Master's Thesis

Predictive Modelling of

Musical Preference Decisions

Léna DELVAL – August 2015

Host Institution :

Music Cognition Lab – Centre for Digital Music, QMUL

Supervisors : Dr Marcus T. Pearce & Dr Yvonne Blokland

Master ATIAM

(UPMC – IRCAM – Telecom ParisTech)

"And mostly all I have to say about these songs is that I love them,

and want to sing along to them, and force other people to listen to them,

and get cross when these other people don't like them as much as I do."

– Nick Hornby, 31 Songs (2002)

Summary

This Master's thesis is dedicated to the challenging problem of modelling musical preference decisions, presenting findings from analysis of new data collected through a Web survey. This Web survey focuses mainly on the influence of the listening situation on people's musical preferences. However, the listening situation being only one of the three components of the sought model, attributes of the music itself and the listener were also collected. Indeed, the goal, here, is to try mimicking the real world, i.e. trying to model how people really behave by tying behavioral data to math.

A general introduction of the matter at hand is proposed, in which are explored the very concept of musical preference as a cognitive process, the need to model it, ways to do so and a potential use of the outcomes. The three agents of the model, namely the context, the listener and the music, are then subject to a more in-depth investigation as some of the factors intervening in our model have been studied before and models of musical preferences were attempted in past research. A study conducted thanks a Web survey is proposed. Using a subset of a new self-constructed data set as stimuli, the survey investigates individual musical preferences and the uses of music in everyday life. In order to single out significant factors influencing musical preference decisions, the collected data is analyzed. The results are then compared with previous findings and theories from the literature about the factors and cognitive processes involved in the perception and appreciation of music.

Keywords: Music Cognition, Music Preference, Music Psychology, Psychomusicology, Contextualized Listening

Acknowledgements

Firstly, I would like to thank my supervisor, Marcus Pearce, who suggested this fascinating research project to me. I am grateful for his constant enthusiasm, great availability and valuable guidance.

I would also like to thank Yvonne Blokland, who is also working on the Musical Preference Project, for the stimulating discussions and her useful suggestions that helped to steer my work.

My sincere thanks also goes to my other fellow labmates from the Music Cognition Lab team, who provided insightful feedback during our weekly lab meetings and presented their research topics to me.

I thank all of the C4DM members I had the chance to meet throughout my stay. I am thankful to them for their friendship and the laughs we shared.

Finally, I take this opportunity to express my gratitude to all of the people at Queen Mary for their warm welcome and making it a great environment to work in.

Table of contents

Introduction

Carried out at Queen Mary (University of London) within the Music Cognition Lab, the project presented in this thesis is investigating the predictive modelling of musical preference decisions. The project, as previously described, is actually part of a bigger research project looking at, on one hand, the psychological principles involved in musical choice and, on the other hand, at electrical brain responses recorded using Electroencephalography (EEG) when a listener chooses music to listen to. This Master's Thesis focuses on the psychological and behavioral aspects of people's musical preferences.

Music is a near universal phenomenon in human society serving a range of functions from mood regulation to expression of identity. Because the forementioned listening strategies/motives involve decision-making, they can be regarded as a cognitive process. The resulting decision, driven by a wide range of factors, prompts action: the listener chooses to listen to a specific song among several alternative possibilities. But, why this one and not another?

Nowadays, thanks to streaming and online purchasing services, people are offered the opportunity to listen to almost anything they want by browsing through not only their own "physical" music collection, but also vast music libraries of digital content. While navigating in a "song-after-song" manner, they make a series of musical preference decisions influenced by several factors. Existing research suggests that these decisions are likely to depend on an interaction between factors related to the music (structure, style, lyrical content etc.), the person (stylistic preferences, personality, mood, current emotional state etc.) and the listening context (social context, concurrent tasks, function of listening to music etc.).

The goal of the project is to try to determine some of the factors that predict the choices we make about the music we listen to, in an attempt to later build a model able to predict any listener's musical preference from a large amount of possibilities. In order to explore this challenging problem, the project involves designing an experiment to collect data from human listeners on musical preference decisions and test hypotheses about the factors driving those decisions by analyzing the collected data.

1 Modelling Musical Preferences Decisions

In this first part, we introduce the concept of musical preference as a cognitive process, the interest to model it as well as the challenges and potential applications of such research.

1.1 Musical Preference Decisions

1.1.1 Overview

The very concept of preference is often described as "a greater liking for one alternative over another or others". We can then easily understand that preferences vary considerably from one individual to another depending on each person's attributes and the context they find themselves in. What can be investigated and particularly interests us are the reasons why one might prefer something. In our case, we study preference for a piece of music that would be liked more or selected over another (or even several others) to listen to.

Because the reasoning behind these decisions can vary a lot among the population and might be partly unconscious, people's answers to the question "Why do you like this specific piece of music?" will probably produce a very diverse set. Some people would attribute their liking to memories attached to the music, other to the emotions evoked by the music when other might simply be unable to explain their preference. Therefore, a wide range of factors is to be considered by anyone wanting to study preferences. Some might be directly and intrinsically related to the music (its degree of sophistication, style, tempo…) while other would be probably be regarded as more user-related (age, sex, personality, musical identity & sophistication…) or context-related (current mood, ongoing tasks…) factors.

The choices we make about the music we listen to seem to be a constantly varying combination of these factors which can be split into three distinct categories: the user, the listening situation and the music itself. If studying the impact of each of these factors on musical choice is obvious, the impact of one on another should also not be forgotten. The purpose of this project is to model these impacts and interactions in order to predict the listeners' musical preferences.

What will be looked at in this thesis are short-term choices rather than lifespan patterns. The latter tends to be more stable overtime than musical preferences and therefore are often called musical tastes. However, it should not be ignored that the two consistently interact and feed each other.

