Tallinn University

Institute of Informatics

The Effects of User Interface Aesthetics in the User's Experience

Master Thesis

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Author's Declaration

I declare that, apart from work whose authors are clearly acknowledged, this document is the result of my own and original work.

This work has not and is not being submitted for any other comparable academic degree.

Thesis has been supervised by PhD David Lamas (Tallinn University, Estonia) and Mati Mõttus (Tallinn University, Estonia).

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Abstract

The goal of the proposed work is to explore the possible effects of aesthetics in the user's experience of software artifacts. Given exploratory research is building on the hypothesis that User Experience is improved by aesthetically appealing user interfaces of interactive applications. If the hypothesis proves to be correct after performing a specially designed experiment, a set of preliminary design guidelines would be composed for helping future work of interaction designers and other ICT sector workers.

For achieving goal of the study, combination of different methodologies is used, such as set of biometric technologies as psychophysiological metrics, eye-tracking, user observation and questionnaires for self-reported emotional feedback.

The purpose of the study is to find out, how and to which extend aesthetics are influencing interaction quality and UX and to turn this knowledge into practical outcome of design recommendations.

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1. Introduction

Aesthetics aspect in ICT domain and interaction-design field has always been a source of debate and discussion.

While design procedures for usability and functionality already have some common principles and time-tested practices of implementation, addressing the emotional level of perception with aesthetic tools when designing for perceived User Experience has not been explored to the same extent.

Recent studies (Tractinsky N., Lavie T. 2003; Strebe, R. 2011; De Angeli, A., Sutcliffe, A., & Hartmann, J. 2006) support existence of a certain relationship between interface aesthetics and User Experience and the way aesthetics affect and shape human interaction with digital artifacts. Those studies support the hypothesis that different level of aesthetics in application interface affect differently user's perception of usability and overall emotional satisfaction from artifact use.

Consideration of this aspect of Human-Computer Interaction is relevant because of the potential possibility to address users on emotional level when designing for User Experience and by doing this, raise attractiveness of the product on todays competitive market. This would also create a potential ground for developing a set of preliminary guidelines for future consideration and their practical application in the field of interaction design and ICT.

Given exploratory study aims to collect knowledge about the existing links between visual aesthetics and interaction design qualities such as perceived user experience.

The research is building on the experience of past studies as well as taking a new, exploratory direction, by using more complicated settings and approaches, contemporary set of methods and modern technical equipment.

Despite quite impressive body of knowledge collected on a relationships between aesthetics, user experience and usability, there are still numerous possibilities for future work and research. The exploration of this domain is stimulated not only with improved methodologies but as well as with technological progress and accessibility of new physical tools for continuous research.

In one of the latest studies of N. Tractinsky (2013) — that replicated and extended existing study on positive correlation between product's beauty and pre-use perceptions of its usability — author states, that his second attempt has opened up a new and lively research area. Tractinsky himself accentuates the need of future exploration in HCI regarding the role of visual aesthetics in HCI, and regarding its antecedents and consequences.

Exploratory nature of the study is inevitably connected with number of risks (Brown, T., Suter, T., 2013), yet also has a potential of numerous possibilities for future improvement and future research building upon previous studies.

Result of this study are to be processed and closely examined in order to reveal possible patterns in correlation between aesthetics and User Experience. If the research hypothesis is proven to be correct, there will be developed a set of preliminary utilitarian guidelines as a practical tool for designing for perceived User Experience. These guidelines will be composed as a tool for interactive designers who don't possess any artistic education or knowledge. Presumably, the developed recommendations will have a potential to lead some design decisions as well as possibly improve user perception and User Experience of an end product.

1.1. Research problem

Albeit aesthetics in interaction design field are considered as optional and secondary feature of product interface, interaction designers intuitively make an effort to compose interface elements that are visually pleasing, since visual appeal can contribute to product success on the market. But creation of aesthetically appealing product requires a decent share of aesthetic education or at least experience in artistic or graphic fields, which people working in non-design departments of ICT, including interaction designers, usually lack.

Possible bridging of aesthetic domain with interactive design pragmatic affordances would help to add an additional value to the end-product and improve so-called "pleasure of use" which is directly connected to positive User Experience. Therefore, it is necessary to reveal correlations between aesthetics and perceived User Experience and compose design recommendations building on those correlations.

Former studies, reviewed later in this paper, showed some existing relations between aesthetics and interactive aspect, but settings of those studies are not sufficiently corresponding to real-use conditions. The aim of this particular study is to show significant correlations between interface visual aesthetics and interaction qualities in real-life conditions of use.

1.2. Research goal

The purpose of the exploratory study is to evaluate series of interfaces and their aesthetic features during specially designed experiment and test the possible feasibility of a more extensive study in future.

Collected data will aim to help to reveal if interface aesthetics have influence on users' positive perception of interface and correlation with interaction design concepts such as UX and usability. Set of preliminary design guidelines is to be developed after analysis of the collected experimental data and in case of validity of study hypothesis.

Hypothesis: User Experience is improved by aesthetically appealing user interfaces and there is a correlation existing between aesthetic value of interface layout and interaction design qualities of Usability and User Experience.

1.3. Research Questions

Research goals will be achieved through experiment designed to explore the previously identified effects, tackling with the following driving questions:

1. Is there a relation between aesthetics and perceived user experience?
2. How can the perceived user experience be improved through aesthetics?

1.4. Research Methodology

Research methodology builds on a specially designed experiment involving set of biometric measures, user's verbal self-evaluation and questionnaires for further reflection on his experience. Literature review of similar experiments and previously done studies is chosen as secondary supportive tool.

Physical part of experiment addresses emotional aspect by collecting physiological data provided by participants. This is achieved by using a combined set of biometric technologies as psychophysiological metrics such as Emotiv neuroheadset for electroencephalography (EEG) research, Mirametrix eye-tracking system and NeuLog Galvanic Skin Response and Pulse Logger sensors.

VisAWI questionnaire and self-evaluation was chosen as supportive methodology to collect data about user's emotional experience and help to measure of perceived visual aesthetics of experiment stimuli.

The study is divided to four sub-stages (Table 1). After performing the experiment and gathering all the necessary data it will be processed by an interpretive statistical analysis and statistically relevant correlations between UX and aesthetics are expected to be revealed.

Steps of Research	Research Questions	Research Methods	Research Objectives
Phase One Preparation of Experiment	Is there a correlation between aesthetics and perceived User Experience?	Literature Review	To study theories and the results of similar previous studies.
Phase Two Conducting the Experiment		User Questionnaires User Observation Biometric Measures Eye-Tracking	Collect information for accepting or rejecting the hypothesis of UX and aesthetics connection.
Phase Three Processing and Interpreting the results	How can the perceived User Experience be improved through aesthetics?	Interpretive analysis Correlations	Processing of collected information. Finding correlations between UX and aesthetics. Evaluation of methods used during the experiment.
Phase Four Designing Set of Guidelines			Based on correlations, development of initial set of graphic design guidelines.

Table 1 Design of the study and Research Methods

2. Aesthetics

“Aesthetics matter: attractive things work better” — states Don Norman (2002), pioneer of Human Computer Interaction field. — “Products designed for more relaxed, pleasant occasions can enhance their usability through pleasant, aesthetic design.”

Aesthetics domain, as a one of the philosophic branches, addresses beauty and visual harmony and is importance as cultural notion of contemporary environment. Almost any object in everyday life can be evaluated according to it’s aesthetical features and as a result of this evaluation one can compose an emotional response towards this object and rate the level of it’s “attractiveness”.

It is important to stress that the term of ‘‘aesthetics’’ has evolved through the years, has been studied from different viewpoints, and has different meanings for different schools of thought. (Tractinsky N., Lavie T. 2003)

Aesthetics also play a crucial part in many commercial based areas such as marketing, product placement, advertising etc. The aesthetic quality of a product influences consumers’ attitudes, and is a major determinant of its marketplace success. (Bloch, P., 1995)

Traditionally, marketers have believed that market choices and customer preferences are driven by the utilitarian value of the product (Chiu, H.-C., Hsieh, Y.-C., Li, Y.-C. and Lee, M., 2005), and therefore clients tend to purchase the products by evaluating their pragmatic functionalities in a first place. Lately, though, the concept of “consumer value” has become the fundamental issue to be addressed in every marketing activity. (Sánchez-Fernández R., and Ángeles Iniesta-Bonillo M., 2007)

It is now quite obvious that hedonistic values have similar, if not the same, effect on the customer/end-user as pragmatic functions of the product.

Therefore, since similar products usually share similar functions, aesthetics provide a certain possibility to gain a commercial advantage on a competitive market and create an added-value component which can help customers to distinguish the product among all others. As a result, overall so-called “perceived value” of the product increases and

It is important to notice that aesthetics do not carry a momentary and hasty effect, but quite the opposite. Not only is beauty a substantial quality of a product but its effect seems to transcend the object and influence other judgements, in what is known as the halo effect. (De Angeli, A., Sutcliffe, A., & Hartmann, J. 2006) In other words, after prolonged use of the product user most likely will remember his overall emotional state and positive attitude towards it, without detaching aspect of visual beauty from the complete experience.

Touching upon role of visual aesthetics dimension in HCI field, D.Norman (2004) stated that aesthetic design can powerfully influence and affect user preferences than traditional operational usability, as just well-functioning product or application is not enough in current highly-competitive market conditions. This comparison should not be seen as two mutually exclusive concepts but rather as areas that beneficially contribute one to another, mutually enhancing experience of end user. Bringing two different domains of pragmatic interactive design and hedonistic graphic design could make a possible contribution to designing for better User Experience and potentially making an end/product more successful on today’s competitive market.

Thus, exploration of the connection between domains of aesthetics, usability and user experience as well as turning this possible connection into practical outcome, appears to be a prime interest of this study.

2.1. Classical and Expressive Aesthetics

When talking about aesthetics domain there is a tendency of separation of visual aesthetics into two distinctive fields, i.e. classical aesthetics and expressive aesthetics (DeAngeli et al. 2006).

In their work “Assessing dimensions of perceived visual aesthetics of web sites” Tractinsky and Lavie develop the comparison of two aesthetic types as major dimensions of user’s perception of visual aesthetics.

Classical aesthetics embody the notion of traditional beauty and it’s perception in a traditional sense, meaning that it mostly addresses the attributes of cleanliness, symmetry, simplicity and attractiveness of design. The classical aesthetics dimension pertains to aesthetic notions that presided from antiquity until the 18th century. These notions emphasize orderly and clear design and are closely related to many of the design rules advocated by usability experts (Tractinsky N., Lavie T. 2003). Overall classical aesthetics concept corresponds to “visual clarity” dimension (Nassar, 1999, cited by Tractinsky & Lavie, 2003) and “simplicity” (Moshagen & Thielsch, 2010) that in Tractinsky's and Lavie's model refers to the following website attributes: aesthetics, pleasant, clean, laconic and symmetrical.

Expressive aesthetics address creativity, novelty and original approach to design and has developed and formed during couple of last centuries. It’s distinctive trait is more liberal approach to design attributes and intentional breaking of the design conventions. It corresponds to “visual richness” dimension (Nassar, 1999, cited by Tractinsky & Lavie, 2003) and “diversity” (Moshagen & Thielsch, 2010) that in Tractinsky's and Lavie's model refers to the following website attributes: creative, using special effects, original, sophisticated, and fascinating.

Whereas the classical normative aesthetics bears some parallels to the many guidelines within HCI, HCI also needs to look into modern aesthetics and its knowledge on modern culture and representation (Bertelsen, O. W., Pold. S. 2004).

One of the methods chosen for this study — VisAWI questionnaire, in addition to built-in 4 facets of aesthetics, was expanded to addresses both sub-fields of visual aesthetics and includes questions asking about classical attributes and as well about level of object’s innovativeness and novelty.

2.2. Empirical Studies of Visual Aesthetics

Empirical studies of visual aesthetics can be divided into two generalized categories.

The first category is “experimental approach” and it includes studies that attempt to experimentally test hypotheses about the effects of some certain isolated elements or qualities of an object or a form on human preferences. This type of research in aesthetic context usually aims to identify general laws of visual aesthetic qualities that can be found in the evaluated object. It is most commonly associated with the ‘‘experimental aesthetics’’ stream of research (e.g. Berlyne, 1974).

The second category is “exploratory approach” and includes studies that are more exploratory by their nature, and which try to delineate higher order factors that represent peoples’ perceptions of the evaluated objects. This stream of research is typified by concerns about subjective perceptions of aesthetics rather than with the objective properties of things. (Tractinsky N., Lavie T. 2003)

Given study designed as an intentional balance between exploratory and experimental approaches, with domination of exploratory approach.

2.3. Evaluation of Aesthetics

In our our modern society, products are judged on both their instrumental and aesthetic merits. (Tractinsky, N., Lavie, T.2003) Previous studies on visual aesthetics demonstrate certain correlation between interface appearance and user emotional perception of digital artifacts. The level of aesthetical appearance can be evaluated the basis of user emotions during the episodes of interacting with application interface.

Two most common approaches used by usability researches and practitioners to evaluate and to compare different systems and design features — objective performance measures and subjective user evaluation. (T. Ben-Bassat, J. Meyer, N. Tractinsky, 2006)

Both of these approaches have shown to be effective for evaluation of aesthetical elements and can be applied depending on context, approach, objects of evaluation and additional conditions of the study.

First is evaluation approach is building on classical rules of aesthetic values, that are based on the previous studies and can be characterized as mathematically calculated rules of aesthetics.

Such objective aesthetic measures for graphic screens are balance, equilibrium, symmetry, sequence, order and complexity, cohesion, unity, proportion, simplicity, density, regularity, economy, homogeneity, and rhythm (Ngo, Samsudin & Abdullah, 2000; Ngo et al. quoted by Zain, Tey & Soon, 2008).

Second approach build on subjective evaluation of collected users' feedback and includes various questionnaires for users, interview-based techniques and experience discussions as well as various criticism frameworks (e.g. Bertelsen, O. W., Pold. S. 2004). This approach allows to collect impressive volumes of qualitative data and understand perception of the product from the user's point of view as well as stumble upon interesting discoveries regarding opinions and emotional feedback of user.

3. User Experience

3.1. Defining User Experience

In his book, Marc Hassenzahl (2010), describes User Experience phenomena as something not very different from regular notion of everyday experience:

"An experience is a story, emerging from the dialogue of a person with her or his world through action. User Experience is not much different from experience per se. It simply focuses our interest on interactive products (as opposed to, for example, other people) as creators, facilitators and mediators of experience."

Therefore, the experience itself in not directly a product or actions associated with use of this product, but a whole narrative that begins before actual use and is not finished after user is done with direct interaction. User experience in the context of ICT is different from such phenomenons as "usability" or "user-friendly interface approach" since it's not strictly linked to the functional aspect of interactive application but builds as on practical products' features as well as on hedonistic values and personal impressions.

While usability focuses on problems, barriers, frustration or stress and how they can be overcomed, UX stresses the importance of positive outcomes of technology use or possession, e.g. positive emotions, such as joy, pride, and excitement or simply value. This does not imply that usability is unessential. It rather emphasizes that positive does not necessarily equate with an absence of the negative. (Zimmermann, P.G., 2008)

User experience has a prolonged effect on a mediator — best example is Apple Computer company, which was the pioneer of the idea of so-called "added value" or an image that company assigned to its products and as a result created something more than just a device, it has created an experience.

Traditionally, the main emphasis of the field of human–computer interaction has been on efficiency considerations. (Tractinsky N., Lavie T. 2003) User experience is a notion that has entered the field of HCI relatively recently but has already been prove to be important, if not crucial, element of the industry.

It implies that user is not just using a certain application or the device, but actually involved in a multi-leveled process of having an experience. This process includes several inseparable parts that form the actual end perception of user: actual usability of the device, emotional reaction of user and visual aesthetic appeal.

3.2. User Centered Design

The main challenge of design of human-computer interaction is that, although it aims on delivering a set of certain experiences to the product user, it is impossible to design User Experience itself, since it consists of too many factors that cannot be predicted in advance. Time of use, surrounding exterior conditions, such personal factors as physical and emotional conditions on the time of use — everything mentioned above can affect User Experience (aka UX) in one way or another.

