyan, blue, violet (or purple), and Magenta. That’s it. There are only eight hues. Pink, brown,
turquoise, and beige are not hues.” (Block, 2008, p.141)

2.2 Saturation

Saturation describes the intensity of a colour. (Sometimes called Chroma or Intensity)
A fully saturated colour is a colour that hasn’t been mixed with any other colour. (Block, 2008, p.142) An example of this would be to say “This colour is 100% red, therefore it is fully saturated”. If a colour is desaturated, the colour has been mixed with its complementary colour, giving it a more grey appearance. (A complementary colour is the opposite colour to the colour in question on the colour wheel) (Block, 2008, p.142) when equal amounts of the complementary colour and the colour in question are mixed, there is no trace of either original hue. The new colour is grey. This works for any colour by blending it with its complementary colour. This is called “desaturation”.

Saturated Colours are sometimes used in contrast to desaturated colours to highlight certain objects, but can sometimes be distracting when used excessively.

“Exercise caution when combining saturated colors, as they can visually interfere with one another and increase eye fatigue.” (Lidwell; Holden; Butler; 2010, p48)

2.3 Value

As stated in the introduction, Values describes how light or dark a colour is. This does not necessarily reflect the saturation and hue of the colour since simply changing the saturation and hue can affect the Value of a colour. The resulting factors can include software products like Photoshop where it’s not always clear how the colour blending operates and if it works in the same way as other comparable software products. If you select hues from a basic colour wheel they will be shown in fully saturated states. The value ranges of these fully saturated colours are inherently very wide. (Block, 2008, p.144)

Colours are used as a means to convey importance and attracts attention. This is something universal about visual design and not inherently a game related exercise. Lidwell; Holden; Butler (2010, p48) writes: “Color is used in design to attract attention, group elements, indicate meaning, and enhance aesthetics.”

I believe that what they in fact mean is that the Values and Saturation are used to separate objects and scenes by importance since the actual Hue isn’t commonly used in traditional art for composition. For instance, in an exercise to demonstrate the insignificance of hues for reading the objects and composition of an image Doll; Baade; Andrews (2014, p.15) writes: “If I cast the image with a range of realistic values, but with one color or in grayscale, the image is still readable” Following this it reads: “If I now shift that around, and recast the image with realistic color and only one value, it becomes very difficult to determine the content of the image.”

When you talk about using “Colours” to create importance in an image, what you are more than likely refereeing to is the use of Colour Values. Hue is something that is occasionally used as a way to convey feelings and atmosphere, not necessarily a good way of structuring a sense of guidance and
structure. An example of this is the following statement:
“Color is fantastic for depicting feelings and emotions” (Doll; Baade; Andrews; 2014, p.23)
However it is hard to find tangible proof of this. Lidwell; Holden; Butler (2010, p.48) writes “There is no subjective evidence supporting general effects of color on emotion or mood”

2.4 Contrast

Contrast in the present context of Colours can mean a multitude of things, but to keep things simple, let us discuss contrast in the already established colour divisions of Hue, Saturation and Values. The basic definition of Contrast is according to the Cambridge Dictionary: “an obvious difference between two or more things”. (Cambridge University Press, 2017)

If the ranges of Hue, Saturation and Values differ substantially, you have achieved Contrast, however one can also speak about low contrast, so for the sake of simplicity, let us look at contrast as a range of Values from no contrast (same Values, Saturation or Hue) to high Contrast. In contrast to Contrast, we have Affinity. “a close similarity between two things” (Cambridge University Press, 2017)

Affinity is a good way of describing a case of low contrast, for instance, a similarity of hues within an image. “Affinity of hue occurs when all colors in the picture are based on a single hue” (Block, 2008, p.145)

2.5 Value range

Value range is the range of Colour Values from white to black. It is usually a scale from 0(black) to 100(white). Value range is usually something artists make use of. An artist might for instance limit his value range to range within a certain number of percentages to achieve a certain visual target. The Value range is however not representative of everyday values such as sunlight since a white paper cannot achieve the same brightness as the sun. Renowned painter Frank Eber says this about the Value range in paintings: “The best we can do is paint the correct values from lightest to darkest to achieve a realistic feel. Once that is done the painting will ‘read’ right. It doesn’t matter if it is not the ‘true range’.” (Eber, 2016)

3 Player Habits

Before we can understand why some games are played in different ways, we need to understand that games are played by different people, and people are inherently different from each other, weather it is a matter of cultural, racial, gender or further differences. Two people can play the same game in different ways and spend different amounts of time on it. By acknowledging this behaviour we can easier separate the relevant factors from each other and easier achieve practical results.