1.1.2 Musical Preference as a cognitive process

Cognition is commonly described as the set of mental abilities or processes of acquiring knowledge and understanding through thought, experience, and the senses. These actions are related to concepts such as knowledge, attention, judgment, evaluation, reasoning, decision making… Human cognition, as we know it, is both conscious and unconscious as individuals might be aware of only a few of the principles underlying these processes. It can be guided by intuition as well as shaped by concepts (or rather models). Cognitive processes call for existing knowledge (what has already been experienced, learned, thought of…) and generate new knowledge.

In psychology and cognitive science, cognition is considered to be "information processing in a subject's mind or brain". Therefore, these disciplines aim to investigate how the psychological functions responsible for information-processing are implemented by the brain.

If cognition, as formerly described, encompasses all the information-processing functions occurring in an individual's mind, we then can easily understand that some of these underlying mental processes are likely to play a key role in music listening and music appreciation. Indeed, when listening to a piece of music, one may be inclined to judge it, evaluate it and finally decide if they like it or not. Besides, such a musical experience seems to call for processes allowing the individual to perceive, respond to and incorporate music into everyday life. People might even do so using previous music experiences such as prior music knowledge and listening or their own musical training.

On the basis of these considerations, musical preference itself seems indeed to involve some information-processing functions of its own. The outcome being the appreciation of a particular piece of music over another (or several others) as mentioned before, the psychological factors behind this decision are yet to be determined.

As we have now established that it makes sense to study musical preference from a psychological and cognitive point of view, we ought to address the issue of the method. Research into cognition and modern music psychology is usually scientific, empirical, and quantitative, meaning that the main way to acquire new knowledge is mostly interpretations of data collected by systematic observation of and interaction with human participants. Different behaviours can be explained in terms of information flow or function and described by models.

1.2 Modelling: Using and Understanding Data

"Essentially, all models are wrong but some are useful" – George Edward Pelham Bow, Empirical Model-Building and Response Surfaces (1987)

1.2.1 Turning Data into Knowledge

Once the data collected, we might find ourselves with loads of unstructured information. It is necessary, for the purpose of understanding the processes we wish to explain, to select and structure that information. Only then we can make sense of it and turn it into knowledge and in some cases, wisdom. To do so, we build models.

Models are used to schematically describe or represent systems or phenomena. Taking into consideration the properties of what is studied, they investigate its characteristics. Built thanks to inductive reasoning, they are often the results of a "bottom up" approach where everything starts with specific observations & measures in which we might detect patterns and recurring phenomena. Tentative hypotheses are formulated and then tested to finally develop broader generalizations or theories about the relationships between the parts of the model and the conditions under which the model is valid.

Models are obviously not ideal as they are abstractions and simplifications. However, they are useful for predictions and the understanding of patterns and complex phenomena. Indeed, it has been proven that individuals using models usually perform better at most tasks than the ones who don't. They help us think more clearly, decide, strategize and design.

In our case, we hope to get a better understanding of people's musical preferences in order to be able to predict them in the future. In the interest of building the most realistic model, the first matter at hand is to understand the parts it is made of. For us: the listener, the music and the listening situation. The most complex and unpredictable of them probably being the listener themselves.

1.2.2 Modelling people

Building a model requires a good prior understanding of its pre-defined parts. These also have to be simplified and modelled if we want to use them as parts of future models. As mentioned before, people might be the most delicate concept to model. Physicist Murray Gell-Mann once said to one of his colleague: "Imagine how difficult physics would be if electrons could think." Indeed electrons don't have any goals, beliefs, objectives whereas humans reason and therefore are considered purposeful thinking actors. Besides, where all electrons are basically the same, particles all following the same rules of physics, humans are complicated and all different, which makes predicting their behavior so intricate.

Certainly, it could be assumed that people have objective functions and optimize (rational actor model) or even that they follow rules (rule based model). But, in reality, it is in the human nature to deviate from rationality and optimal choices as people are subjects to biases. They are not rational in systematic ways, they make mistakes, have impulses and are diverse. Consequently, a different approach must sometimes be considered: a behavioral model, exploring how people really behave, how they might think. This can be achieved by, first, assuming rationality and rules and then observing naturally occurring (or lab-simulated) phenomena to eventually find and explain biases.

Pulling theories out of the literature, we propose to test pre-existing hypotheses concerning musical preference by trying to make sense of data collected through a Web-survey focused on contextualized listening. Gathering information about the listener himself, we hope to shed light on the factors driving musical preference decisions and with this new knowledge, to be able to better inform music recommendation systems.

1.3 Application to Recommendation Systems

The enormity of possible musical choice brought by the recent evolution of music consumption shed light on the need to develop intelligent tools to help listeners choose music to listen to. Interest in music technology and musical preferences growing more and more, a pure engineering approach has taken over the field. However, fully user-aware systems for music recommendation are yet to become a reality. Indeed models of the listener used to inform digital music players (e.g., iTunes, Spotify, Last FM) seems to be the weakness of most existing systems because of their lack of robustness and scientific ground.

Since no breakthrough in this field has been achieved to this day, the proposed research intends to address this gap by studying choices made by listeners in their everyday life. The goal, here, is to develop a scientific understanding of the processes underlying the listeners' musical choice and contemplate the potential applications to music recommendation systems and other interactive systems. With intelligent user-aware models, systems would be able to provide music that would fit each listener in any situation and for each need/wish they might have about the music they're listening to. Therefore the data collected during our study will be thoroughly examined in order to understand the exact nature and weighting of the factors driving people's choice in different context and their impact on the decision-making process.

2 State of the Art

In this second part, we take a look at some of the existing literature in the field of musical preference psychology. The three parts (Music, Context and Listener) we plan on investigating are introduced as well as some of their properties impacting people’s choice of preferred pieces of music.

2.1 Introduction to the Psychology of Musical Preference

The psychology of music preference is the subdiscipline of music psychology studying the psychological factors behind peoples' music preferences. As previously discussed, people are diverse and complex and, therefore, so are their preferences. If the first studies mostly focused on the factors related to the music within the field of experimental aesthetics, it quickly became broader, encompassing influences of the listening situation and the listener’s characteristics. Music affects and is being used by people in various all over the world on a daily basis. Such things as individual personality traits, musical training, musical genre and emotional response are factors reported to influence musical preferences.