What can be done instead of unrealistic design of UX is design **for** UX, in other words — User Centered Design (UCD), which suggests transmitting a desired experience to the end user through the set of tools and methodologies and that takes user's basic needs into consideration. UCD is not limited to interface design only but rather addresses the variety of factors that can impact user perception in one way or another.

Designing an experience (and corresponding products) requires a detailed understanding of people needs as well as the context it is being designed for. (Hassenzahl, M. 2010). In other words, by designing for User Experience and User Centred Design one should create a whole story of product use and transmit in to the end product, be it a digital device or application.

3.3. Importance of User Experience

The importance of user experience can be viewed from different angles, but living in a capitalistic society and according to its values user experience directly connected to commercial success of the product on the market.

High competition of companies on the ICT market is motivating factor for paying more attention to this previously unnoticed dimension and pursue investing into improving their products not only in usability aspect, but in overall transmission of positive impression to an end user.

In other words, in order to be successful products have to please customers emotionally as well as fulfill their practical needs. (Goodman, E., Kuniavsky, M., Moed, A. 2012)

User Experience and designing for it should not be confused with a practical notion of ergonomics, which is a different design field. Although ergonomic can contribute to User Experience to some extent and both notions share some common ground in usability field as well as both aiming on improving interaction process of user with digital artifacts, they have different scopes: while ergonomics concerned with practical concepts as “productivity”, “safety”, “optimization” and other rational values, User Experience is addressing some subtle aspects of Human-Computer interaction such as subjective pleasure of use, emotional feedback and overall user’s satisfaction.

Despite User Experience being emotionally-based and therefore representing quite a subjective notion it can still be addressed and improved through a series of certain actions and techniques aimed on improving of user’s impression about end-product. The result of this effort cannot be guaranteed and will vary depending on user personality, skills and other subjective factors, however working in this direction is definitely has a value both in commercial and social aspects.

This study intends to discover if and how User Experience of interactive artifacts can be improved through applications’ interface aesthetics.

4. Role of Aesthetics in UX

4.1. Role of Interface

User interface is a relatively new concept introduced to the world less than a century ago and yet it is impossible to underestimate its role in modern society and its impact on everyday routines is enormous. Contemporary world and digital technologies phenomena became inseparable during last decades and as a result variety of interfaces were introduced and now are widely used in every domain of modern life.

Interfaces, in different shapes and forms, are everywhere: either it's a led display of the modern toothbrush or refrigerator, ATM machine screen, tube station kiosk keyboard, personal computer or tablet, cellphone and many more. Interfaces are mediators between the enormous body of data that exist in the world and users as actors, who interact with this data on different stages of their life.

As a result interfaces have an impressive power to shape our activities, our perception of those activities as well as to some extent influence our behavior and emotional perception of interface and overall user experience.

The phenomena of human-computer interaction is no longer limited by an ICT domain, but it became a great part of modern human life. The very nature of interaction changed from episodic occurrences to a continuous flow of data interchange and consumption.

4.2. Previous studies of Aesthetics and UX correlation

Several of previously conducted studies have found strong positive correlation between evaluation of a product's beauty and pre-use perceptions of its usability.

In one of the most recent studies N.Tractinsky (2013) performed replication of his previously conducted experiment (N.Tractinsky, 1997), exploring further the relationship between user pre-use perception of usability and products visual beauty.

The original study experiments were designed and conducted in Israel to test the robustness of Kurosu and Kashimura's (1995) study findings to cultural and methodological bias. The experiment extension was re-designed according to analysis of flaws and mistakes from previous study and mainly included methodological improvements in order to avoid any bias of cultural background on participants or environmental conditions of experiment. Third study involved 26 different designs that were shown to participants in two rounds in randomized order, to exclude any bias.

Three replicating studies of N.Tractinsky has revealed a correlation between a perceived pre-use usability and evaluation of design aesthetics. The author claims that his study supports new and lively area of research in HCI regarding usability and visual aesthetic.

Another study is particularly interesting in a context of this master thesis since for given exploratory study it shares quite similar methodology with research listed below.

New method for evaluating aesthetics was tested and validated (Moshagen, M., & Thielsch, M. T., 2010) with online study where stimuli were displayed as functioning (not a static print screen image) web page but no task was provided. Stimuli were available all time during evaluation. Questionnaire based methods, AttrakDiff (Hassenzahl, M., Burmester, M., & Koller, F., 2003), Expressive and Classic Aesthetics (Lavie, T., & Tractinsky, N., 2004) were in use.

Data was collected in quantitative form (interval 5-point Likert scale) from 512 participants. 42 websites were selected for evaluation according to general 4 aspects of aesthetics: simplicity, diversity, colorfulness and craftsmanship.

This master thesis study, among other methods, involves evaluation of user's first impression about experiment stimuli. Reinecke et al conducted similar research (Reinecke, K., Yeh, T., Miratrix, L.,... 2013) building on resembling methodology to find out if and how color-richness and visual complexity of web site affects aesthetic value. Conclusions were made that colorfulness and visual complexity explain 48% of the variances in users' first impression.

Stimuli was presented in a firm of a static screenshot. Data was collected by asking participant one question: “How appealing is the screenshot picture to you?”. Answer was given in quantitative form (interval 9-point Likert scale).

Stimuli were displayed for time period of 0.5 seconds and data was collected immediately after demonstration of the stimuli. Conclusions were made after 184 participants participated. Objects were randomly selected from pool of 450 snapshots that needed to fit two contrast-based criterias: colorful/colorless and simple/complex.

4.3. Design Challenges

“For a successful navigation design, it's important to consider the interface as well. The interface is the intermediary between users and content, an interpreter and guide to the complexities of a site.”
(Fleming, J. 2001)

Creating a complex and functional User Interface is a challenging task for every designer. Even more challenging is to create a functional and at the same time aesthetically pleasing interface.

This may become a challenge for a person without possession of two different backgrounds and educations or set of skills and affect negatively the outcome of end work.

Good design has to address multiple aspect of human computer interaction. It has to bridge the functionality and structure of the application system with end user, making its features understandable, visible and accessible as well as to keep some level of visual appeal.

Besides being a functional tool for a user an interface has to be intuitive, fast responsive and provide an interaction without building on confusing information architecture that leads to errors.

It is possible to suggest that aesthetics can affect the user perception of application usability to a certain extend and therefore this study aims on providing a set of guidelines, that were developed based on a collected data from the experiment. Since the nature of the study is exploratory the guidelines are not a direct call to action, but rather a set of recommendations and observation aimed to lead some design decisions and make end product more appealing to user.

5. Aesthetics Exploratory Study

Purpose of given exploratory study is to conduct complex design experiment and to evaluate interface visual aesthetics during the process of user interacting with selected stimuli. Collected data must allow to reveal if interface aesthetics are somehow related to such interaction design qualities of User Experience and usability.

Therefore is important to have all data recorded according to experiment timeline and keep close attention to affective stimuli and user perception of those stimuli during a time of experiment.

Main focus will be on several key-aspects: selecting the stimuli, timeframe of stimuli, data collection methods and choice of participants. These aspects are explained in next sections.

5.1. Introduction

Numerous user studies listed in the literature review have proven existing relations between interface aesthetics and product's usability. Interface aesthetics appeared to be more complex phenomenon than it seems, leads to suggestion that for better results, aesthetics must be studied with more complex settings than before.

Upcoming study design intends to make its settings possibly similar to real use conditions with minimal amount of distracting elements. If the correlation appears to be relevant and certain aesthetic patterns will appear among stimuli with highest rate of visual appeal, the initial design guidelines list is meant to be composed as a practical tool for interaction designers.

The study is designed for simultaneous evaluation of aesthetics, user experience and usability.

5.2. The Design of the Study

The study is carried out as follows:

1. Stimuli Selection
2. Analysis of Selected Methods for Experiment
3. Experiment Participants
4. Description of Experiment
5. Description of Collected Data
6. Analysis of Experiment Results and Discussion
7. Development of set of preliminary Design Guidelines

5.3. Selecting the Stimuli

Selecting the right stimuli has crucial importance for experimental research, since carefully selected variables can positively affect the validity of experiment. The process can be a major challenge when selecting an appropriate stimuli for environmental research (V. Shafiro, B. Gygi. 2004).

The experiment intends to explore possible effects of graphic design in UX of software artifacts. Building on the hypothesis that UX is improved by well-designed user interfaces, music players and their graphical interfaces were chosen to be the objects for evaluation in upcoming experiment.

This particular choice of evaluation objects, digital music players, is justified by several rational reasons. Music players represent the desirable combination of visual aesthetics and functionality, which makes possible assessment of those features and exploring the correlation between visual aesthetics and UX. Wide variety of both commercial and non-commercial applications on the digital market ensures that selection of stimuli will be well thought-out and various interface styles will be presented in the final selection. This aspect is especially crucial since the study aims to explore visual aesthetics and limited visual variety can negatively affect the results.

Another important aspect is previous experience of interaction with similar objects, so the participants could interact with unfamiliar programs but relate on their previous experiences and interaction patterns. It would to some extend guarantee users emotional stability and confidence so that experiment participant won't get frustrated because of interacting with completely unfamiliar digital artefact, because this kind of frustration can cause grand share of bias and therefore affect the final data. Based on this logic and taking some other criterias into consideration music players appeared to be most appropriate stimuli for given study.

Of course, there are also other interactive products that could possibly meet all study requirements and fit study settings. This fact provides several opportunities for possible development of the study and future work involving other stimuli combinations.

Despite the fact that there is a vast variety of music players available, the process of selection of appropriate stimulus must be carried out with great attention. Before choosing the stimuli, some preliminary characteristics for selection and evaluation were developed by the team in order to have a well-composed set of variables.

Because of the compound nature of digital music players, several factors need to be taken into consideration in order to provide the experiment with best representativity.

5.3.1. Criterias for Stimuli Selection

1. Graphic design diversity

   Since experiment is focusing on User Experience and its dependence on visual aesthetics, the final selection of stimuli composed to present a variety of different artistic styles.

   Despite the minimalist trend, dominating in the industry of graphic design (J.Zeldman, K. McGrane, A. Walter, V. Pieters; 2013), the final selection was not affected by this temporary fashion. Current sample consists of both skeuomorphic, so-called "web 2.0" and flat design examples as most vivid tendencies that reflect design trends of the music market of the last decade.

2. Interface complexity and composition

Objects with different level of complexity affect human perception differently (H. Yee Eng, D. Chen, and Y. Jiang; 2005). Appearances of digital music players vary from bare simplicity to multileveled structures. Our goal was to choose various players that include both simple and complex interfaces.

3. One platform limitation to participants

   Because of the variety of music players available for installation and also of few technical limitations, the OS chosen for experiment was Windows platform. Therefore previous experience with Windows OS became crucial criteria for selection of participants, because unfamiliar OS may cause confusion during process of performing experiment tasks and as a result — unwanted bias in usability data.

4. Novelty of testing subjects

   To avoid bias, it was decided that during the experiment participant will test objects that he has no previous experience with. This way first impression of application's visual aesthetics will be more vivid and his emotional response towards the stimuli will be unaffected by any previous interactions.

5. Task performance

   There is certain set of tasks that user is about to perform during the experiment and therefore, all selected stimuli must have certain set of functionalities. There can be exclusions if the stimuli can be paired into separate cluster with separate tasks (like in case of LastFM and SoundCloud services which, because of their web-based nature, do not allow composition of playlist from computer's hard drive, yet allow this task to be replaced with similar one, like composition of a playlist from the web service online library).

6. No advertising blocks implemented in interface

   In this sample, our team intentionally tried to refrain from choosing music players with interfaces that include blocks for commercial advertising. The reason is the fact that advertising appearance is created without taking into account aesthetical features of music player interface and therefore conflict of interface design and add design takes place.

These blocks contain frequently animation, changing images and otherwise attractive objects that distract viewers' attention from the task and perception of the whole interface might get biased.

7. Limited number of testing subjects

   It was agreed to limit the number of interfaces to two per session. Otherwise the results of the experiment might get affected by participants' exhaustion, caused by long evaluation process. Answers must be given with necessary reflection, not for sake of ending the session as soon as possible and therefore two objects per one participant is the optimal number.

5.3.2. Selected Objects

iTunes (apple.com/itunes/, Figure 7) has a primary function of regular media player, but can also be used as a media browser, combined with a store, an organizer, storage for downloaded apps and tool for managing data from other devices etc. The player can be installed both on Mac OS and PC. User interface is simple composition wise, clean and has no distracting details or unnecessary enhancements. Colour palette includes shades of grey along with white, pale light-blue and black accents and the only colour accents are album covers and genre labels. It has almost a flat design, with very elegant, almost non-existent shadows and highlights added in few places.

Winamp (winamp.com, Figure 8) --- Winamp can be used both on Mac OS and PC. It's default interface is executed in dark tones, with contrasting light gray lettering and panels and some added sections of orange. Volume is added to interface with subtle use of shadows and bright tones.

Winamp also has multiple downloadable skins which allow its interface to be altered. Majority of skins are very bright, combine multiple colors with questionable compatibility, and contain Web 2.0 style buttons, 3D panels with lots of realistic shadows and reflections.

MediaMonkey (mediamonkey.com, Figure 9) --- MediaMonkey is currently available only for PC users. The application is flexible in terms of UI design and also functionality, because both can be altered. By default the interface is dark with contrasting bright letters, background includes dark gray gradients with undertones of brown and yellow.

MediaMonkey is more of a media construction kit, than a player with fixed interface. Additional modules can be added and composition of the player can be rearranged. There are also non-changeable features present, such as list of songs and player panel itself. MediaMonkey offers a variety of skins which look alike with variations in colour and tones. Skins are mostly executed in grey palette with rare exceptions.

VLC Media Player (videolan.org/vlc/index.html, Figure 10) — VLC is simple on-demand player and it's distinctive feature is absence of any strong graphical UI style. Interface colour scheme is mostly executed in shades of grey with a bit of white and pale blue for accentuating details. VLC has no skins.

Spotify (spotify.com/, Figure 11) — one of the most popular music applications on the market at the moment. User interface is complex in terms of composition and density of program features. Graphics are elegant and simple, with clear lines and well-balanced composition. Darker colour scheme gives a luxury and sophisticated feeling and there is almost no colour in interface itself, only added color accents are album covers in “Radio”, “Browse” and “Discover” sections. There is no possibility to change or alter the appearance of the service.

MusicBee (http://getmusicbee.com/, Figure 12) — Popular music player with simple and clean design.

Has animated logo with a flying bee on it and the theme of bees is as well reflected in overall design: black and yellow color palette, logo with bee etc.

Has several skins and possibilities for editing player playout.

Jaangle (www.jaangle.com/, Figure 13) — Music player and organizer for PC platform.

The interface is quite complicated in terms of data density but UI design is plain and simple.

There is an option for changing application colour (skins) but the composition of the screen and organizations of panels cannot be changed.

Winyl (http://vinylsoft.com/, Figure 14) — free digital audio player and audio library application for organizing and playing audio on Windows. Simple interface, bright colours and low level of contract. Has 6 built-in skins to choose.

SoundCloud (soundcloud.com, Figure 15) — SoundCloud is a music service which heavily relies on a social networking aspect (such as sharing music, uploading created music and discussing it).
The interface is simple and plain with mix of greys, blacks and bright orange to add some contrast and accentuate background colours.

Distinctive feature of SoundCloud is visualization of each track as a sound wave, which can be used for commenting on a certain section of a file. Comments look like avatars placed on a sound wave and can be unwrapped to read a full comment. Same comments are displayed under the song as comment stream.

Windows Media Player (windows.microsoft.com/en-us/windows/windows-media-player, Figure 16) — The player design is very light and simple, made in pale light blue tones.

UI is not flat, there are still buttons with added volume that are typical for Web 2.0 style and Windows products.

5.4. Analysis of Selected Methods

This section describes methods that were selected for the study and justifies use of a certain methods for this particular experiment.