3.1 Play Sessions

As stated in the introduction, I will be conducting research aimed at looking at occurring (if present) correlations between Colour Values in video games and the end users time spent interacting with the game during play sessions. The research will be aimed at people of different ages in different countries playing games of the same genres
using the same gaming consoles with different Visuals. (Mainly Low Values in Contrast to High Values) As previously stated, this may be extended if interesting correlations in Saturation occur as well. Until this research is conducted, I have here attempted to collect some basic starting point data that may act as a baseline for starting the research.

Disclaimer: Limitations of this research include such areas as: Subject Localization, Age, Game Consoles, Games, Gender and Time of day playing.

In 2013, Giant bomb (CBS Interactive Inc., 2013) conducted research on its forums where they collected 326 votes from readers. The collection of data was lacking in multiple ways and did not account for many factors. The question led: “How long is your average gaming session?” The results showed as follows:

<table>
<thead>
<tr>
<th>Time Duration</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 Hour</td>
<td>7%</td>
</tr>
<tr>
<td>1-2 Hours</td>
<td>40%</td>
</tr>
<tr>
<td>2-3 Hours</td>
<td>28%</td>
</tr>
<tr>
<td>3-4 Hours</td>
<td>13%</td>
</tr>
<tr>
<td>4-5 Hours</td>
<td>6%</td>
</tr>
<tr>
<td>5-6 Hours</td>
<td>2%</td>
</tr>
<tr>
<td>6&lt; Hours</td>
<td>3%</td>
</tr>
</tbody>
</table>

In 2014, Nielsen (The Nielsen Company, 2014) posted research regarding gaming habits of U.S Gamers 13+. According to their statistics, the average weekly playtime for a gamer was in 2013: 6.3hrs. This is a 12% increase from the year before at 5.6hrs. This data was collected based on a survey of 2000+ U.S consumers (Across multiple devices)

It is important to state that there are multiple factors when measuring the length of a player session that needs to be taken into consideration before stating causality. Not only are games designed to be played differently, but games are being played by different people with different time schedules and different desires.

According to research conducted by the global information company, The NPD Group, in 2014, mobile gamers (people playing on phones, music players and tablets) play sessions have increased by 57% in comparison to 2012.

The research was conducted by fielding an online survey completed by 5,566 individuals ages 2 and older. (For very young children, the parents answered on their behalf)

This can be interpreted in several different ways. One way is to say that games developed between 2012 and 2014 were designed in a way that made players want to play longer play sessions even though the player ordinarily played games in shorter sessions. Another way of looking at it is to conclude that new players started playing mobile games and that these new players are willing to or desire to play games for longer sessions. It could also mean that players who have never played games before started playing, and that their preferences raised the previous play session time statistics.

There are different game genres and types of games and this is not taken into consideration when conducting this kind of research. Certain players might like to play longer play sessions at night and shorter ones at daytime. There are factors like time of day or gender that needs to be taken in to account if we are to specify a reason for the increase in session times. One also needs to look at the number of
play sessions per day to see if the time is spent on fewer play sessions or if the overall time spent playing is the only thing that has increased.

One factor when it comes to game retention is the initial impressions of the game. The intensity of a game experience might differ greatly if you compare the first hour of gameplay to the 20th hour of the same game. According to DeltaDNA:

“One of the core challenges of free-to-play (F2P) is how to on-board and engage players as quickly and easily as possible to ensure they will stick around.” (DeltaDNA, 2016)

According to their statistics, most F2P games will lose 20% of installs within two minutes from first ever launching the application. You need to take this into account when measuring game sessions since a game might deliberately be more engaging, causing longer play sessions within the first hours of a game.

DeltaDNA used a sample of 275 (F2P) “comparable games selected from the DeltaDNA platform” to conduct research and according to their statistics regarding these games, “90% of games have a median first session length of less than 20 minutes.”

6 Summary

Having a solid understanding of how colours work is a key aspect of making Values work to your advantage during development. In order to create visual styles where you have complete control over values whilst still being able to design with both hue and saturation in mind takes a great understanding in colour theory. If you are to highlight key objects, keeping mood in check with temperatures, convey specific feelings through certain hues and still have control over a specific value output, this requires the entire art team during development of a project to work together. It is at this moment unclear if specific Colour Values are able to cause eye fatigue, distress or other negative impacts to the extent that they effect player session times, but given that research is being done in the field, there is a possibility that giving your development team a deeper knowledge of how colours work will eventually effect the effectiveness of creating visuals in a way that gives you greater control over game design and player retention.