As previously stated, these factors can be split into three main influences: music, listener and context. These are the three main parts of our model and we consider their properties to be factors impacting people’s everyday musical likes and dislikes. The impact of each factor deserves a thorough individual investigation. In order to know make assumptions and know how to design our study, the pre-existing literature about these impacts and reciprocal relations between parts and factors has been investigated. Many interactions got our attention, we chose to focus on a few of them we thought were relevant to our objectives.

2.2 Agents & Factors

2.2.1 The Music

The "Music" agent is probably the richest of our three parts as it includes experimental aesthetics, musical style, low-level acoustic features (dissonance, temporal regularity…), cognitive aspects (complexity, familiarity, ambiguity…) and higher-level aspects such as the emotional content of the music conveyed by both the music and lyrics. Even though each of these aspects However, as overelaboration and overparametrization of a model is not advised and we chose to spotlight only a few.

- **Collative variables : Berlyne's theory**

In his book "Aesthetics and Psychobiology", published in 1971 [1], Daniel Berlyne adopted a psychobiological approach in studying the perception and appreciation of artistic stimuli. His new approach aims to establish links between aesthetic and psychological phenomena.

Berlyne claimed that, in this case, preference is related to what he called "arousal potential": the amount of activity produced by the stimuli. His theory states that the most liked music is the one with a moderate level of arousal potential and liking is susceptible to gradually decrease towards the extremes. He formalizes his hypothesis in the shape of an 'inverted-U" relationship between liking and arousal potential (**Fig. 1**).

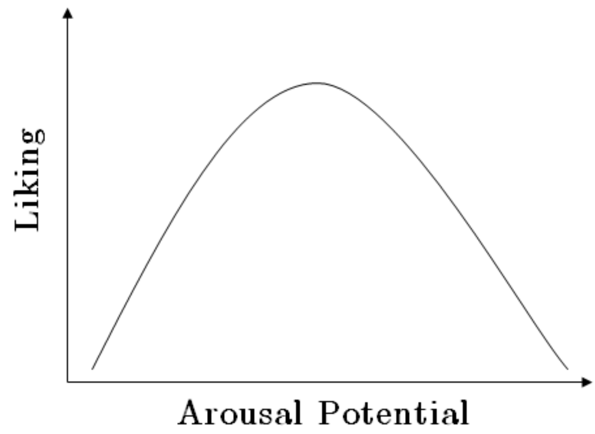


Fig 1 – The “inverted U” relationship between Liking & Arousal Potential, according to Berlyne’s theory

Aside from the obvious variables of musical tempo and volume, Berlyne introduced more ‘formal’ properties, likely to mediate arousal potential, described as “collative properties”. The most investigated ones are complexity and familiarity. Indeed, as music becomes more and more complex/familiar it is said to possess more arousal potential but can become too complex/familiar for someone’s liking at some point on the arousal potential dimension. Although evidence has been provided that Berlyne’s theory holds for liking and complexity, the relationship between liking and familiarity is not as clear as some study results show a positive monotonic relationship, like in North & Hargreaves (1995) [15] where liking for their 60 excerpts of popular music seems to constantly increase with familiarity (**Fig 2**).

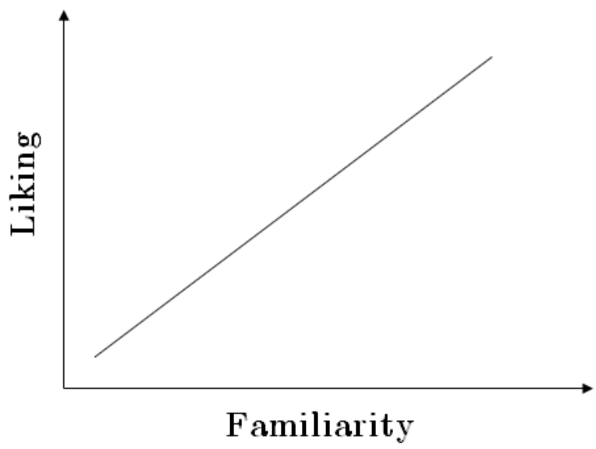


Fig 2 – The relationship between liking & familiarity, as in North & Hargreaves (1995)

[13].

- <u>Prototypicality</u>

In 1988, Colin Martindale, in a study on color preference [13], argues that "Aesthetic preference is hypothetically a positive function of the degree to which the mental representation of a stimulus is activated. Because more typical stimuli are coded by mental representation capable of greater activation, preference should be positively related to prototypicality." On most occasions, the preference for prototypes has been proven and seems, according to Martindale, to have a greater impact on preference than collative variables. This theory is based on the notion that people prefer things that are easy and quick to classify (prototypes), because they are likely to be stimulating in bigger proportions.

The prototypicality of a stimuli is a measure of how easily people can classify it by matching it with an 'abstract schema' (or prototype) representing the appropriate category. Knowledge about prototypes and their characteristics is acquired through experience and repeated exposure. For instance, the more you encounter birds, the more accurate and refined your prototype and notion of the concept "bird" becomes, and the easier it gets for you to identify birds. Therefore we can conclude that people might be more likely to like music that sounds like the music they are used to listen to or at least good prototypes of the various genres they like rather than atypical music.

- <u>Emotional content & response</u>

Although the existence of a direct causal link between music and emotion has been questioned throughout the history of music psychology, it is now recognized as a field of studies on its own and shares the same framework than most psychological studies. There are two major approaches to conceive emotion, which are reviewed by Sloboda and Juslin in their book, "Music and Emotion : Theory and Research" (2001) [25].

The *categorical* approach claims that people experience emotions as categories distinct from each other. These categories are subject to discussion. Indeed, the number and names of the different categories varies from one categorical theory to another. Some theories are based on "basic emotions" such as sadness, happiness, anger, fear and disgust, constructing more complex emotions through subdivisions or additions. In 2008, Zentner et al. [28], proposed "The Geneva Emotional Music Scale" which is "music-specific" and made of 9 categories: wonder, transcendence, tenderness, nostalgia, peacefulness, power, joyful activation, tension and sadness.