Because emotional feedback can be provided in many different forms — such as face expressions and mimics, gestures, body language, behavioral patterns etc. — emotional satisfaction becomes a variable that is quite hard to be measured precisely.

Hence, from the variety of available methods it was decided to concentrate on given combination of objective biometric methods and subjective user self-evaluation methodologies as this combination provides most optimal and unbiased data for future processing and analysis.

5.4.1. Supportive Data

User background information was collected with a structured interview in the beginning of each session. Questions included such participant's data as age, nationality, gender, education, English language proficiency (on a scale: basic, intermediate, proficient), residency, experience with computer, operating system experience (Windows OS) and experience of computer-based music players.

Video and audio of each participant's session were recorded during the study.

Purpose of video is to store discussion with user and users' behavior during study as well as for future evaluation of possible mistakes and methodological errors of given exploratory study.

5.4.2. VisAWI Questionnaire

Initially, VisAWI questionnaire was designed for assessment of visual aesthetics of web-based interfaces but it was adjusted to fit the experiment by editing the questions and adapting them to application interface evaluation.

During methodology development four interrelated facets of perceived visual aesthetics of websites were identified and validated in a series of seven studies. Simplicity and Diversity have been considered as classical parameters of aesthetic objects throughout the history of empirical aesthetics, Colors are a critical property of aesthetic objects, and Craftsmanship addresses the skillful and coherent integration of the relevant design dimensions. These four facets jointly represent perceived visual aesthetics, but are still distinguishable from each other and carry unique meaning. (Moshagen M., Thielsch M.T., 2010)

Developers of methodology claim VisAWI appears to be a sound measure comprising facets of both practical and theoretical interest, which allow for a precise assessment of perceived visual aesthetics of websites. (Moshagen M., Thielsch M.T., 2010)

For the sake of addressing more aesthetical aspects and gaining more data two additional sets of questions were added to the questionnaire: Classic and Expressive Aesthetics (Tractinsky, N., Lavie, T., 2003). This allowed the study to have a larger scope as well as gain more information about subjective user opinion about these important aesthetic dimensions.

Based on that VisAWI questionnaire can be confidently used as suitable methodology for study.

5.4.3. Biometric Measurements

One of the ways to assess user's reactions to aesthetic stimuli is to measure user's biometric figures. Given study must help to reveal the possibility of using biometric sensors during user testing and show if recorded data is usable for evaluation of participants' emotional state.

During the experiment, several specific technologies such as biometric indicators were used: pulse, skin conductance and brain electric signals, which were fixed to the participants' body during the whole process of interaction with applications selected for evaluation.

When analyzing the data from physiological user response, possible connections between user physiological reactions and aesthetic value of the interfaces can be established.

Since user cannot control his physical responses to the stimuli the data collected through this methods is suggestively considered to be more objective.

5.4.4. Eye-Tracking

"Once a novel addition to a UX researcher's toolbox, eye-tracking now is frequently employed to help evaluate and improve designs at various stages of development cycle."
(Boiko, A., 2013)

Eye-tracking system is a combination of portable hardware device and a complex software, that records and processes data from the device. The technology is proven to be effective for variety of research fields, most popular of which are academic research, commercial market research, educational purposes, gaming industries and usability domain.

The tracker, which is a unique combination of camera and calibrated viewer, usually sits just below the computer screen. It calibrates by making a user follow series of simple steps and holds calibration quite well, allowing device to work consistently during the whole session. Currently, eye-tracking software runs only on the Windows OS.

There are at least three aspects that stand to benefit from eye tracking research: visual perception, human–computer interaction, and computer graphics. Recent rapid improvement and development of eye-tracking methodologies has provided the availability of more accessible technologies and stimulated eye tracking research efforts, mostly in psychology and computer science domains. (Duchowski, A., 2007)

In particular experiment the eye-tracking methodology is used for multiple purposes: to analyze user's gaze movements during the experiment (as a basis of mental effort while determining efficiency of interface), as well as to synchronize screen recording with biometric data from other tools and track concentration of user's attention on a certain areas of computer screen.

Other aspect of efficiency — objective physical effort (mouse clicks, keystrokes, times of user inactivity etc) — is detected from eye tracker's screen record which is analyzed after experiment.

5.4.5. First Impression Aesthetics and Pleasure of Use

Evaluating visual aesthetics is mostly done by recording self-reported hedonic value, triggered by previously perceived visual stimulus. In this study, first impression involves short-time display of stimuli.

Provided cases do not include any interaction because first impression takes place already before usage begins. Therefore, first additional question was asked immediately after first opening of music players. This question was about first aesthetic impression: "How beautiful does this player look to you?" Answer was expected on 5-point Likert scale, where 1 means "This player looks unattractive at all to me" and 5 means "This player looks very attractive to me".

Second, comparative question, was asked in the end of the testing session, after participant had seen and interacted with both players: "Which player did you consider to be more aesthetical?". Answer was given by the same principle of 5-point Likert scale.

Data analysis of collected data would contain correlation matrix of User-reported Aesthetic values with pragmatic satisfaction values.

5.4.6. System Usability Scale (SUS) Questionnaire

The System Usability Scale (SUS) was released into this word by John Brooke in year 1996 (Sauro, J., 2011). SUS is technologically independent and has been successfully tested on hardware devices, consumer software, web-sites, cell phones, ATMs and other digital and non-digital artifacts. It has eventually become an industry standard with references in over 600 publications.

SUS consists of a 10 item questionnaire with 5-point scale response options for respondents; from “Strongly agree” to “Strongly disagree”. It allows to evaluate a wide variety of products and services, including hardware, software, mobile devices, websites and applications.

For this particular study, SUS-questionnaire was chosen for 3 reasons:

SUS questionnaire contains smaller number of questions — it is essential for participants not to get exhausted during application evaluation, otherwise their answers might get biased by the will of finishing the questionnaire as soon as possible.

SUS questions clearly express pragmatic satisfaction issues and usually do not require additional explanations from facilitators.

Output value of SUS corresponded to the output value of aesthetics evaluation.

Additional question about UX is about pleasure of use: I was pleased to use this player. (with gradual answers “disagree” or “agree”).

All questions of SUS and the additional question use 5-point Likert scale.

5.4.7. Participants

This master thesis study was intentionally designed to be universal and there were no specific criterias for participation in the experiment. It was also intentional to have possibly large sample (at least 2-4 evaluations for each stimuli out of 10).

Assuming that participants’ social and cultural background influences aesthetic value (Reinecke, K., Yeh, T., Miratrix, L.,... 2013), makes it important to collect data about age, gender, nationality and education. Background information enables filtering data in later analysis and helps to get a better understanding of study sample.

Most of people do listen to music on their computers and therefore are familiar with music player applications. Participants who have never used music players will most probably have lower results usability-wise during the experiment. For this reason, the participation was limited and only those candidates were selected for experiment who are familiar with music players. Higher usability is expected for those who use some particular player every day. Users are to be asked about this issue and two unfamiliar players out of ten, will be assigned for testing.

Testing was done with Windows OS. Participants were invited one at the time. On testing day, they were scheduled to arrive every hour. Average time for session was about 45 minutes, varying from 20 minutes to one full hour depending on participants pace of task completion. Evaluation episodes of applications were limited to 10 minutes per each interface. In case participant were unable to complete all the tasks during 10-minute time frame, he/she was asked to finish his task and move along to the next application or finish the session.

Complex empirical studies are more demanding against strictly followed study conditions and users may need corrective instructions during task completion. A mediator will be present during study to answer possible questions and help with the problems.

5.5. Description of Experiment

The design of this master thesis study does intend to make experiment settings possibly similar to real-life conditions. Interactive products were tested in lab environment setting that simulates regular work or home surroundings.

Evaluation of interaction qualities — such as efficiency, effectiveness, perceived pleasure and emotional satisfaction — might get biased when entire usage process is not completed seamlessly like in real life. Therefore the intention of given study is to conduct simultaneous evaluation of aesthetics and interaction qualities during entire usage process without interrupting user before task is completed.

Hence, it is important to have all data recorded in real-time and to keep close attention to affective stimuli. Main focus was concentrated mainly on four aspects: selecting appropriate stimuli, observing time and duration of stimuli, data collection methods and choice of participants. Collected data must presumably allow to reveal relations between interface aesthetics and interaction qualities. These key aspects for setting the experiment are explained in next sections.

5.5.1. Equipment

Due to complex nature of study experiment, wide variety of tools was used for gather all the necessary data:

- Desktop computer with 24'' monitor for testing the objects.
- Laptop computer to record the biometric data and filling the questionnaire.
- Mac Mini computer for recording and operating EMOTIV Headset.
- Windows 8 Operating System.
- Microphone and camera for observing user.
- Mirametrix s2 eye tracker with screen recording software.
- EMOTIV EPOC Headset with EEG data recording software.
- NeuLog Heart rate & pulse logger sensor NUL-208.
- NeuLog Galvanic Skin Response (GSR) logger sensor NUL-217.

Because of numerous gadgets that were needed for the experiment, conducting experiment by only one person became too complicated and unrealistic. As a result, too mediators were present during each sessions to simultaneously interact with participants, operate camera, two computers and process data recording from various sensors and eye-tracking device.

5.5.2. Steps of Study

On-site experiment will contain following steps:

8. Explaining the experiment to participant.
9. Demographic questions: age, gender, education, nationality.

10. Setting up psychophysiological equipment: eye tracking, skin conductance sensor, heart rate sensor, EEG headset.
11. Explaining tasks to participant. Steps of tasks are also written to memo paper.
12. Session with player one.
13. VisAWI questionnaire with player one.
14. Session with player two.
15. VisAWI questionnaire with player two.
16. Retrospective comparative aesthetics evaluation with question: "Which one you like best?" Both tested players are available for reviewing during questionnaire.

5.5.3. Experiment Scenario

The experiment had several organizational levels each of which had to be carefully planned.

For more effective time-management special timeline was designed in order to calculate amount of time that will be spent on each participant.

Timeline of experiment:

- Wiring the participant and calibrating measuring tools. 5 to 10 minutes.
- Explaining experiment to participant. 5 minutes.
- Completing set of tasks with two players. 15 minutes for each object, 30 minutes in total.
- Short interview with user about his initial impression. 5 minutes.
- Completing VisAWI questionnaire. 10 to 15 minutes for both players.

Total time: approximately 1 hour, with 15 minutes buffer between sessions to prevent participants from rushing.

The experiment was held according to following scenario:

1. Video recording is activated.

2. Greeting the participant and explaining the experiment.

   Introduction of experiment is followed by basic questions about user previous experience with music players and explaining what to expect during next hour:

   - Do you listen to music on computer?
   - What MP's do you use (our list available)?
   - Which genre do you like? (may be more than one).
   - Your task today will be to use two unfamiliar MP-s to create playlist, order the songs, rate the songs, save (export or share) playlist, alter the playback settings (volume, shuffle) and start playing. When you open the player, we will ask about your first impression about aesthetics. Then you will have ca 5 minutes to get familiar with MP. After that we'll start the task. Task ends by pushing the play button. Content of task will be printed on paper and placed on table to be checked during completion.

3. Connecting wires and calibrating sensors while interacting with the user and explaining him functionality of each tool. It is crucial for user to feel relaxed and comfortable at this point of experiment, since physical discomfort can affect user's emotional response dramatically. Following devices are connected to the participant:

   - Emotiv EEG Neuroheadset is placed to participant's head.
   - NeuLog Heart rate & pulse logger sensor NUL-208 is fixed on participant's ear.
   - NeuLog Galvanic Skin Response (GSR) logger sensor NUL-217, two sensors fixed on user's wrist.

4. Setting up Mirametrix eye-tracking device. It is important for participant to find optimal sitting position during that time and keep his head straight during software calibration. This step includes following actions:

   - Finding optimal sitting position. (Adjusting chair height, distance to screen, finding comfortable hands position on keyboard and mouse.)
   - Calibration of eye-tracker with special Mirametrix calibration software.
   - Starting the recorder and assigning a folder for recording files.

5. Participant invited to practice with first music player. This is the phase when participant is asked about first impression about object visual appearance. It is important to emphasize that at this stage participant is only evaluates aesthetics and not usability. Participant invited to rate his emotions of player interface aesthetics on 5-point scale where 1 — extremely unattractive; 5 — extremely attractive.
6. Explaining tasks and guiding user through music location and variety of contents in "Test Music" folder. The participant is requested to complete actions by using songs from flash drive. All actions are listed on paper which is placed in front of participant.
7. Starting EEG record on second computer.
8. Starting NeuLog record on second computer. Serious of signals is developed for future processing and synchronization of results.
    - Simultaneously setting EEG marker.
    - Clear audio signal for synchronizing video.
    - Clear visual mark for synchronizing screen recording
9. Starting tracking task by synchronously setting EEG marker and audio marker
10. Stopping time to task by synchronously setting EEG marker and audio marker
11. After finishing with first object user is asked to evaluate his experience with player usability. Participant invited to rate his emotions of using the player on 7-point scale where 1 --- extremely negative experience; 7 --- extremely positive experience.
12. Participant is invited to practice with second music player. He is again asked to evaluate first impression of music player interface.
13. User starts performing set of tasks with second music player. EEG marker and audio marker are being set.
14. User finishes performing set of tasks. EEG marker and audio marker are being set.
15. User is asked to rate his experience with second player.
16. Eye tracking and screen recording are stopped.
17. User is asked to compare two objects, by asking questions:
    - Which music player, out of two, looked aesthetically better?

- Which music player, out of two, was more pleasant to use?

18. Stopping eye-tracker recording, removing sensors from the user.
19. Explaining VisAWI questionnaire.
20. VisAWI questionnaire is filled by participant.

    The questionnaire is filled twice — evaluating one music player at a time.

21. While participant is completing the questionnaire

    - Stop EEG recording
    - Stop NeuLog recording

5.5.4. Objects of Evaluation

Objects of evaluation were presented to participant in full working order. When opened, object interface was completely blank with default and non-modified presets, with no pre-saved data or visible signs of previous user.

Eight folders, each containing from 3 to 20 files of music, were prepared as a source and made available on external flash drive. Flash drive was used, because native locations of music directly on the computer (my music, shared music, etc.) are often get automatically synchronized with application's playlists, making task completion easier for some players compared to others.
Online players, such as Spotify and SoundCloud, were previously logged in to access web-based services.

Two objects were assigned for evaluation to each experiment participant.

Assigning objects was done based on participant's familiarity with certain music players — unfamiliar objects were given for evaluation. One intention of study is to compare objects' aesthetic value, therefore selection was done with different aesthetic properties.

All objects were initially lined up on OS application bar, located at lower edge of screen. Objects were also duplicated and lined up vertically on computer desktop as shortcuts with bigger icons for easier notification of visually impaired users.

Listening to music wasn't part of the task, because music is powerful emotional stimulus and may cause bias in evaluation of objects.

5.5.5. Tasks

During the experiment participants were given a set of previously prepared tasks which were aimed to help them reflect on objects aesthetics and usability. Tasks were available in English and Estonian and were given to participants in printed version and in a preferred language.

Before starting the work on tasks users were given a spare time of approximately 5 minutes to get familiar with the player they will be evaluating and to browse along menus and interface.

Set of available music tracks was located on flash drive in folder named "Test Music", in subfolders that are named after music genres. Participants were to complete requested actions by using songs from flash drive.

Participants were asked to complete the same tasks with two music players, both times they were limited in time by a 10 minute time segments.

Experiment tasks in English and Estonian can be seen in Appendix A1 and Appendix A2.

5.5.6. Experiment Conditions

For every experiment it is crucial to have non-biased participants as well as be sure in their well-being and high level of comfort. Factors that can cause discomfort, thus shall be minimized to minimum otherwise the validity of the experiment might get affected.

All objects were in full working order with complete functionality. Choice of objects was limited to Windows operating system. All objects were installed and shortcuts were lined up on OS desktop taskbar, located at lower edge of screen. Listening to music was not part of the task, because music is powerful emotional stimulus and may distract users' attention from visual stimuli.