When conducting research about playtime and player habits, you need to be aware of the different factors that can potentially trigger specific player time changes such as stagnation, rise or decline within multiple game play sessions. It is important that we understand the correct correlations and do not misinterpret game design for visual impact. The best possible research could be conducted by letting players experience the same game with different values. A way to do this could be to overlay active real-time post effects regarding Saturation, Contrast and overall Value Adjustments. This research would still be relying on letting different players experience different Value experiences since letting the same people play the same experience a second time could also contribute to a loss of interest, thus leading to a change in player session time.
References


Eber, Frank, FE., 2016. Value range in painting. FRANK EBER: A PAINTER'S BLOG, [Website] 08/05/2016. Available at: https://frankeber.wordpress.com/2016/08/05/value-range-in-painting/ [09/01/2017]

Giant Bomb, 2013, How long is your average gaming session? [Website] Available at: http://www.giantbomb.com/forums/general-discussion-30/how-long-is-your-average-gaming-session-1438129/ [08/01/2017]


Visual Properties and Player Retention

My name is Filip Frandsen and I am a student studying Game Design & Graphics at Uppsala University.

The purpose of this research is to generate data that can help structure guidelines when developing art styles for projects. The goal is to be able to determine what Values are best suited for a certain type of experience.

When answering the questions in this form, you will be fully anonymous

Personal information is restricted to age and country of residence

I appreciate you taking your time to help with this research!

The results of this research will be published later this year, (2017)
The answers you provide will be of high importance to the research being conducted.

NEXT

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Google Forms
Visual Properties and Player Retention

*Required

Examples of Colour Values and Saturation

Value = Brightness

Low Value  Medium Value  High Value

Low Saturation  Medium Saturation  High Saturation

Questions

1. What is your country of residence? *

Choose
2. How old are you? *
- <15
- 15-20
- 21-30
- 31-40
- 41-50
- >50

3. What type of lighting conditions do you most often have around you when you play? *
- Sunshine or Bright light
- I play games in the dark
- It varies
4. What kind of games are you most likely to play the longest? (Per play session) *

- The picture is not available in the electronic version for reasons of copyright
- The picture is not available in the electronic version for reasons of copyright
- Games with overall Low Colour Values (Dark games)
- Games with overall High Colour Values (Bright games)
- It varies

5. Do you ever experience eye fatigue while playing video games? *

- Yes
- No
Visual Properties and Player Retention

Eye Fatigue

6. If Yes - Does your eye fatigue occur with:

- The picture is not available in the electronic version for reasons of copyright
- Games with overall Low Colour Values (Dark games)
- It's about the same - 50/50
- The picture is not available in the electronic version for reasons of copyright
- Games with overall High Colour Values (Bright games)
Questions

7. What is more visually appealing to you? *

- The picture is not available in the electronic version for reasons of copyright
- The picture is not available in the electronic version for reasons of copyright

- Games with overall Low Colour Values (Dark games)
- Games with overall High Colour Values (Bright games)

8. How long is your average play session with Low Colour Value games? (Dark games) *

- <1 Hour
- 1-2 Hours
- 2-3 Hours
- 3-4 Hours
- 4-5 Hours
- 5-6 Hours
- 6+ Hours
9. How long is your average play session with High Colour Value games? (Bright games) *

The picture is not available in the electronic version for reasons of copyright.

- <1 Hour
- 1-2 Hours
- 2-3 Hours
- 3-4 Hours
- 4-5 Hours
- 5-6 Hours
- 6+ Hours
10. What emblem captures your attention the most? *

- Emblem 1
- Emblem 2
- Emblem 3

Do you have any additional input on the subject? *Not required*

Your answer

Thank you!

Your participation is very helpful.

If you have any further questions please contact me at:
Filip.Frandsen.6495@student.uu.se

BACK   SUBMIT

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D - Subscriber count per website (26/04-2017)

<table>
<thead>
<tr>
<th>Subscribers</th>
<th>Website</th>
<th>URL</th>
</tr>
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<tbody>
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<td>439,706</td>
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</tr>
</tbody>
</table>

Figure 16. Table of subscriber count per website (Frandsen, 2017)

E - List of websites where the questionnaire was made available.


Disclaimer: The survey available at the Nintendo subreddit was removed after having been published but was available long enough for somebody to access it. Given the nature of how the survey was conducted, there is no way of knowing if somebody from the Nintendo subreddit did access it.
The above websites have a combined subscriber count of **1,357,835** (26/04-2017) without counting the Nintendo subreddit and **1,613,398** (26/04-2017) subscribers if you include the Nintendo subreddit subscribers.

**F - Hellobar** example. The image shows how the **Hellobar** can look when used on a webpage.

![Hellobar example](image)

Figure 17. Example of the **Hellobar** (Frandsen, 2017)
**G** – *Emblem 1, Emblem 2 and Emblem 3* are examples of colour contrasts.

Figure 10 Emblem 1. (Frandsen, 2017)

Figure 11 Emblem 2. (Frandsen, 2017)

Figure 12 Emblem 3. (Frandsen, 2017)
Figure 18 and Figure 19 are images from the Survey conducted for this paper.

The picture is not available in the electronic version for reasons of copyright.

Figure 18. Screenshot from Angry Birds Season – Go Green, Get Lucky

The picture is not available in the electronic version for reasons of copyright.

Figure 19. Screenshot from Limbo