However, the *dimensional* approach seek to characterize emotions depending on their positions along a few continuous dimensions. These theories consider that experiencing emotions is not a discrete phenomenon. Similar to categorical approaches, there are a few different categorical approaches with more or less different dimensions.

The most popular and used to this day is the *circumplex model* introduced by Russel (1980) [24]. Emotions are defined based on their location along two dimensions: "valence" and "arousal". *Valence* characterizes the level of positivity of the emotion, it ranges from negative to neutral to positive. In the same way, *arousal* refers to the level of activation of the emotion, it ranges from calm (or sleeply) to neutral to active (or excitement). Each emotion is then a combination of activation and positivity and can be situated on the created model (**Fig 3**)

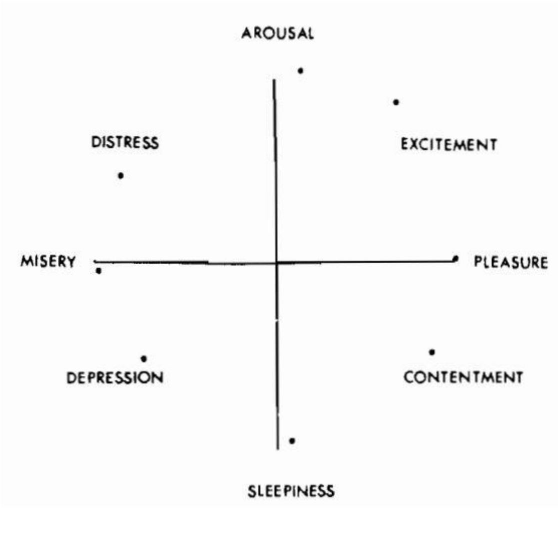


Fig 3 – Eight emotions in Russel's Circumplex Model, as in Russel (1980)

This theory has been tested with music by North and Hargreaves in 1997 [17]. After listening to pieces of pop music, some participants were asked to rate them for arousal and valence, whereas other had to rate them according to 8 categories. Results were consistent with the Russel's model, music characterized by a certain category ended in the expected quadrant of the circumplex model. Besides the dimensional approach and the circumplex describe emotions in terms compatible with Berlyne's theory. It makes studying a potential greater liking for, for instance, a moderate arousal level easier. Similarly, we might hypothesize that people like "happy sounding"(high valence) music better than "sad sounding"(low valence) music.

Yet, some people might like sad music and report that it makes them feel happy (Garrido & Schubert, 2011) [3].This is the difference between "felt" and "expressed" emotions. A song might express a certain emotion and the listener might recognize it but still experience either the same emotion (congruence) or a completely different one (incongruence). However, expressed and felt musical emotions have a tendency to be similar (Hunter et al., 2010) [5]. Besides, some findings show that emotions are recognized more strongly than felt, like in Zentner et al. (2008) [28].

It should not be forgotten that the extent to which emotions are expressed and felt might also be related to individual differences (personality traits, mood…) and therefore vary from one individual to another. This aspect of musical preference will be developed later.

2.2.2 The context

As immediate access to music has been made easier thanks to the advent of mp3 file, streaming services and portable devices, music listening has become more situational than ever. People can listen to almost any music anywhere and at any time, hence the increasing recognition of the influence of context on musical preference decisions. Indeed, some songs might be more or less liked, or more or less likely to be selected for listening, in some specific contexts. Moreover, the reason people select them or not might vary from one context to another and be the result of different underlying psychological processes.

- **The situation itself**

Early studies investigating the uses of music in everyday life proposed wide categories: *leisure, work* and *personal* (Sloboda et al., 2001) [27]. In order to avoid ambiguity and broaden the spectrum of listening situations, more refined categories relating to activities were introduced by more recent studies. For instance, Krause and North (2014) [10] proposed situations such as: *posh cocktail reception*, *before going to sleep* and *house party*. North and Hargreaves (2004) [20] looked at different aspects of the listening situation: *Who, What, When, Where, and Why?* i.e. the social context, the musical style, the time, the location and activity and finally, the function of listening to music.

On this basis, we created a list of situations of our own for the needs of our study.

- **Functions and motives**

North and Hargreaves (1996) [16] presented some results showing that the purposes of listening to music depend on the situation. Many functions of listening to music have been reported throughout different studies. Among them: "to get energized", "to evoke memories", "to pass the time", "emotion regulation", "expression of self"… Sloboda and Lamont (2009) [26] identified four main functions:

- Distraction: A way of engaging unallocated attention and reducing boredom;
- Energizing: A means of maintaining arousal and task attention;
- Entrainment: The task movements are timed to coincide with the rhythmic pulses of the music, giving the task or activity elements of a dance;
- Meaning enhancement: Where the music draws out and adds to the significance of the task or activity in some way.

- **Musical Fit**

Once the situation established, people might select music according to different factors such as liking, familiarity and mood. Some situations may lead the listener to select more preferred and/or familiar music whereas some other situations might call for less liked or more unfamiliar music. Similarly, the listener might give a particular importance to the emotional content and potential for induced emotion for each song.

In 2012, Kamalzadeh et. al [9] reported that people prefer familiar music during tasks requiring attention and non-familiar music during tasks that did not necessarily require attention. Besides, people seem to be more selective of the music they listened to when no attention is required by the current task and selection based on mood seem to occur more often in contexts requiring non or little attention. However the participants seemed to disregard mood in tasks requiring attention, preferring "non-distracting music".

Both the *valence* and *arousal* dimension of musical emotion can be significant factors for music selection in some contexts.

Indeed, some individuals select sad music to match their mood (mood-congruence) and other choose happy music to feel better (mood-incongruence, mood regulation). The mood-congruent behavior, here, is referred as the "misery loves company effect" by Hunter and Schellenberg (2011) [7] who observed a greater liking for sad music among participants in an induced sad mood than for participants in an induced happy mood.