Given experiment has been conducted in calm environment with three computers in use — one for the experiment participant and two for mediators of the experiment and following questionnaire. User was repeatedly asked series of questions regarding his/her level of comfort and was encouraged to express his thought or concerns during the time of experiment. Mediators were taking notes about user behavior and his answers to questions during the experiment.

No leading suggestions were given and participants weren't exposed to any pressure when completing the tasks. Participant's comments about task completion and overall impressions of experiment were discussed only after the experiment was finished.

Video and audio recording of each participant were recorded during the experiment. Purpose of those recordings is to store discussion with user and users' behavior during study for future analysis of qualitative data.

6. Results and Discussion

6.1. Collected Data

In total, there were 20 test users who participated in exploratory study for this master thesis.

Music players were assigned for testing as shown in Table 1. Different music players got evaluated from 2 to 6 times. The reason why certain players were evaluated so few times was the restriction of stimuli selection to use only unfamiliar players: so popular players like Windows Media Player was tested only 2 times, Winamp and SoundCloud — 3 times.

Aesthetic preference indicates which player user considered to appear more aesthetically pleasing. User was asked about his preferences immediately after the episode of use of both players. In three cases, reported preferences gave different results than VisAWI aesthetics evaluation, conducted at the end testing session.

The initial sample of 20 users proved study settings to be applicable and collected data to be usable. When asked about physical aspect of wiring and wearing biometric measuring tools, none of participants reported sensors to be distractive or inconvenient.

At the moment, collected data allow to make many different conclusions:

- VisAWI facets allow to conclude which aesthetical aspects are influencing usability most.
- Correlations between “Emotion Slider” and retrospective VisAWI questionnaire show how are UX and aesthetics related.
- Psychophysiological data supports determining exact timing of emotion.
- Eye tracking supports determining exact visual stimuli and timing of emotion.

6.1.1. User Reported Metrics

Aesthetic preference (Table 1, column 4) indicates which player user considered more aesthetical. Preference was asked immediately after the use of both players. In three cases (marked with asterisk in Table 1), reported preferences gave different results than VisAWI aesthetics evaluation, conducted at the end testing session.

Participant	Player 1	Player 2	Aesthetic preference
1	MusicBee	Spotify	2*
2	iTunes	VLC	1
3	MediaMonkey	Vinyl	1*
4	Jaangle	MusicBee	2
5	Vinyl	Spotify	2
6	Winamp	Windows Media Player	2
7	Jaangle	MusicBee	2
8	iTunes	MusicBee	2
9	MediaMonkey	Spotify	2
10	Vinyl	MusicBee	2*
11	SoundCloud	VLC	1
12	SoundCloud	Windows Media Player	2
13	MediaMonkey	Jaangle	1
14	VLC	Spotify	2
15	iTunes	Winamp	2
16	Winamp	iTunes	2
17	Jaangle	Vinyl	2
18	MediaMonkey	MusicBee	2
19	Spotify	VLC	1
20	iTunes	SoundCloud	1

* preference is different from Aesthetics value

Table 2 Pairing of music players for testing

Pilot study revealed gradually average perceived aesthetic value of all music players. This data can help in purposeful pairing them later in main study. Table 3 contains average user reported values for all players. All these values are normalized for better comparison. SUS value indicates perceived pragmatic satisfaction. 1st impression indicates first aesthetic impression immediately after opening an interface. Pleasure of use indicates how pleased user was to use the player. Aesthetic value indicates overall aesthetic value of player after the use of player. 1st impression and pleasure of use were single questions. SUS and Aesthetic value were retrieved as latent question through multiple-item questionnaires.

	SUS value	1st impression	Pleasure of use	Aesthetics value
Jaangle	0,313	0,313	0,250	0,361
MusicBee	0,815	0,708	0,804	0,674
Vinyl	0,450	0,563	0,344	0,614
Spotify	0,681	0,800	0,670	0,688
Winamp	0,417	0,583	0,333	0,490
WinMP	0,825	0,625	0,750	0,611
iTunes	0,650	0,700	0,615	0,660
SoundCloud	0,517	0,500	0,350	0,361
VLC	0,358	0,375	0,481	0,350
MediaMonkey	0,392	0,500	0,331	0,557

Table 3 Results of evaluating aesthetics and UX

Table 4 shows correlations between items from Table 3. These results indicate quite good correlation between all assessed aspects. Intention of further study is to continue data collection for better validity of existing correlations and to add more objects for evaluation to improve significance of correlation.

	SUS value	1st impression	Pleasure of use
SUS value	0,801		
1st impression	0,926	0,727	
Pleasure of use	0,724	0,674	0,674

Table 4 Correlation matrix

6.1.2. Effectiveness and Efficiency

Effectiveness of interface can be calculated from time, users spent to complete the task: effectiveness was higher when less time was spent. Experienced user was able to complete task in 2 minutes, but participants of study were inexperienced. They were given 10 minutes to complete the task. If user did not complete the task in 10 minutes, then it was indicated as completion failure.

Efficiency of use can be calculated from effort, users made to get task done. Physical effort is determined as number of interactive operations and mental effort means intensity of learning unfamiliar interface. Efficiency is assessed by analyzing screen recording and eye tracker data. Number of mouse and key inputs indicates physical effort and eye movements and fixations indicate mental effort. Effort was evaluated subjectively by eye tracker and screen recording analysis. Results were presented on 5-point scale where "1" means minimal and "5" maximal effort.

Table 5 shows average effort and time, each player took to complete the task. Finally Measures of effort and time were correlated with values of aesthetics: aesthetic value from VisAWI and first impression. As seen in Table 6, effort and time to task have negative correlation with interface aesthetics.

Preliminary conclusions of given study are:

1. Aesthetic interfaces are more satisfying i.e. provide better user experience.
2. Aesthetic interfaces allow to complete tasks faster (more effectively) and take less effort for completing tasks (they are more efficient)

Player	Effort	Time to task (sec)
MusicBee	1,83	274
Spotify	2,00	274
iTunes	2,00	240
VLC	3,00	416
MediaMonkey	2,33	417
Vinyl	2,00	356
Jaangle	2,67	544
Winamp	2,33	423
WindowsMP	2,00	278
SoundCloud	2,00	476

Table 5 Efficiency and effort

	1st impression	Aesthetics	Effort
Aesthetics	0,8883172904		
Effort	-0,7986139337	-0,7397829153	
Time to task (sec)	-0,8745783065t	-0,8903034272	0,6275163815

Table 6 Correlations between Aesthetics and pragmatic usability

6.1.3. Psychophysiological measures

During the experiment, several biometric tools were used:

1. EMOTIV EPOC Headset with EEG data recording software — to conduct electroencephalography (EEG) and record user's electric signals produced by the brain and possibly perform the analysis of emotions and feeling during the usage episode.
2. NeuLog Heart rate & pulse logger sensor NUL-208 — to monitor participant pulse rates during the experiment as additional data source of emotional response to the stimuli.
3. NeuLog Galvanic Skin Response (GSR) logger sensor NUL-217 — to measure the conductivity of experiment participant skin as a result of emotional response to the stimuli.

Facilitators of the experiment possessed no previous experience of working with such kind of technological tools, but in the end large amount of biometric data was successfully collected and recorded and this can be definitely seen as positive result of study. But in the end, data obtained from psychophysiological tools wasn't useful for this particular study.

Several reasons of why analysis of collected biometric measures did not demonstrate any relevant correlations are listed below.

First of all, the duration of interaction episodes during the experiment and timing of data gathering was too short to reveal any strong emotional responses and behavioral patterns. For example, NeuLog sensors couldn't read enough data for any relevant analysis because participants' skin conductance reached level, required for analysis, only by the very end of each session. Actions during average interaction episodes followed each other faster than pulse or skin sensors were able to react.

Stronger emotional stimuli could make pulse change rapidly, but aesthetic stimuli is relatively weak. This would require it to be exposed considerably longer for desired effect, but real-life conditions of interaction are different.

Second, in case the data revealed some sort of emotional excitement, it was hard to detect the nature of this activity — was it a positive or rather negative response to the stimuli. So, mostly psychophysiological measures used for this study demonstrated level of concentration and participant's reactions, but not the emotions per se.

Other problem with psychophysiological measures is noise. Biometric sensors are so sensitive that usable signal is often covered by various artefacts: for example numerous sudden changes in skin conductance indication were caused by trivial movement of users' hand (skin conductance sensor was fixed to the left wrist) and not participants' emotional state.

Though these data was not useful for aesthetics research and this particular study settings, it gave important experience about how to proceed with psychophysiological measuring and allowed to get familiar with nature of biometric data.

6.1.4. Correlation between UX and facets of aesthetics

Objective measures and following processing of quantitative data, gathered during the experiment, helped to reveal a certain correlations between VisAWI questionnaire 4 facets of aesthetics, classic and expressive aesthetics and pragmatic value of SUS questionnaire which was used for this study as a User Experience measuring method.

Statistical analysis of data obtained from both questionnaires revealed that there was a moderate positive correlation between UX and almost all VisAWI aesthetic facets and classical + expressive aesthetics.

Following correlations were revealed (Pearson's correlation coefficient used, Table 7):

Moderate positive correlation (0.3….0.7 Pearson's coefficient):

- SUS and VisAWI Facet of Complexity (Correlation coeff. 0,785)
- SUS and VisAWI Facet of Diversity (Correlation coeff. 0,427)
- SUS and VisAWI Facet of Craftsmanship (Correlation coeff. 0,507)
- SUS and Classical Aesthetics (Correlation coeff. 0,433)
- SUS and Expressive Aesthetics (Correlation coeff. 0,390)

No significant correlation:

- SUS and VisAWI Facet of Colorfulness (Sig.= 0,056; $\alpha = 0.05$)

Despite the fact that one aesthetic facet of Colorfulness didn't reveal any statistically significant correlations, all other variables revealed correlations on satisfaction level and might serve as a basis for future work on practical set of design guidelines.

6.1.5. Subjective observation results

Subjective observation, video recordings transcription and future analysis of eye-tracking recordings revealed several interesting patterns in participants' behavior and helped to determine areas of particular interest of this study in interface design of tested applications.

Those areas were:

- **Gaze concentration** — after analyzing eye-tracking videos it became obvious that most users concentrated on upper left and central part of the screen. (Figure 2)
- **Icons versus Text Menus** — during subjective observation during the the experiment, interfaces with text menus seemed to cause more effort for finding options, required for task completion, than interfaces with pictograms (computer icons) as a representation of menu functions. (Figure 3)
- **Text size and Fonts —** players that had highest index of UX and aesthetical correlation used simple and non-decorative system fonts — such as Arial, Verdana and Georgia. Players that were using bigger point fonts seemed to cause less effort to operate the interface menu.
- **Color Use —** during verbal discussion with participants most of them expressed approval of using colors in design and especially accentuated use of bright colors in application interface.
- **Level of Contrast —** according to subjective observations of users actions and shared feedback, during the testing sessions many of participants found some players to be "too dull", "too grey and blank" and "unnecessarily boring color-wise".

- **Additional Interface Enhancements** — some players demonstrated dramatic differences in interface composition, some of which later turned out to be relevant elements of interface design and UX.

Listed patterns have little connection to the music players' application per se, but mostly are reflection of overall relevant tendencies that have the potential of using this data for bridging dimension of User Experience and aesthetics.

6.2. Discussion

Given exploratory study successfully performed a complex experiment and demonstrated the existence of correlation between certain aspects of aesthetics and User Experience. This signifies that consideration of this connection might be beneficial for user centered design and emotional perception of interactive interface by end-user as well as provides fundament for future work and deeper research.
In addition, proved correlation served as a basis for development of preliminary design guidelines, which in future could be potentially expanded into solid framework and contribute positively to ICT area, benefiting graphic and interaction design fields in particular.

It is necessary to mention absence of any statistically significant correlation between pragmatic satisfaction of use value of SUS questionnaire and VisAWI aesthetic facet of "Colorfulness". This event is most likely be connected with the fact that most of the players shared similar color palettes based on a combinations of different shades of grey, black and white and weren't diverse enough in terms of colors to reveal any significant correlations.

Therefore we can state that in future, the right way to judge connection between colorfulness and usability would be including more color oriented and diverse interfaces in the study.

During experiment data processing it became obvious that biometric measures such as skin conductance sensor, heart rate and pulse sensor and EEG headset have no particular relevance for the study and therefore cannot be used for making any relevant conclusions.

It is necessary to add, that albeit the psychophysiological data had no use for this particular study settings, it still contributed to the experience of how to proceed with psychophysiological measuring and allowed to get familiar with nature of biometric data.

Worth mentioning the fact that despite VisAWI questionnaire was a useful tool for given experiment setting and it was additionally expanded to cover more aesthetical dimensions and therefore explore wider set of visual aspects, there are still some relevant aspects of aesthetics that were left behind the initial study focus. For example, properties influencing aesthetic appraisal of user-interfaces were shown to include colors, balance, grouping, structure, and order, simplicity and density, novelty and prototypicality as well as complexity (Moshagen M., Thielsch M.T., 2010).

As possible solution it might be worth suggesting for future studies to add unstructured interview with users and ask why they considered players aesthetical or not aesthetical. This would contribute a decent share of qualitative data and might lead to some interesting results as well expand the potential area of study research.

To conclude, the study has completed all planned steps and confirmed the hypothesis about an existing connection between aesthetics qualities of digital artifacts interface and user's experience. This was a decent basis for developing a suggested design guidelines as an exploratory work that needs expansion and further scientific contribution in order to grow into solid and practical guide for interaction designers and graphic designers designing for improved User Experience.

7. Conclusion

7.1. Preliminary Design Recommendations

The main purpose of every commercial product is to provide profit to it's authors. In order to be successful it has to be attractive, functional and emotionally appealing, meaning that it has to provide unique and positive User Experience. While good User Experience design doesn't guarantee product's success on the market, the bad design is nearly always a guaranteed path to failure. (Goodman, Kuniavsky and Moed, 2012).

Considering high level of competition on interactive application development market, there are a lot of applications that share almost identical level of functionality. So, if pragmatic affordances are similar and functional content is the same what then makes end user to lean towards choosing one application or another? If it's an added value of emotional satisfaction and pleasure of use, how can designer to organize his work in order to provide one?

The set of guidelines which could help interactive designers and other people, who are involved into product design process yet possess no particular artistic experience, to potentially improve their product by making it more appealing to the end customer, would be useful.

Since user first impression and initial opinion are built during first 50 seconds of exposure to new digital artifact (Lindgaard, G., 2006), the importance of creating visually appealing product cannot be underestimated.

Given study has revealed some particular patterns among stimuli and correlations between certain aesthetic facets and UX. With this data at disposal, it became possible to select players that have scored the highest rating from experiment participants for each facet separately and based on this evaluation, to extract certain visual characteristics and transform those into set of guidelines.
Criteria for positive rating was 4.5 points out of 7 (rated on 1...7 Likert scale) as it corresponds with beyond average percentage of 60%.

Objective observations of eye-tracking videos and transcriptions of verbal evaluation of certain qualities of experiment stimuli can serve as an additional, supportive tool for development of a set of design recommendations that can possibly lead to successful bridging UX and graphic design domains.

7.1.1. Complexity, Composition and Screen Positioning

Moshagen M. and Thielsch M.T. (2010) in their research ”Facets of visual aesthetics” for studying validity of VisAWI questionnaire, described Complexity (also mentioned as Simplicity) facet in a following way:

“Simple layouts can be processed more fluently and should therefore be valued positively. Accordingly, research in human–computer interaction has repeatedly demonstrated the importance of simplicity for the aesthetic appreciation of websites.”

Highest scores of value of VisAWI “Complexity” facet during players’ evaluation have received three Music Players. Mean values of questions addressing positive design characteristics on a score table from 1 to 7 were taken to select players with highest (mean above 4.5) score:

- **iTunes** (mean value 4.6 in “Layout is Easy to Grasp”, 5.0 in “Everything goes together on this site”, 5.0 in “Layout appears well structured”)
- **MusicBee** (mean value 6.0 in “Layout is Easy to Grasp”, 5.7 in “Everything goes together on this site”, 5.5 in “Layout appears well structured”)
- **Spotify** (mean value 4.5 in “Layout is Easy to Grasp”, 5.2 in “Everything goes together on this site”, 5.2 in “Layout appears well structured”)
- **Windows Media Player** (mean value 6.0 in “Layout is Easy to Grasp”, 5.0 in “Everything goes together on this site”, 5.5 in “Layout appears well structured”)

Observations of interfaces of those music players and subjective evaluation of contents revealed common patterns in the design complexity of all those applications. Three of four player interfaces share almost identical composition patterns of 4-block symmetrical composition.

It includes two information columns on left and right with a central block that is divided to upper block and central block. In case of iTunes right upper block is absent and interface has light 3-block composition.

It is necessary to mention that each block is dedicated to a certain functionality which might help user to learn application faster, memorize distribution of interface data easier and come to an understanding of overall functionalities of interactive application.

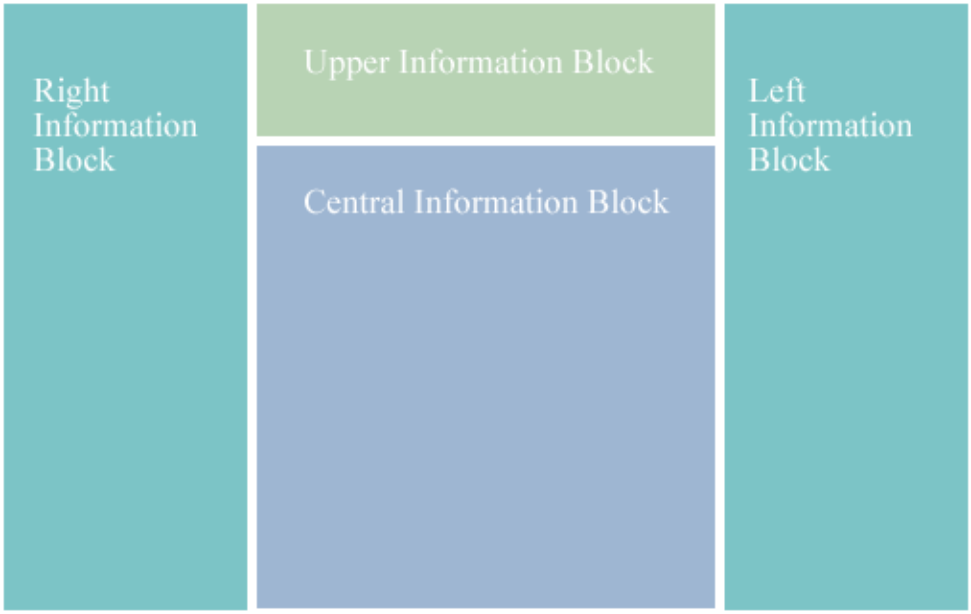

Figure 1 Example of information 4-block positioning on interface screen

This observation also confirmed by observation of eye-tracking videos that revealed, that majority of participants concentrated their gaze on upper left corner and central part of the screen (12 cases for upper left, 16 for central part of the screen), with also some attention to upper right side as well (5 gazing cases in total).
This phenomena might be explained with cultural sinistrodextral reading pattern, when process of reading a book is started from left to right, from up to down — so even outside the reading context the person is tacitly ready to consume information on the screen beginning the same "starting point".

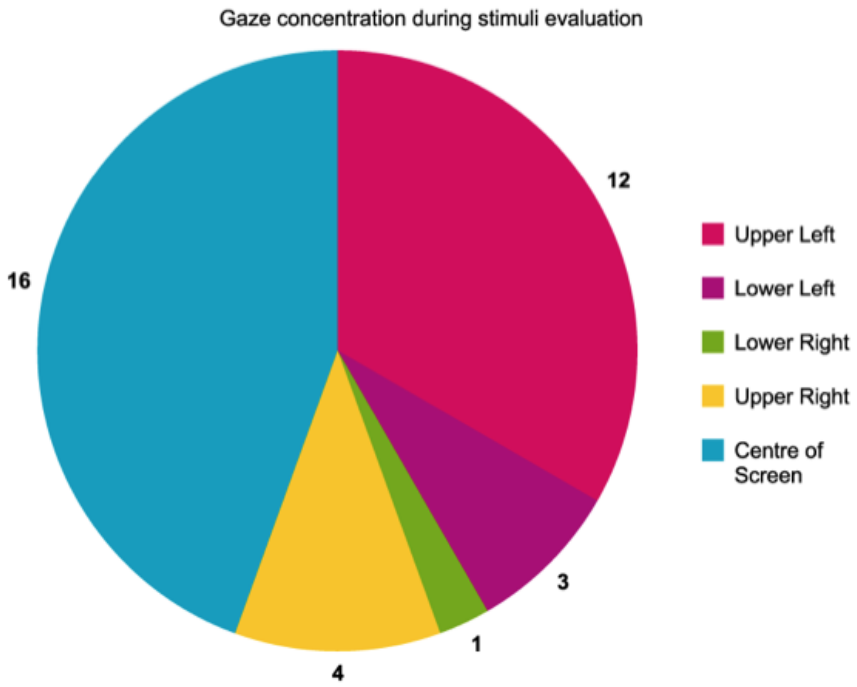

Figure 2 Gaze concentration distribution during evaluation of stimuli

This particular habit, combined with mentioned earlier 4-block composition principle, can be used by designers to engage application end-user with the product as soon as possible by placing relevant information, general menus and functionalities to those particular areas of the screen and dividing them to functional blocks.

Design Recommendation for Complexity and Composition:

1. It can be advised to split data accordingly to the sub-section depending on functionalities and arrange it to information blocks on interface. It is best to avoid using abundant number of blocks, limiting maximum to 3 or 4.
2. It is recommended to use balanced, symmetrical composition. Some objects are beautiful not merely because of their surface properties or their formal structure but because of their absolute size, or their scale.(McManus I.C., Weatherby Y. 1997) Compositions with deliberate asymmetry in scaling is recommended to be used within Da Vinci's "golden ratio" (Figure 17). In this research, iTunes player is an appropriate example of 3-block composition.

3. It might be rational to place relevant information and basic functions of applications within central and left areas of the screen, as the study showed high share of gaze concentration in these two screen sections. All secondary information suggested to be placed to the right side of the application interface since it has proven to gain some attention as well.

   It is recommended to avoid placing relevant information to the bottom of the screen since this area attracts very little attention of the user. The exception can be made in case there is existing design tradition of placing certain elements to the bottom of the interface (e.g. most players in the selection had "Play" button in the bottom of the interface since it's common design practice of music players)

7.1.2. Diversity

"Diversity facet comprises dynamics, novelty, and creativity. The psychobiological theory on aesthetics (Berlyne, 1971) posits that complexity and novelty are collative variables that determine the arousal potential of a stimulus. A stimulus that is merely simple is perceived as boring, because it results in a low arousal and eventually in a negative aesthetic response. Diversity counteracts low arousal by provoking interest and tension (Hekkert and van Wieringen, 1990; Hekkert et al., 2003) and is therefore an important component with respect to the aesthetic appraisal of websites."

Moshagen M. and Thielsch M.T. (2010)

Highest scores of value of VisAWI "Diversity" facet during players evaluation have received four Music Players. Mean values of questions addressing positive design characteristics on a score table from 1 to 7 were taken to select players with highest (mean above 4.5) score:

- **Spotify** (4.6 in "Layout is pleasantly varied", 5.6 in "Layout is inventive", 5.6 in "Layout appears dynamic")
- **iTunes** (4.4 in "Layout is pleasantly varied", 4.6 in "Layout is inventive", 4.8 in "Layout appears dynamic")
- **MusicBee** (4.4 in "Layout is pleasantly varied", 4.0 in "Layout is inventive", 5.5 in "Layout appears dynamic")

Observations of interfaces of those music players and subjective evaluation of contents revealed common patterns in the design diversity of some of mentioned applications.

Certain pattern can be traced regarding contrast and tonal accents — most players in this selection have at least one contrast color in their interface:

- **Spotify** — contrasting warm green details in interface buttons, banners and icons.
- **iTunes** — spots of blue for accentuating active interface items such as pressed buttons etc.
- **MusicBee** — spots of blue for accentuating active interface items, colorful icons on the left panel of interface

Players that got the lowest rating during 1st impression evaluation — are mostly executed in soft, non-intensive and colourless manner, without any distinctive color accents used or tonal contrasts, which also contributes to the overall presumable color-diversity pattern.
It is also worth mentioning that during the study experiment, several participants verbally expressed their approval of color use.

Second distinctive feature which can be seen as a pattern is use of illustrative material in interface, such as CD-album covers, cover art, background art and logo mascot characters.

It is important to note that illustrative content takes up to 5-8% of total interface area, which helps to keep a balance between tasteful design and diversity of interface that is pleasant to spectators' eye. Examples of illustrative visual elements in player interface are given below:

- **iTunes** — uses cover art as an icon in upper panel of the interface.
- **Spotify** — uses cover art at the left panel on the screen and illustrated live feed on the right panel of the interface. Spotify is the most illustrated player of the overall selection.
- **MusicBee** — uses appealing mascot of a bee in the application logotype and identity. Uses cover art in the right section of the screen.

Design Recommendation for Design Diversity:

1. It might be useful to include a visual element into interface that will add some additional context to interactive application content and contribute to an emotional, entertainment aspect of the interface. In order not to overload the interface with decorative data, it is recommended to limit use of illustrative elements up to 8%.

   Illustrative visual elements can be: an illustration, a logo, contextual photo. Advertising banners cannot be considered as decorative elements since their visual appearance on interface has random nature and they often don't go together with general design.

2. It is advisable to use color accents in application interface yet to limit use of contract and vivid tones to one single color theme for entire design.

3. It is recommended to use contrast accents in application graphic design to raise the perceived interface diversity, evoke positive arousal and emotional response towards application interface.

7.1.3. Colourfulness, Color Schemes and Tonal Combinations

"Wide agreement exists concerning the unique effect of colors and their composition on aesthetic appraisal in general (Arnheim, 1974; Kawabata and Zeki, 2004; Martindale and Moore, 1988; Solso, 2003) and with respect to the design of websites in particular (Cyr et al., 2010; Hall and Hanna, 2004; Hoadley, 1990; Moshagen et al., 2009). Accordingly, this facet taps aesthetic impressions stemming from the selection, placement, and combination of colors."

Moshagen M. and Thielsch M.T. (2010)

No statistically significant correlation was revealed after data processing between UX and VisAWI aesthetic facet of "Colorfulness".

As stated in the Discussion chapter, this lack of correlation is likely to occur because most of the players shared similar color palettes based on a combinations of different shades of grey, black and white. Thus, color-wise, players weren't diverse enough to reveal any statistically significant correlations of color dimension and User Experience.

In the context of possible future development of given study it can be suggested to arrange more diverse selection of players and repeat the experiment, in order to be able to evaluate this dimension once again and explore possible positive correlations once again.

No Design Guidelines for Colorfulness is to be given at this stage of research.

7.1.4. Craftsmanship

"Craftsmanship can be characterized as the skillful and coherent integration of all relevant design dimensions. A website needs to be harmoniously designed and the artistic ideas need to be implemented with skill and care. From an art-historical perspective, Engholm (2002) describes different schools of style in web design and also points to their dependencies on available technologies. Website design is an area of rapid development and continuously changes as technology progresses (Ivory and Megraw, 2005). Therefore, it may also be necessary that websites are based on modern technologies to avoid the impression of being outdated."

Moshagen M. and Thielsch M.T. (2010)

Highest scores of value of VisAWI "Craftsmanship" facet during players' evaluation have received two Music Players. Mean values of questions addressing positive design characteristics on a score table from 1 to 7 were taken to select players with highest (mean above 4.5) score:

- **Spotify** (mean value 5.8 in "Professionally Designed" field, 5.6 in "Designed with Care")
- **MusicBee** (mean value 5.7 in "Professionally Designed" field, 5.2 in "Designed with Care")
- **iTunes** (mean value 5.6 in "Professionally Designed", 6.0 in "Designed with Care")

The most distinctive feature of those two applications that they share several functionalities which is accordingly reflected in visual application interface. Besides being a music player, both applications offer an additional features such as being a music store or a radio.

We might suggest that this level of technological integration gives viewer the impression of high quality product, professional craftsmanship and overall satisfaction of using contemporary and modern digital artifact.

Design Recommendation for Craftsmanship:

1. Since interactive applications are inevitably connected and, in some sense, dependent on technological progress and appearances are often judged by correspondence to this aspect, it can be recommended to use modern technologies that contribute to the overall experience of use as well as to the aesthetic perception of application interface.
2. It is best to avoid using outdated technologies that give an impression of behindhand aesthetic perception of the designer and affect pleasure of use as well as perception of aesthetic component of the interface.

7.1.5. Classical Aesthetics

Classical aesthetics embody the notion of traditional beauty and it's perception in a traditional sense, meaning that it mostly addresses the attributes of cleanliness, symmetry, simplicity and attractiveness of design. These notions emphasize orderly and clear design and are closely related to many of the design rules advocated by usability experts (Tractinsky N., Lavie T. 2003).

Highest scores of value of "Classical Aesthetics" segment (included to VisAWI questionnaire for the sake of richer results and gaining more data) during players evaluation have received four Music Players. Mean values of questions addressing positive design characteristics on a score table from 1 to 7 were taken to select players with highest (mean above 4.5) score:

- **iTunes** (mean value 5.8 in "Clean Design" field, 5.6 in "Aesthetic Design", 6.0 in "Pleasant Design", 4.6 in "Symmetric Design")
- **MusicBee** (mean value 4.5 in "Clean Design" field, 5.7 in "Aesthetic Design", 5.7 in "Pleasant Design", 6.1 in "Symmetric Design")

- **Spotify** (mean value 5.5 in “Clean Design” field, 5.4 in “Aesthetic Design”, 5.6 in “Pleasant Design”, 5.4 in “Symmetric Design”
- **MediaMonkey** (mean value 5.5 in “Clean Design” field, 4.8 in “Aesthetic Design”, 4.0 in “Pleasant Design”, 6.0 in “Symmetric Design”)

Most of players listed above use simple and non-decorative system fonts — such as Arial, Verdana, Georgia or Times New Roman. These fonts have also proven to be are the most common fonts of their respective font type used today (Bernard, M., Hui Liao C., Mills, M. 2001).

Players that had most correlation between aesthetic appearance and UX haven’t been using fonts smaller that 12-point size, some of interfaces leaning towards 14-point lettering (e.g. SoundCloud).

For higher accessibility it is recommended to use font size of 12- and 14-points. Style wise it is advisable to select sans serif styles, since users tend to lean towards san serifs in terms of aesthetic preferences (Bernard, M., Hui Liao C., Mills, M. 2001).

Players with high level of contrast between letters and background color (e.g. dark background and bright letters or vice versa) revealed to have higher index of aesthetic value, than players with low level of contrast between lettering and application background (e.g. light grey background and dark gray letters). Additionally, during verbal evaluation of tested applications, participants shared an opinion that low level of contrast complicates reading and therefore slows task completion process.

Design Recommendation for Classical Aesthetics:

1. It is recommended to user simple and classical font garnitures which have proven to enable faster reading and information consumption. Such are: Arial, Verdana, Helvetika, Georgia or Times New Roman.
2. Recommended size for headlines and highlighting primary information of the interface are 12- and 14-point letters since they improve accessibility of the interface. (Bernard, M., Hui Liao C., Mills, M. 2001)

3. It is common design practice to use Sans Serif fonts for interfaces, especially when designing for mobile applications. San serifs are also appeared to be more appealing in terms of aesthetic preferences (Bernard, M., Hui Liao C., Mills, M. 2001).
4. It is advisable to place all secondary information to the application drop on menus, in order not to overload interface first screen. This practice helps to achieve so-called visual "cleanliness" and improves organization and accessibility of interface.