In a similar way, North and Hargreaves (2000) [18], studied "Musical preferences during and after relaxation and exercise" and observed two arousal-based strategies: arousal moderation and arousal polarization. In the first one, people tend to select music that will bring them a moderate level of arousal, whereas, in the second one, people tend to choose music that might put them in one of the extreme of the arousal scale : very active or sleepy. For instance, for arousal polarization, when exercising people might prefer arousing music to energize whereas before going to bed, they might prefer calm music. Arousal moderation might be observed when people are already at one of the extremes and wish to calm down or wake up.

In conclusion, music needs is used for different purposes and has to meet some criteria in terms of liking, familiarity and emotional content (valence and arousal) in order to "fit" specific situations and be selected/liked. For instance, it would not make sense to select calm and sad music for dancing as you might want to energize or to listen to aggressive music before going to sleep since you might want to calm down. In these cases, the music obviously does not fit the situation. People seek for "situational appropriateness".

2.2.3 The Listener

As mentioned before, the listener is probably the hardest agent to model and yet the most influential one. People's diversity creates a varied set of musical preferences. In fact, each individual has his/her own preferences. However, there are some theories about the influence of factors such as age, sex, personality, musical sophistication, mood and pre-established tastes.

- Age

Different age groups have their own musical preferences. It has been argued that older people are familiar to a wider range of musical genre. Besides, the liking for more "sophisticated" musical genre like classical music or jazz increases with age. Indeed as people get more exposed to these genre, they seem less complex to them than before, therefore they might enjoy them more.

Furthermore, the “nostalgia effect” and the crystallization of taste during late adolescence/early adulthood have been studied by North and Hargreaves (2002)[19]. People seem to prefer artists they used to listen to when they were young.

- <u>Sex</u>

The general findings in studies looking at differences between males and females suggest that females tend to like ‘softer’ musical genre such as pop better whereas males tend to like ‘harder’ genres such as rock music. (Robinson et. al, 1996 [23]).

Moreover, according to North et. al (2000) [18], females tend to respond to music in a more emotional way than males. They tend to use music listening as a means to fulfill emotional needs such as “expressing feelings” or “get through difficult times” whereas males use it more for impression: “to be cool” or “to please or impress friends”.

- <u>Personality traits</u>

Personality, in the field of psychology, is often characterized along 5 distinct dimensions: the *Big Five personality traits*. The five factors are *openness to experience*, *conscientiousness*, *extraversion*, *agreeableness* and *neuroticism*. Research in music psychology investigated different correlations between these five dimensions of personality, the different uses of music and musical preferences.

    - Openness

Some studies such as Langmeyer et al. (2015) [12] found that people scoring high in *openness* were more likely to prefer complex and reflective genre like jazz and classical as well as intense and rebellious music like rock or heavy metal whereas they seem to dislike more mainstream genres such as pop. For each global factor of the Big Five, correlations with some more specific factors exist. For instance, openness is related to aesthetic appreciation, which might explain this greater liking for complex music among more “open” people.

Moreover, open individuals seem to like a wider range of musical genres (Rawlings et. al, 1997 [22]). In 2011, Hunter and Schellenberg [7] investigated the effects of openness and frequency of exposure on liking and found that the inverted-U shaped response relating liking to exposure (familiarity) was the most common among the responses of individuals who scored high in openness. This study demonstrate that open individuals appreciate novelty (low familiarity) more than others.

- Extraversion

The second most investigated and important personality trait influencing musical preference is *extraversion*. Studies reported that extraverts like music styles with a higher level of valence and a higher level of arousal (Langmeyer et al., 2015 [12]). Furthermore, individuals scoring high in extraversion seem to listen to music more frequently and use it as background while performing other tasks (Chamorro-Premuzic, 2009 [2])

- Agreeableness

A study, conducted by Ladinig and Schellenberg in 2012 [11], collected ratings for intensity, happiness and sadness in response to music excerpts varying in tempo and mode, and found that agreeable people tend to have more intense emotional responses to music in general.

- Neuroticism

Neuroticism referring to the "emotional stability" of the individual. Therefore the positive correlation between neuroticism and the emotional use of music found in Chamorro-Premuzic (2009) [2] is not surprising. Moreover, neuroticism has been reported to be negatively correlated with intense and rebellious music but positively related to more upbeat and conventional styles. (Langmeyer et al., 2015 [12])

- Conscientiousness

The more conscientious people are, the less they like intense and rebellious music such as rock and heavy metal. (Langmeyer et al., 2015 [12])

- <u>Musical Sophistication</u>

The main effect of musical sophistication on musical preference reported to this day is a relationship between liking and complexity. Indeed, individuals with high levels of musical sophistication prefer music with higher complexity than do people with lower levels of musical sophistication. There is evidence for this theory in a study conducted by North & Hargreaves (1995) [15]. A musically sophisticated person might need a greater complexity to get the same satisfaction from a piece than someone else, less engaged in music in his/her daily life. Hence, a greater liking for more complex pieces and genres.

- <u>Current Mood</u>

As mentioned before in **2.2.2**, the current mood experienced by the listener influences his preference for a piece of music as he might follow a mood-congruent or mood-incongruent strategy. Expecting to feel specific emotions by listening to music, the listener might choose music with a specific emotional content according to what emotional state he finds himself in and what emotional state he wishes to reach.

- <u>Musical Tastes</u>

People have pre-established tastes for certain musical genres and artists that might influence their liking for specific pieces. Indeed, a jazz aficionado might like a specific piece of music simply because it is or sounds like a jazz piece. This idea is a consequence of the preference for prototypes presented in **2.2.1** : people like music that sounds or reminds them of the music that they like.

2.3 The Reciprocal Model

Already knowing some of the factors influencing our musical preference & classifying them into three main influences (music, listener & context), Hargreaves, Miell, and MacDonald (2005) [4] built a reciprocal response model of musical response (**Fig. 4**). This model can be taken as a base for our own investigations. The listener, music & context influences are briefly described as well as their bi-directional influence on each other. The different properties of the music, listener and context we evoked in **2.2.** are represented in each box and the nature of relationship between the different boxes can be observed. Only a few factors in each box will be investigated and our "response" box is the studied outcome, namely the liking for a piece of music (influenced by the current mood).

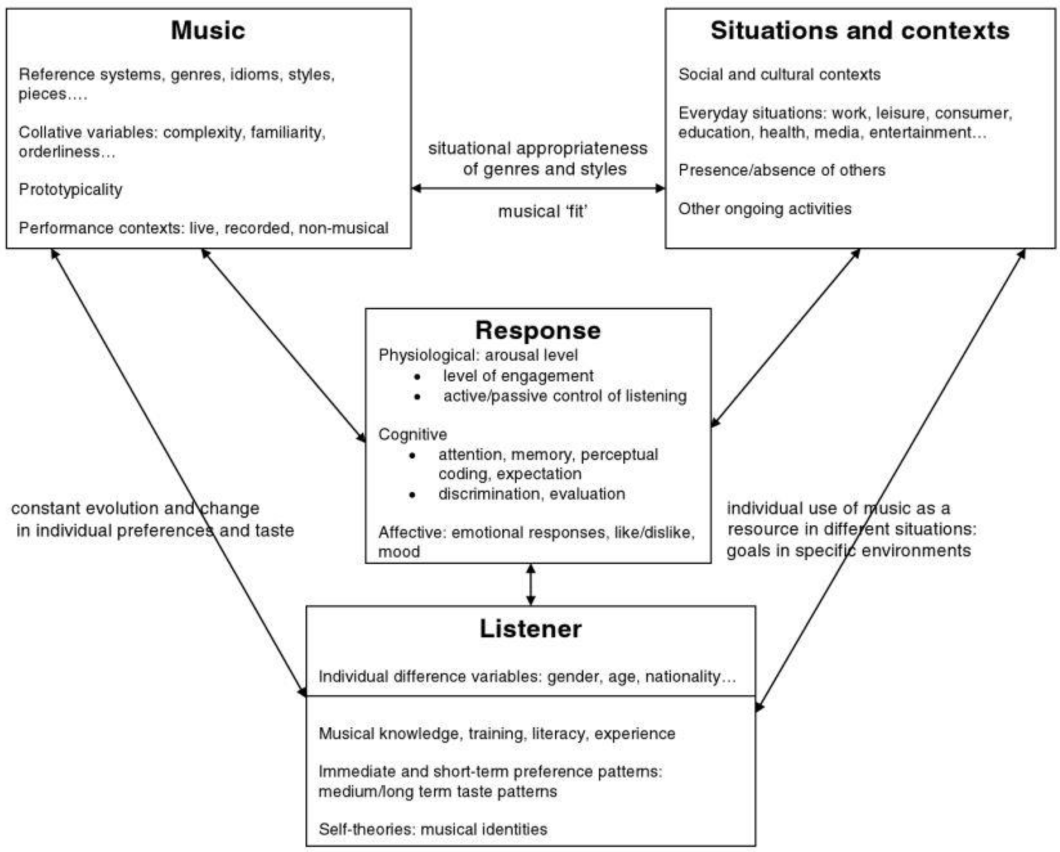


Fig 4. – Hargreaves et al. (2005) – Reciprocal Feedback model of musical response.

3 Experiment : The context-based survey

In this third part, we look at the proposed experiment itself, from experimental design to stimuli selection to results.

3.1 Experimental design

3.1.1 Objectives

The proposed research investigates the relationships between, mainly, the influence of the situation on musical preferences in relation to music. The uses of music in everyday life are studied thanks to a self-report approach using a Web survey. Looking at each main actor's properties, we wish test some of the hypotheses introduced in section 2 in order to better understand the underlying psychological principles influencing musical preferences.

We chose to do so in what we believe is a more ecological approach: by giving people the opportunity to nominate and rate self-selected songs for each situation we presented to them. This way, we look at, not only people's likes and dislikes using experimenter-selected music, but also the music people might select for themselves to listen to in real-life situations. Indeed, most studies in the field of music psychology seem to use music selected or designed by the experimenter only. Since we wish to study musical preferences in everyday life, we thought including ratings of music the listener would actually like, listen to and be familiar with in the real-world was important. Krause & North (2014) [10] investigated people's musical preferences by asking people to nominate songs for 8 different situations. However, each participant had to create a playlist for only one situation out of the 8 proposed in the study whereas each of our participants is asked about his use and selection of music for each of our 11 situations.

Furthermore, the stimuli we selected are excerpts of “real” music from various genre and styles, since musical excerpts specifically designed for the purpose of experiments might provide more control but often do not sound like actual music people might listen to and like in real life.

To sum up, information about the listener are collected as well as ratings of situations, self-selected music and excerpts of popular music selected by the experimenter.

3.1.2 Experimental protocol

Choice of measures and collected data

We selected a few properties for each main actor in order to investigate their impacts on musical preferences.

For the music, we chose to look at the emotional content (expressed valence and arousal), the emotional affect (felt valence and arousal) and familiarity. Prototypicality according to genres is controlled as typical pieces of each genre were selected to make sure people recognize the various styles and maybe like pieces of their preferred genres. The selected musical excerpts were pulled out of a self-created Data Set we call the “Music Pilot” Data Set made out of 104 songs from various genre. Details about the stimuli and its selection can be found in **3.2**.

For the listener, we collected background information, namely age, sex, nationality, country of origin, country of current residency, spoken languages, education and occupational status. The Big Five personality traits are measured for each participants with a 44 item questionnaire: the Big Five Inventory (John & Srivastava, 1999 [8] & **Appendix A**). We use the Goldsmiths Musical Sophistication Index (Gold-MSI), a questionnaire developed by Müllensiefen et. al (2014) [14] to assess our participant’s musical sophistication. We also asked participants to report their musical tastes by rating their liking for 29 musical genres and naming their favourite artists/composers.