7.1.6. Expressive Aesthetics

Expressive aesthetics address creativity, novelty and original approach to design and has developed and formed during couple of last centuries. Its distinctive trait is more liberal approach to design attributes and intentional breaking of the design conventions. It corresponds to "visual richness" dimension (Nassar, 1999, cited by Tractinsky & Lavie, 2003) and "diversity" (Moshagen & Thielsch, 2010) that in Tractinsky's and Lavie's model refers to the following website attributes: creative, using special effects, original, sophisticated, and fascinating.
In other words expressive aesthetic approach is freer of conventions and limits of classical aesthetics and has a great deal of exploratory attitude.

Despite quite sound description of the concept, some participants struggled with understanding of the "Expressive Aesthetics" definition and questionnaire questions, so this might have affected the overall evaluation of the stimuli and all players in this aspect were given lower rating than in others.

Highest scores of value of "Expressive Aesthetics" segment (included to VisAWI questionnaire for faster processing of data) during players evaluation have received two Music Players. Mean values of questions addressing positive design characteristics on a score table from 1 to 7 were taken to select players with highest (mean above 4.5) score:

- **iTunes —** (mean value 5.3 in "Creative Design" field, 4.8 in "Sophisticated Design", 4.6 in "Original Design", 4.2 in "Fascinating Design")
- **Spotify —** (mean value 4.8 in "Creative Design" field, 4.6 in "Sophisticated Design", 5.0 in "Original Design", 4.4 in "Fascinating Design")

When dealing with multifunctional and complicated interfaces it is important to build informational architecture of application wisely and introduce user with most relevant information by positioning it on initial work screen. Additional or secondary functionalities are commonly placed into drop menus.
One of the creative approaches to address this has evolved during last few decades and is based on presentation of information via metaphors also known as interface pictograms or interface "icons". This approach helps to eliminate such common problems as reading issues, dyslexia, cultural language barriers etc. and makes information more accessible and visible on application interface.

Most players in study selection proved this design principle to be valid based on example of two basic music player's functions: "Repeat" and "Shuffle" options. Instead of representing this two concepts as words in secondary drop menu, there were graphical pictograms placed on user interface, in other words, symbols — a subgroup of artifacts that carry a special function: to be used for representation, communication and storage of a certain knowledge or information (Peschl, M., Stary, C. 1998).

It's a common practice in ICT to replace words with pictures that carry similar semantics and almost all music players of study selection followed the same principle, making understanding of concepts intuitive and fast.

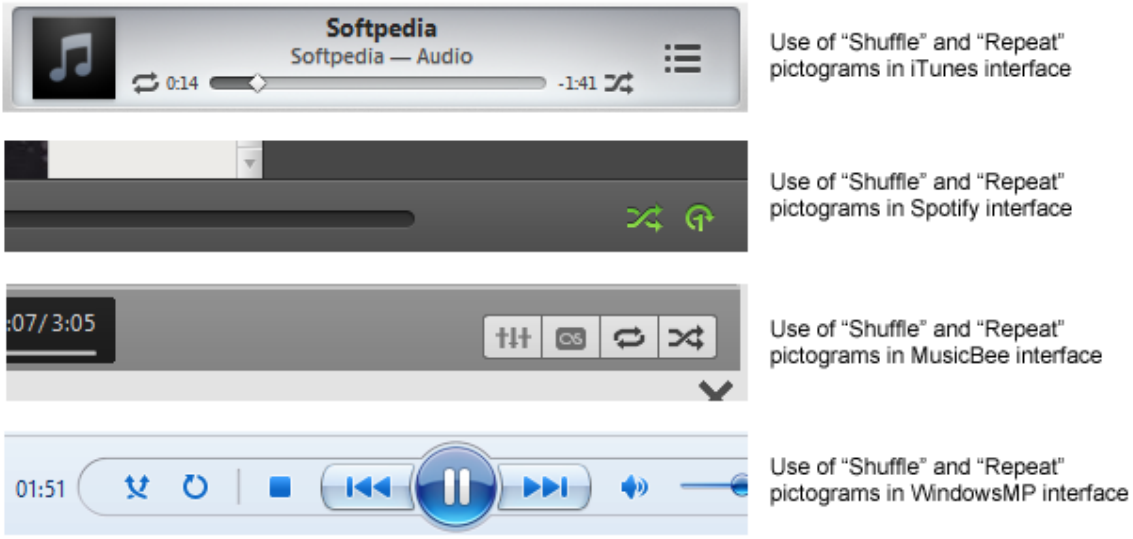

Figure 3 Location of "Shuffle" and "Repeat" pictograms in some of music players

Design Recommendation for Expressive Aesthetics:

1. It is advisable to use pictograms and visual metaphors for better representation of relevant information on the application interface. Visual metaphors can contribute to rational functionalities of interface as well as make it more expressive and visually reach in terms of aesthetic perception.
2. To address the novelty and creativity in the design, it is recommended to follow, study and implement latest design trends as they reflect latest discoveries in the field.

7.2. Future work

This exploratory study made an initial step in developing such practical guidelines and, with future investment of time and effort for more profound and detailed studies, it has a potential of being developed into solid design framework.

Despite the fact that this particular study was unable to make a lot of use from all the collected data from biometric sensors and psychophysiological measures, there still can be seen some existing potential for those tools. This, of course, implies altering the study accordingly to technological requirements of sensors and re-evaluating the choice of tools and sensors.

Results of this particular study could benefit from validated with larger sample of test users and additional set of objects for testing. This would ensure significance of initially revealed correlations between aesthetics and interaction qualities.

Since biometric tools used in this particular settings has proven to be not effective or too complicated, it is not possible to recommend them for use in future work. Yet, some methodologies and tools has demonstrated great share of efficiency and therefore can be used in further studies.

Those are:

1. For evaluating UX

a. SUS questionnaire.
b. Question about pleasure of use.

2. For evaluating Aesthetics

c. Question about first impression aesthetics.
d. VisAWI, Classic and Expressive aesthetics questionnaire.

3. For evaluating pragmatic usability.

e. Eye-tracking.
f. Screen recording.
g. Task to time.

There are certain methodologies that weren't used for this particular study yet could be used in future experiments as study enhancing components. Adding expert opinion as personal evaluation of application interface, also known as interface criticism (Bertelsen, O., & Pold, S., 2004), could be one of those suggested tools, although it demands a certain amount of previous knowledge and expertise in area of visual arts or possession of artistic education.

This exploratory work forms a basis for future discussion of bridging a distinct field of interactive design in ICT, User Experience and aesthetics. Also it establishes a fundament for future development of a set of recommendation for potentially improving interface design of interactive applications that this study has begun to compose.

Summary (in Russian)

Целью данной дипломной работы является установка наличия связи и корреляции между опытом пользователя и эстетической составляющей интерфейся интерактивных приложений.

Гипотеза дипломной работы состоит в том, что опыт пользователя и эстетика интерфейса взаимосвязаны. Если в ходе эксперимента данная гипотеза будет подтверждена — интерактивные приложения набравшие максимальный индекс корреляции, будут проанализированы для выявления тенденций графического характера, которые могут позитивно влиять на конечный опыт пользователя. На базе этого анализа будет составлен список рекомендаций для интерактивных дизайнеров и в отрасли информационных технологий в целом.

Для данного исследования был разработан уникальный эксперимент, объединяющий в себе различные методики, такие как: аппарат измерения взгляда пользователя, опросники для установления опыта пользователя и первого впечатления от интерфейса, физические устройства для забора биометрических данных и тд. Это сочетание метрик используется для подобного рода эксперимента впервые и является исследовательским и пробным шагом.

После анализа полученных данных было установлено, что биометрические сенсоры способны собрать большой объем информации, однако, эта информация не дает точной картины эмоционального состояния пользователя из-за большого процента внешнего шума и, как следствия, слишком большой погрешности для последующего анализа данных. Позитивным результатом биометрических замеров можно считать безперебойную работу техники и сбор значительного количества данных от каждого участника эксперимента.

Однако, анализ видеозаписи участников эксперимента, записи с аппарата для измерения взгляда пользователя и опросников дали достаточное количество данных для последующей статистической обработки данных и подтвердили гипотезу данной дипломной работы.

Таким образом, гипотеза о корреляции между опытом пользователя и эстетической составляющей интерфейса интерактивных приложений была подтверждена. В ходе поробного статистического анализа корреляций между эстетическими аспектами и позитивным опытом пользователя, было выявлено 5 значительных корреляций, на базе которых был разработан свод рекомендаций для визуального оформления интерфейсов интерактивных приложений, призванный способствовать в работе дизайнера для улучшения опыта пользователя.

Данная работа носит исследовательский характер и является первым, пробным шагом, призванным сблизить разрозненные области интерактивного и графического дизайна.

В заключении перечислены предложения по улучшению дальнейших экспериментов в этой области и потенциальные способы для развития исследовательской деятельности данного направления.

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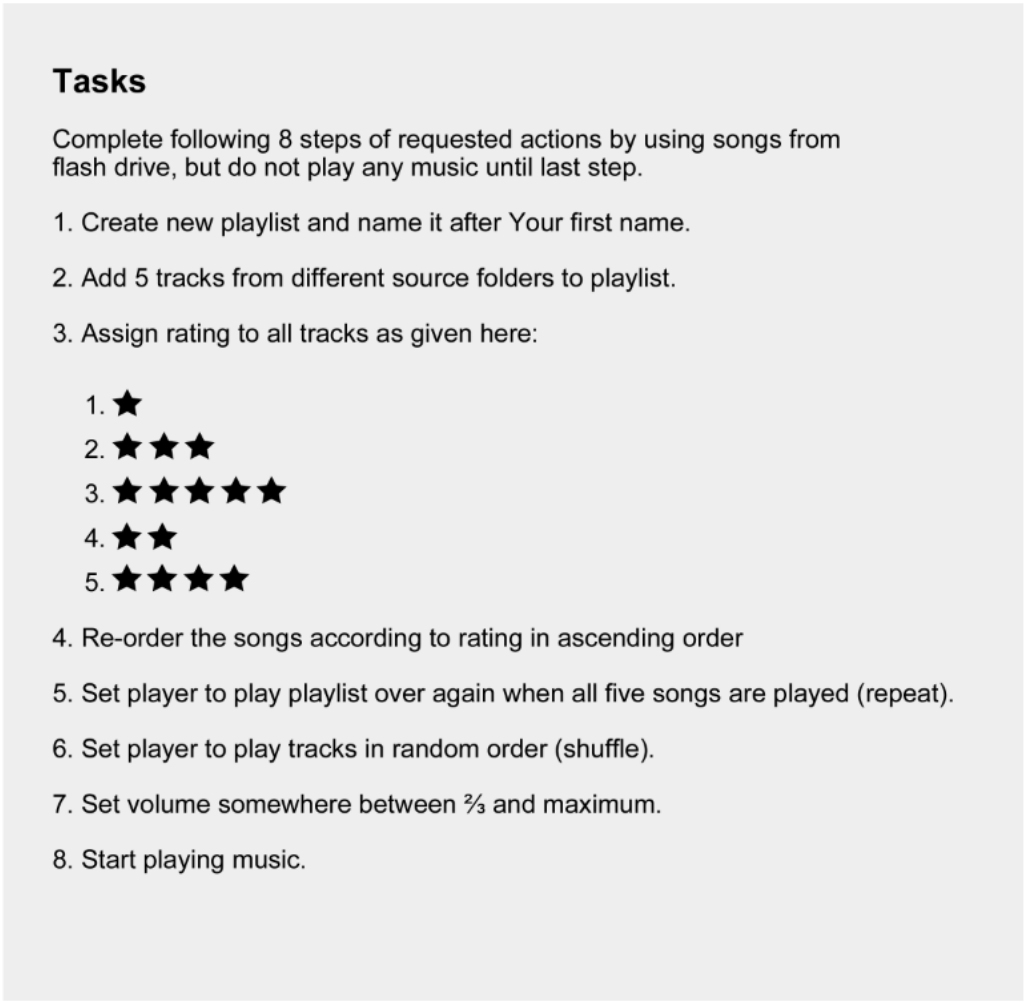
Appendices

Appendix A



Tasks

Complete following 8 steps of requested actions by using songs from flash drive, but do not play any music until last step.

1. Create new playlist and name it after Your first name.
2. Add 5 tracks from different source folders to playlist.
3. Assign rating to all tracks as given here:
    1. ★
    2. ★★★
    3. ★★★★★
    4. ★★
    5. ★★★★
4. Re-order the songs according to rating in ascending order
5. Set player to play playlist over again when all five songs are played (repeat).
6. Set player to play tracks in random order (shuffle).
7. Set volume somewhere between ⅔ and maximum.
8. Start playing music.

Appendix A.1 Experiment Task Script (English)

Ülesanded

Järgnevad 8 punkti aitavad Sul eksimata ülesannet täita.
NB! Ära pane enne seadistuste lõppu ühtegi laulu mängima..

1. Loo programmi tarvis endanimeline playlist või kaust.
2. Lisa playlisti 5 erinevas stiilis laulu.
3. Lisa lauludele reiting:
    1. ★
    2. ★★★
    3. ★★★★★
    4. ★★
    5. ★★★★
4. Järjesta laulud reitingu järgi.
5. Seadista pleier programmi automaatselt uuesti esitama.
6. Sea pleier mängima laule juhuslikus järjestuses.
7. Seadista helitugevus ⅔ ja maksimaalse vahele.
8. Pane programm mängima.

Appendix A.2 Experiment Task Script (Estonian)

List of Figures and Tables

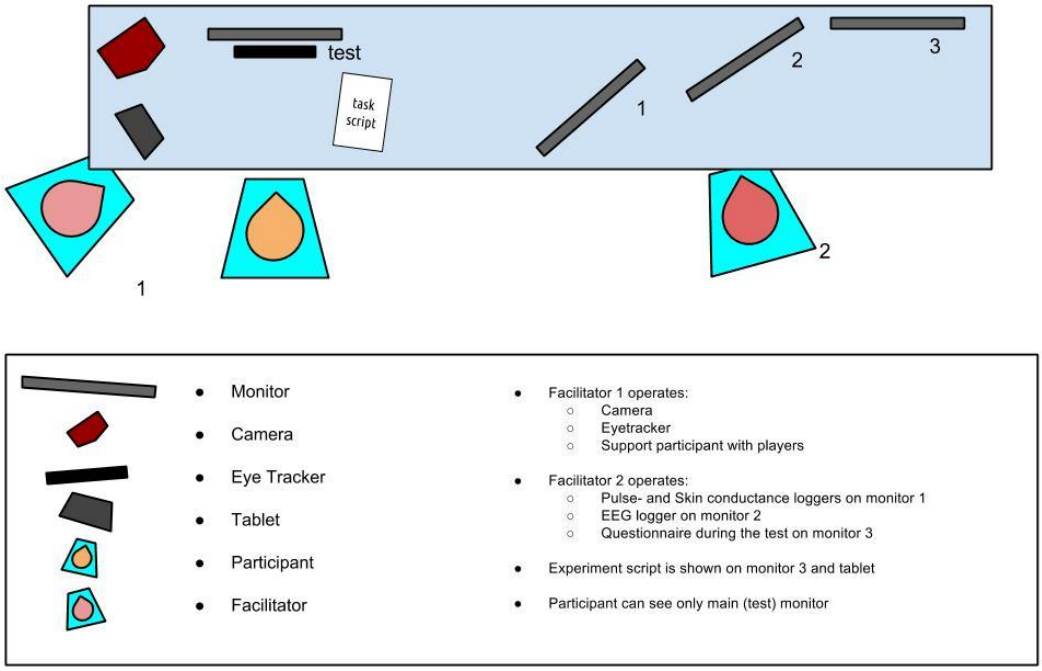


Figure 4 The experiment venue set up

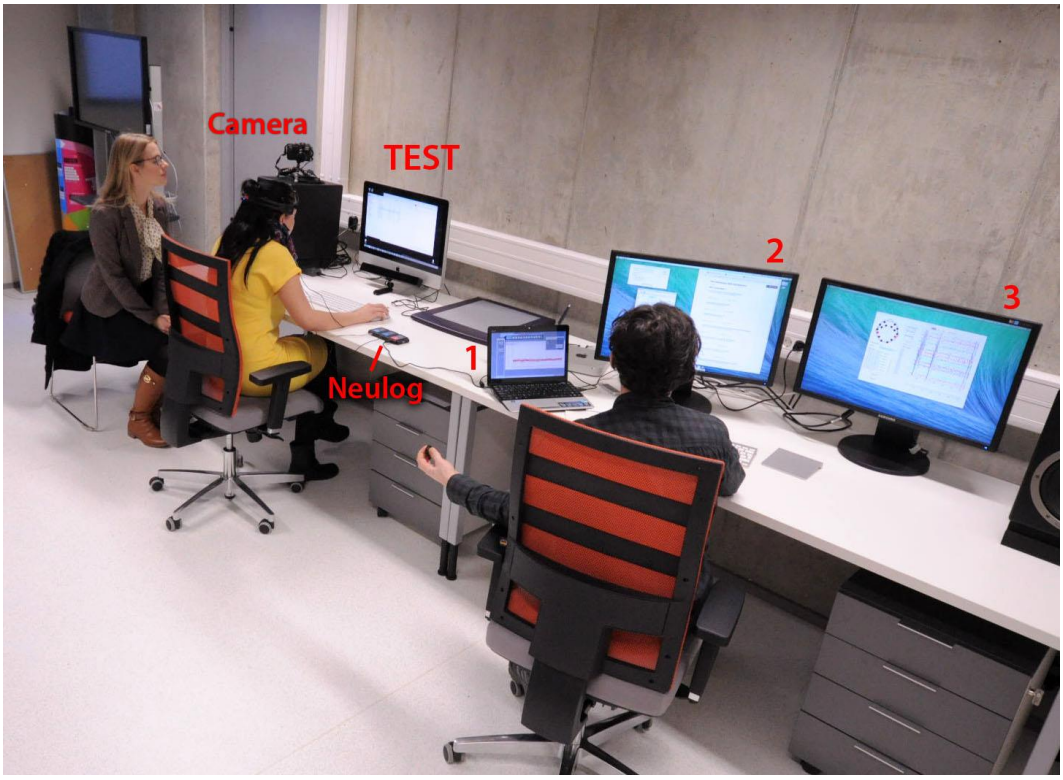


Figure 5 Study setup

- Separate computer was set up for completing VisAWI questionnaire after main study. Used music players were available for reviewing on large screen on background (Figure 3).

Figure 6 Separate working place for conducting VisAWI questionnaire

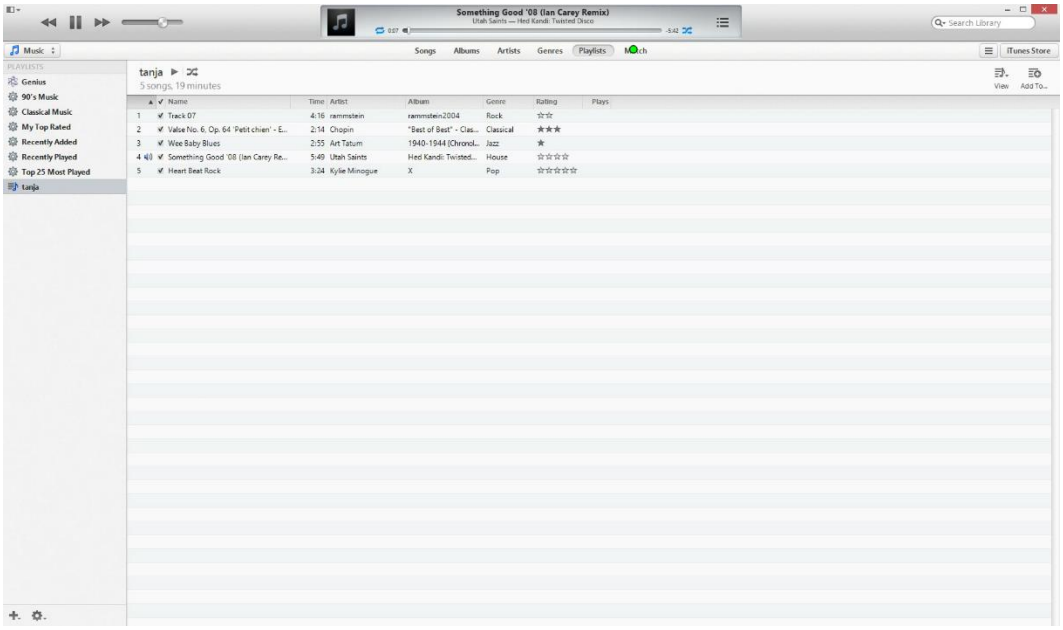


Figure 7 iTunes Player default interface

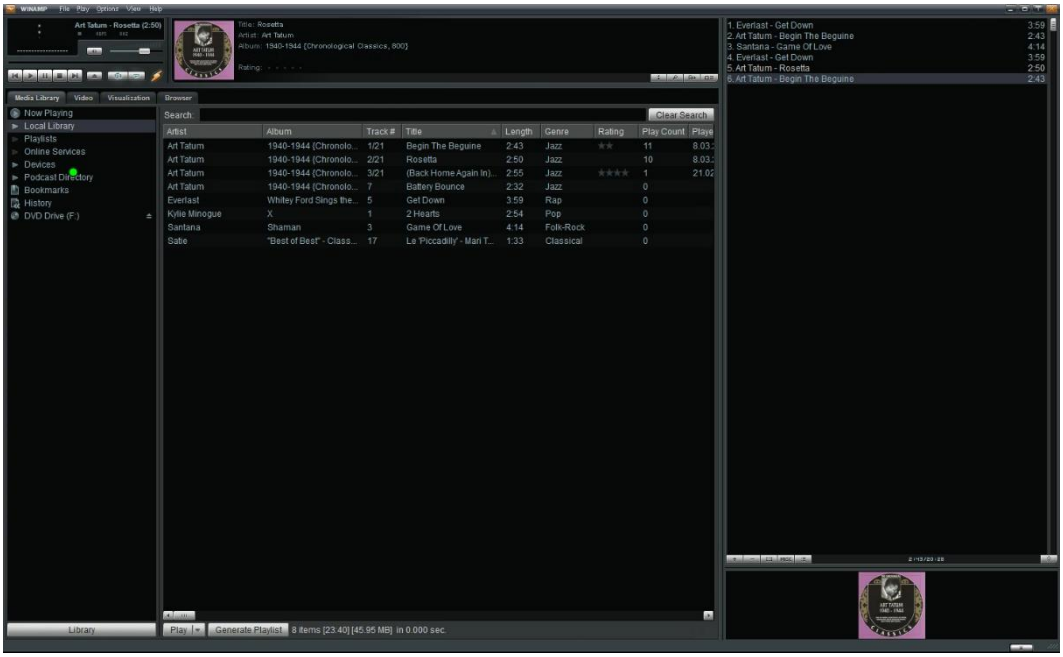


Figure 8 Winamp Music Player default interface

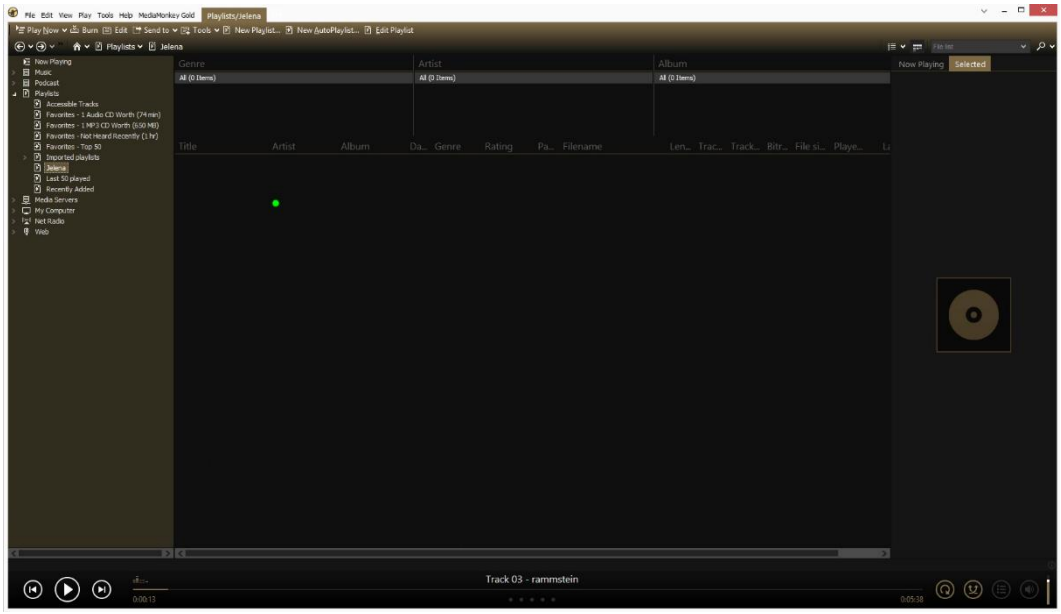


Figure 9 MediaMonkey Music Player default interface

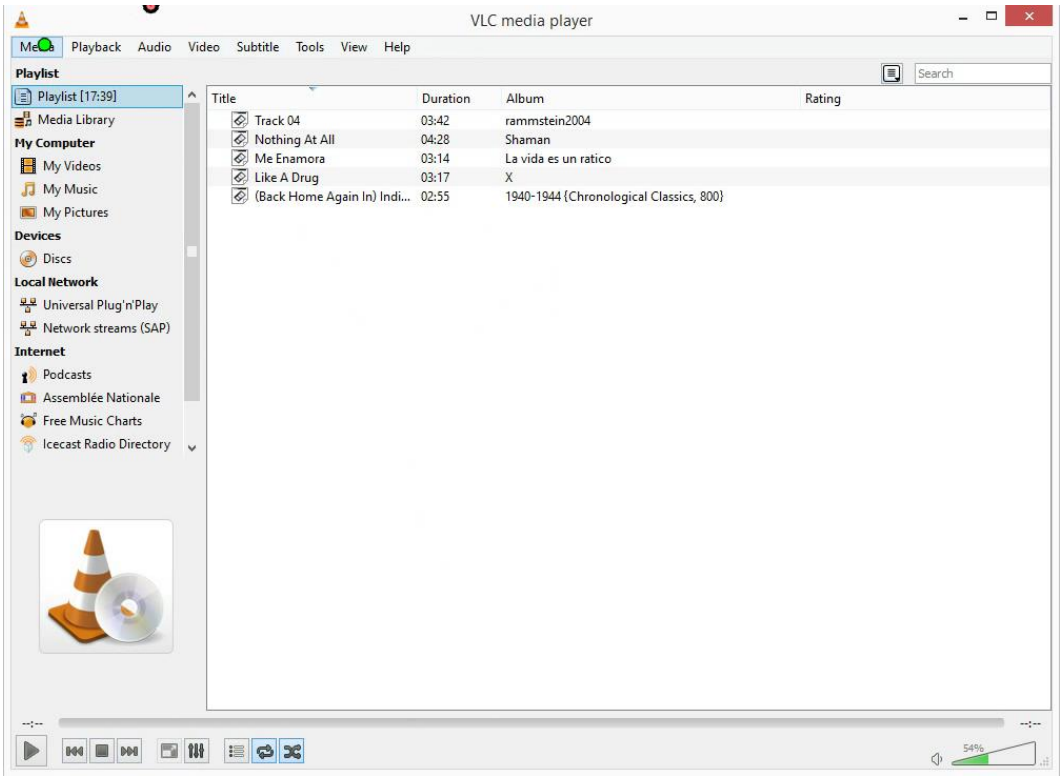


Figure 10 VLC Music Player default interface

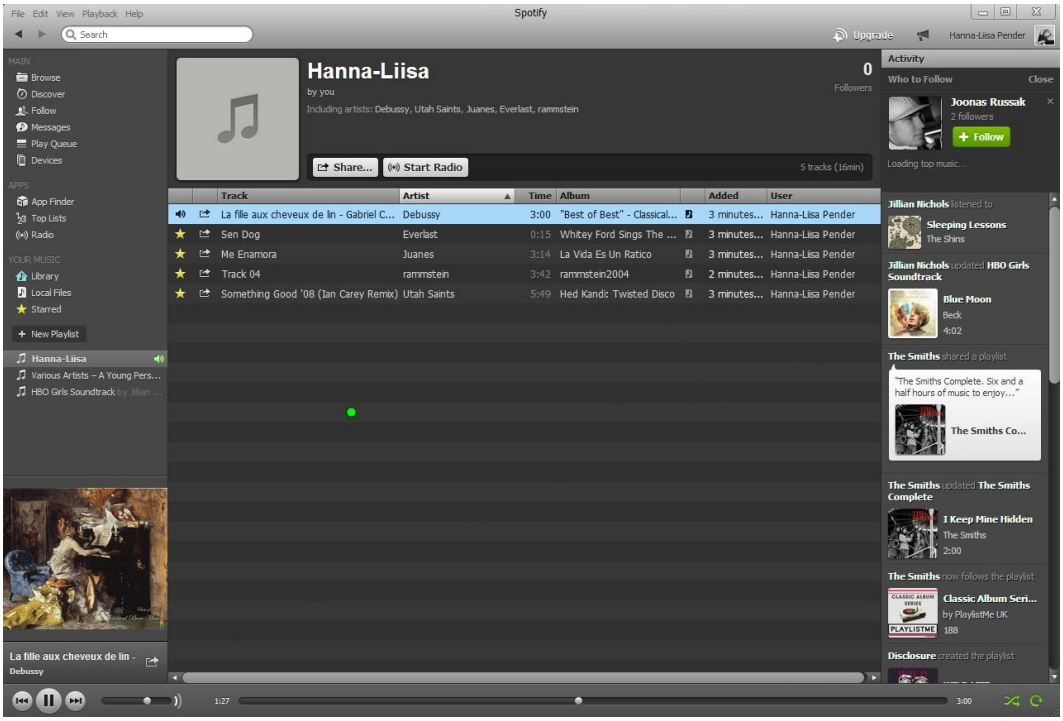


Figure 11 Spotify Music Player default interface

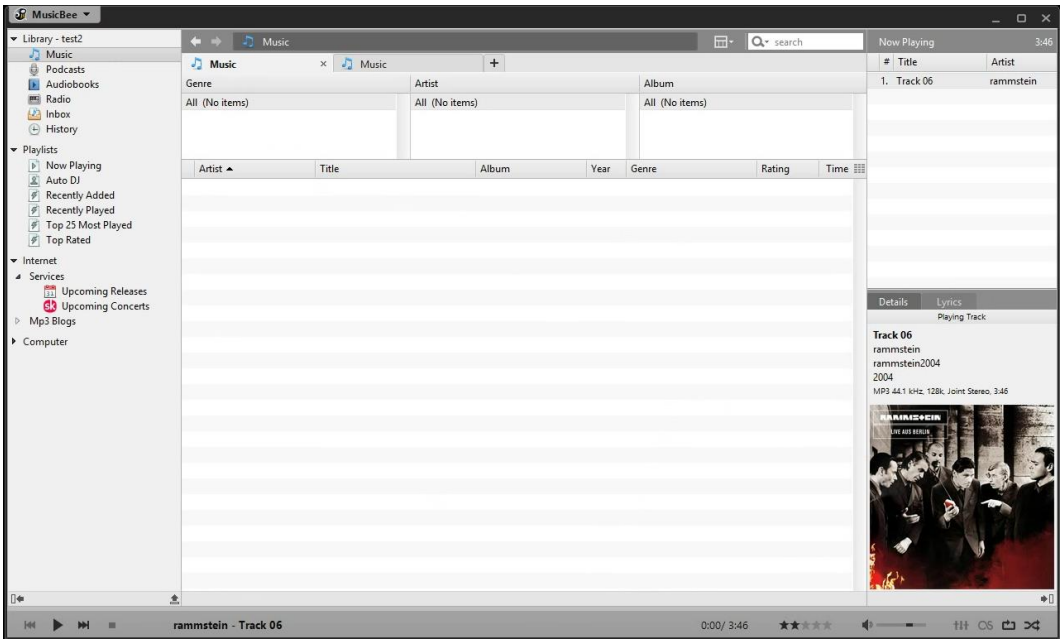


Figure 12 MusicBee Player default interface

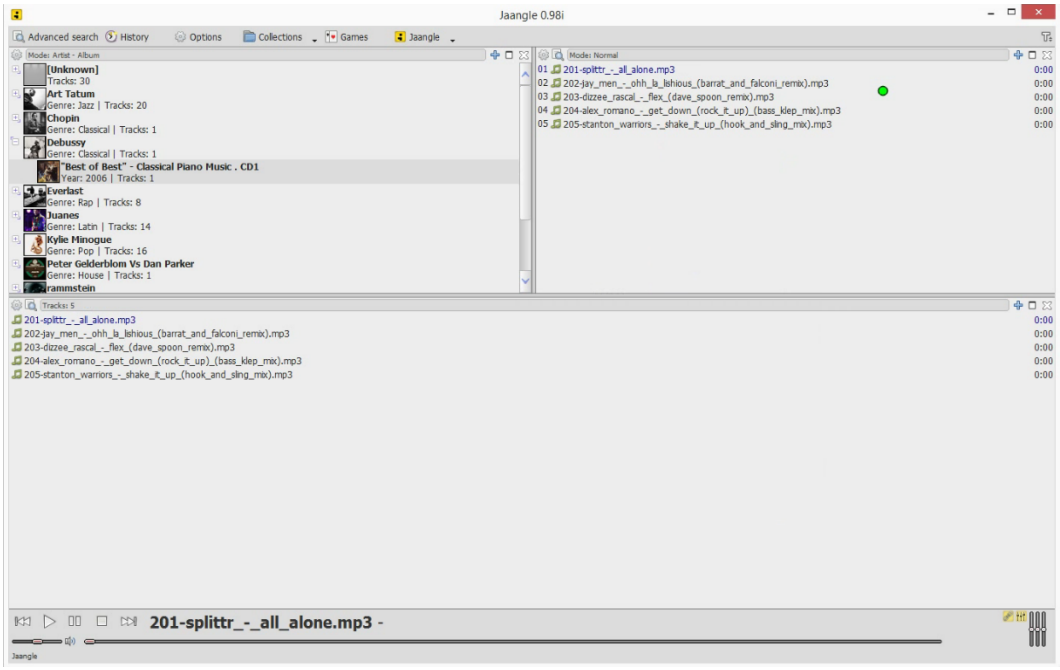


Figure 13 Jaangle Music Player default interface

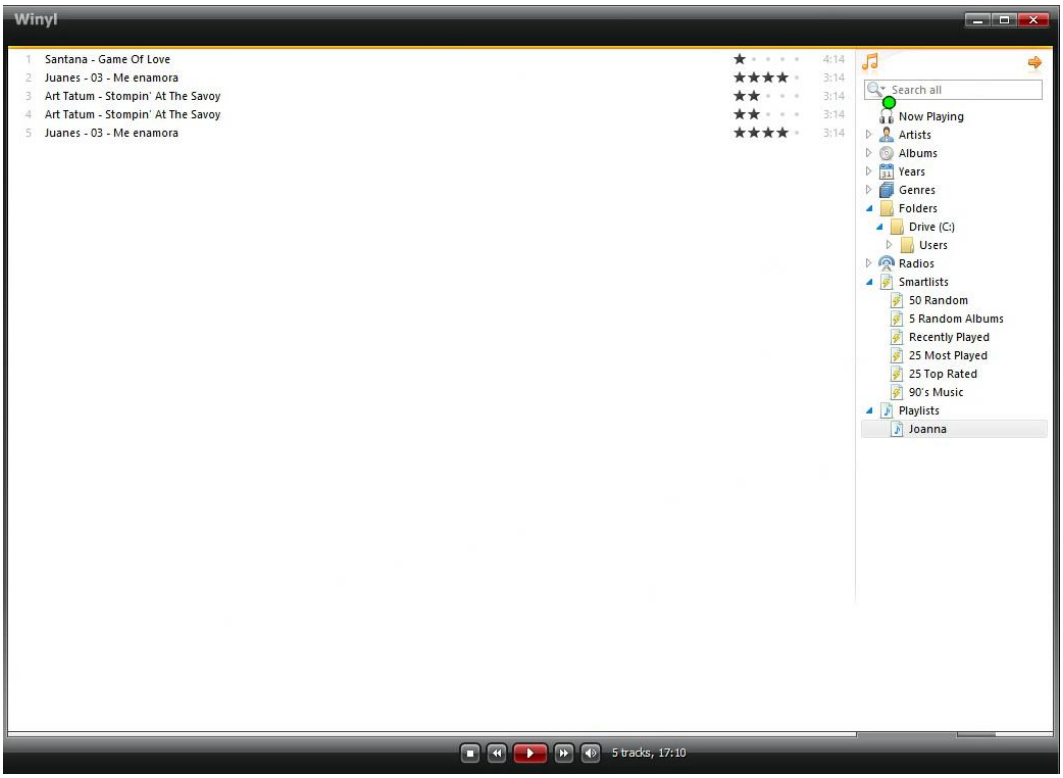


Figure 14 Winyl Music Player default interface

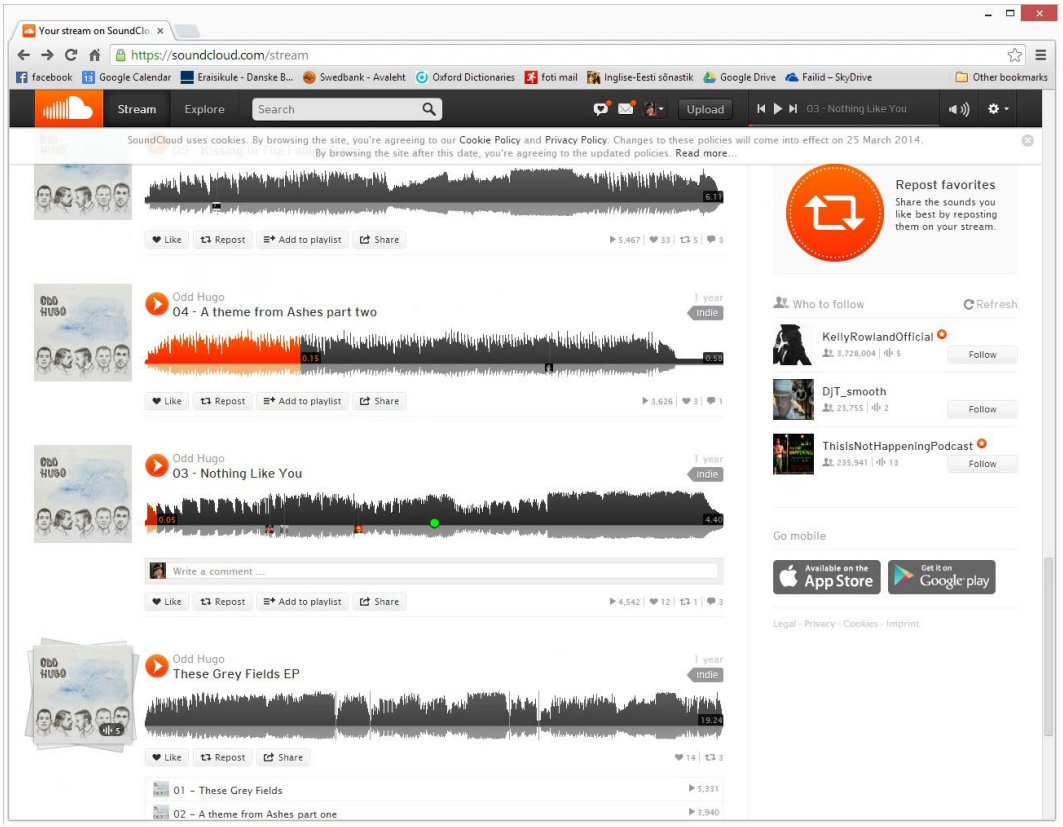


Figure 15 SoundCloud Music Player default interface

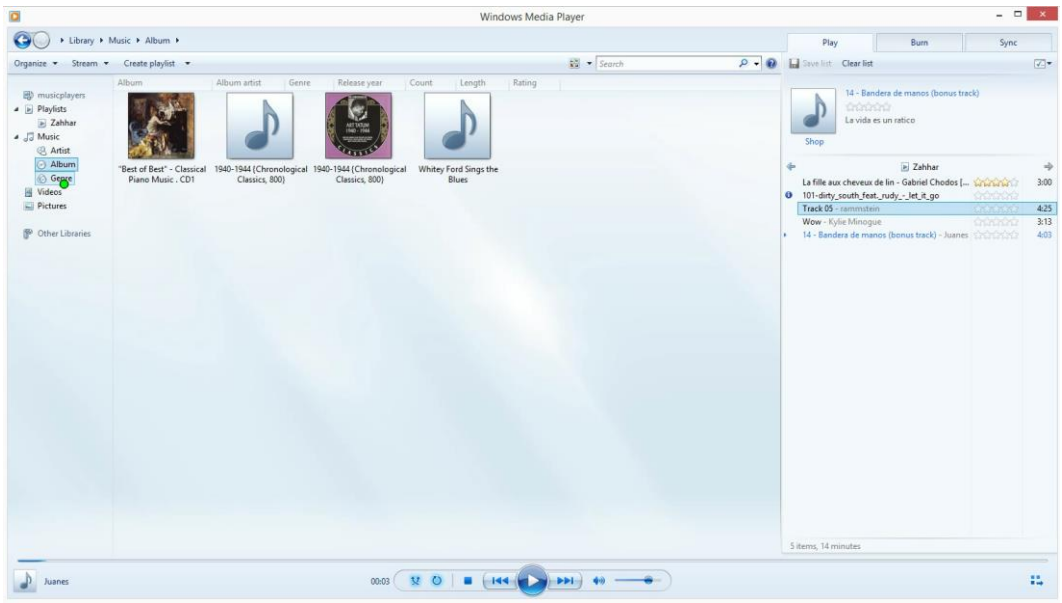


Figure 16 Windows Media Player default interface

- In mathematics, two quantities are in the golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities. Line segments below demonstrate the principle and proportions of the golden ratio.

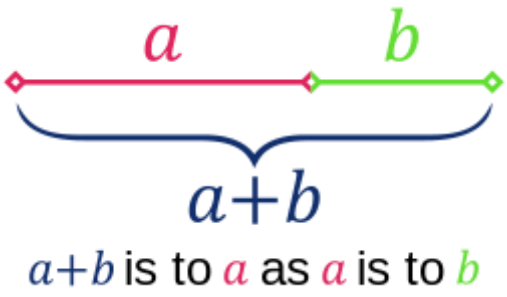


Figure 17 Golden Ratio principle

- User's gaze and the level of concentration in one particular spot is mapped differently when using eye-tracking. The bigger red dot radius is — the more intensive is user's gaze. (Figure x).

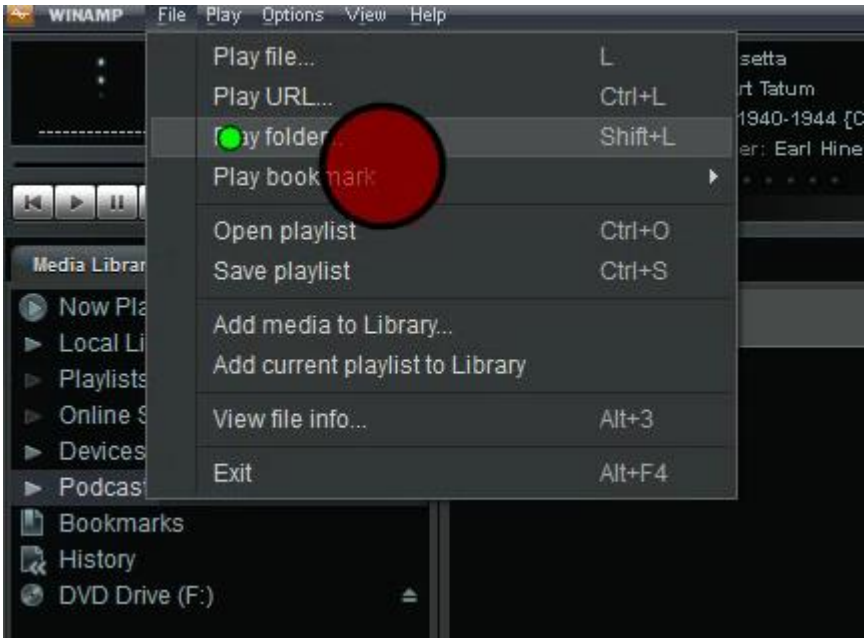


Figure 18 Visualization of gaze concentration on application menu during eye-tracking session

Correlations		First impression	pleasure of use								
		This music player looks nice!	I was pleased to use this player	complexity	diversity	colorfulness	craftsmanship	classical_aes	expressive_a	SUS_value	overall_aesth
This music player looks nice!	Pearson Correlation	1	,580**	,514**	,656**	,698**	,768**	,744**	,585**	,449**	,819**
First aesthetic impression	Sig. (2-tailed)		0	0.001	0	0	0	0	0	0.008	0
	N	40	40	40	40	40	40	40	40	34	40