For the context, we asked our participants about the associated emotion (valence and arousal), the frequency, function and importance of listening to music, and if they selected music or not for each situation. We used the four main functions of listening to music presented in **2.2.2**, namely *distraction*, *energizing*, *entrainment* and *meaning enhancement*.

Based on the previous studies on contextualized listening, we came up with a list of 11 listening situations in which we assumed most listening episodes might occur in everyday life. We specifically selected situations in which people may have a control over the music they listen to, situations where they select, and not just hear, music. We also paid attention to the social context, time, location and activities of these situations and tried to produce a diverse enough list for the purpose of our study.

Our situations are:

- Chatting with Friends
- At home, doing housework (e.g. cooking, cleaning…)
- Exercising (e.g. jogging)
- At home deliberately and attentively listening to music
- Commuting (Train/Bus/Tube/Car)
- Getting ready in the morning
- Walking down the street
- At work
- At a house party
- At home reading for pleasure (book, online article, magazine…)
- Winding down to go to sleep

As a measure of musical preference, we asked people how much they liked each song they nominated and our excerpts as well as how likely they would be to listen to it in our 11 situations.

We summarize our approach in **Fig. 5**.

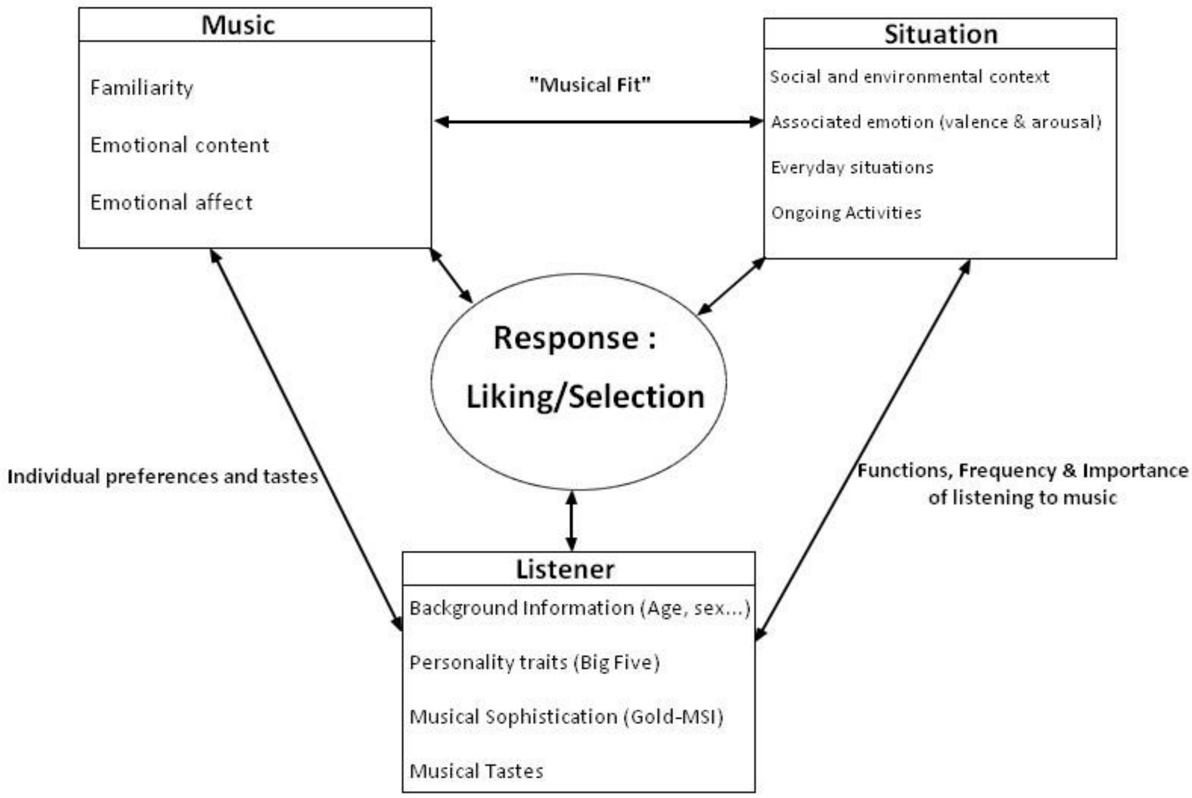
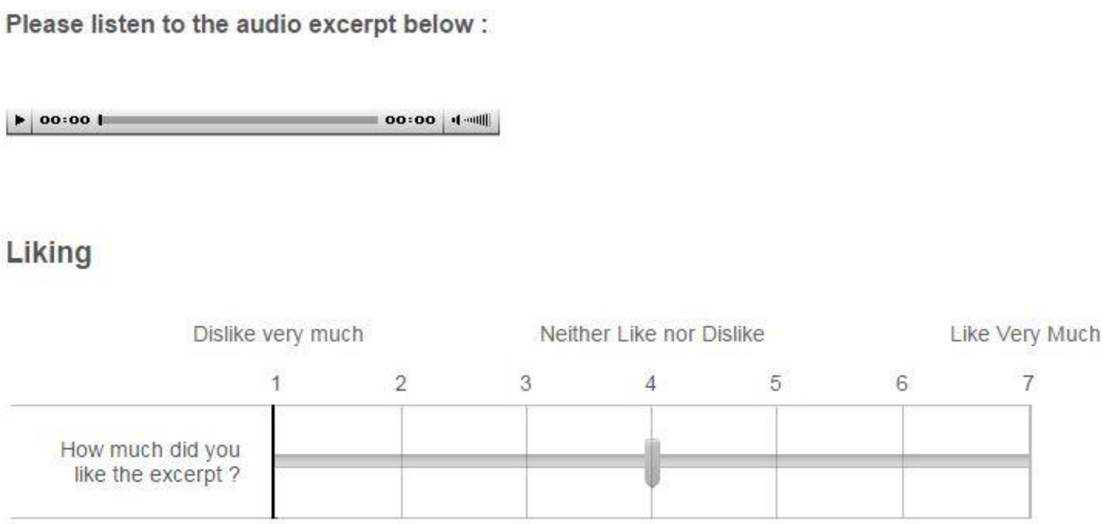


Fig 5 – Choice of measures and collected data

<u>Design of the Web survey</u>

Our Web survey was designed using Qualtrics[1], an online private software, enabling online data collection. The survey was accessed via a private link and after entering a password, participants were allowed to start.