I was pleased to use this player	Pearson Correlation	,580**	1	,463**	,562**	,516**	,570**	,470**	,478**	,785**	,632**
Pleasure of use	Sig. (2-tailed)	0		0.003	0	0.001	0	0.002	0.002	0	0
	N	40	40	40	40	40	40	40	40	34	40
complexity	Pearson Correlation	,514**	,463**	1	,347*	280	,684**	,700**	,386*	,484**	,685**
VisAWI facet	Sig. (2-tailed)	0.001	0.003		0.028	0.08	0	0	0.014	0.004	0
	N	40	40	40	40	40	40	40	40	34	40
diversity	Pearson Correlation	,656**	,562**	,347*	1	,542**	,622**	,631**	,801**	,427*	,822**
VisAWI facet	Sig. (2-tailed)	0	0	0.028		0	0	0	0	0.012	0
	N	40	40	40	40	40	40	40	40	34	40
colorfulness	Pearson Correlation	,698**	,516**	280	,542**	1	,655**	,572**	,488**	,331	,737**
VisAWI facet	Sig. (2-tailed)	0	0.001	0.08	0		0	0	0.001	0.056	0
	N	40	40	40	40	40	40	40	40	34	40
craftsmanship	Pearson Correlation	,768**	,570**	,684**	,622**	,655**	1	,814**	,641**	,507**	,909**
VisAWI facet	Sig. (2-tailed)	0	0	0	0	0		0	0	0.002	0
	N	40	40	40	40	40	40	40	40	34	40
classical_aesthetics	Pearson Correlation	,744**	,470**	,700**	,631**	,572**	,814**	1	,577**	,433*	,879**
	Sig. (2-tailed)	0	0.002	0	0	0	0		0	0.011	0
	N	40	40	40	40	40	40	40	40	34	40
expressive_aesthetics	Pearson Correlation	,585**	,478**	,386*	,801**	,488**	,641**	,577**	1	,390*	,812**
	Sig. (2-tailed)	0	0.002	0.014	0	0.001	0	0		0.023	0
	N	40	40	40	40	40	40	40	40	34	40
SUS_value	Pearson Correlation	,449**	,785**	,484**	,427*	,331	,507**	,433*	,390*	1	,534**
pragmatic satisfaction of use	Sig. (2-tailed)	0.008	0	0.004	0.012	0.056	0.002	0.011	0.023		0.001
	N	34	34	34	34	34	34	34	34	34	34
overall_aesth_value	Pearson Correlation	,819**	,632**	,685**	,822**	,737**	,909**	,879**	,812**	,534**	1
VisAWI + Classic + Expressive	Sig. (2-tailed)	0	0	0	0	0	0	0	0	0.001	
	N	40	40	40	40	40	40	40	40	34	40
** Correlation is significant at the 0.01 level (2-tailed).											
* Correlation is significant at the 0.05 level (2-tailed).											

Table 7 Correlation indexes between VisAWI facets of aesthetics and pragmatic value of SUS questionnaire