In most of the survey, participants were asked to give ratings using sliders (see **Fig. 6**) or answering multiple choice questions. Both of these features were designed as Likert scales of 5 or 7 choices, i.e. scales with an odd number of choices in order to



have a neutral position. Participants were asked to try to use each scale in its entirety, using both the extreme and neutral values when needed.

1 http://www.qualtrics.com/

Fig. 6 – Example of a 7–point Likert scale slider

- **Part 1 : Background information**

The very first part of the survey simply consists in questions about background information (age, sex, nationality…).

- **Part 2 : Situational Playlists Creation**

In the second part, called **"Situational Playlists Creation"**, each of the 11 situations were presented to the participants in a random order. For each situation, they were asked to rate how frequently they listened to music in that situation (ranging from 1=Never to 3=Sometimes 5=Always). If the participant reported never listening to music (rating of 1) in that situation, the survey skips to the next situation. However, the participants that reported listening to music were asked if they select specific music (songs, artists, albums…) or not when listening to music in that situation (Yes or No). Whenever "Yes" is answered, we asked the participants to nominate 3 to 6 songs (artist and song title) they were likely to listen to in the presented situation. We asked participants to not feel obliged to nominate 6 songs for each situation but rather to try to spontaneously name as many songs as they could think of that, according to them, best fit the listening situation. The participants that reported not selecting specific music in the presented situation directly moved on to the next situation.

Once all the "Situational Playlists" created, participants were asked, for each created playlist, to select the two songs they thought were the best fit for the situation. Then, for each of these two songs, they were asked:

- How much they like it, *ranging from* (1) = Dislike very much *to* (7) = Like very much
- How familiar the song is to them, ranging from (1) = Not Familiar at all to (7) = Extremely Familiar

- The level of felt valence they associate with listening to this song in that situation, ranging from (1) = Very Low to 7= Very High

- The level of felt arousal you associate with listening to this song in this situation, ranging from (1) = Very Low to 7= Very High

- How likely they are to listen to it in the other 10 situations, ranging from (1) = Very Unlikely to (7) = Very Likely

❖ **Part 3: Situational Ratings**

The third part of the survey, called **"Situational Ratings"**, consists in listening to 24 musical excerpts we selected and rate them. Excerpts were presented in a random order.
After listening to each excerpt, participants were asked, using the same scales from 1 to 7:

- How much they liked it

- How familiar the excerpt sounded to them.
- How they would describe the excerpt in terms of FELT valence
- How they would describe the excerpt in terms of FELT arousal (high or low).
- How likely they are to listen to it in each of the 11 presented situations.

❖ **Part 4: More about the Situation**

In a fourth part, called **"More about the Situation",** participants were asked to give ratings about the situations and their use of music in each of them
For each situation, participants were asked, using the same scales from 1 to 7:

- The level of valence they associate with the situation.
- The level of arousal they associate with the situation.
- How important is listening to music in this situation to them.
- How much they agree with the presented statements (the four functions of music listening) about their personal use of music in the situation.

❖ **Part 5: More about the listener**

Once Part 4 completed, participants were asked to fill the Big Five Inventory and Gold-MSI questionnaires and rate a list of 29 musical genres based on how much they liked them. We also gave participants the opportunity to name genres they thought were missing from our list and tell us up to 10 of their favourite artists/composers if they wanted to.

3.2 Stimuli

3.2.1 The “Music Pilot” Data Set

The 24 musical excerpts used for Part 3 (Situational Ratings) of our survey were taken from an unpublished self-created data set of 104 musical excerpts we call the “Music Pilot” Data Set.

We conceived this data set with the aim of covering peoples’ different musical preferences. Indeed, we wanted people to potentially be exposed to both very liked and very disliked music. Therefore, a wide range of musical genres and eras was included as we tried to cover the 4 quadrants of the *circumplex model* (cf **2.2.1**) in terms of expressed emotion. We also tried to include different levels of familiarity by selecting more or less famous songs and artists. A representative excerpt was selected, normalized, faded-in and faded-out for each of the 104 songs.

Each excerpt of the “Music Pilot” data set has been rated for liking, familiarity and expressed emotion (valence & arousal) using 7-point Likert scales, in a first online survey designed by Dr. Yvonne Blokland.

In this survey, the data set was split in two sets. Participants were randomly assigned a first set of 52 excerpts to rate and if they wished to continue, had to rate the second set made out of the other 52 excerpts. Since some people only rated one set and some other never completed the entire survey, not every excerpts got the same number of ratings. Therefore, we also need to look at the standard deviation for each of these ratings before selection.

3.2.2 Stimuli Selection

As we wish to link the emotional content (expressed valence & arousal) of the excerpts to preferences in specific situations, we selected our 24 excerpts based on the "expressed valence" and "expressed arousal" ratings from the "Music Pilot" Data Set. Consequently, we looked at the excerpts that had the highest scores of valence and arousal (with minimal to moderate standard deviation) in each of the 4 quadrants. 6 excerpts per quadrants, considered as the "extremes", were selected.

A list of the selected stimuli and ratings from the "Music Pilot" is presented in **Table A.1, Appendix A**. Excerpts are located in the cirumplex model thanks to mean ratings of "expressed valence" and "expressed arousal" (see **Fig. 7**) All excerpts were 16-bit mp3 files with a sample rate of 44100 kHz files and lasted 25 to 33 seconds.

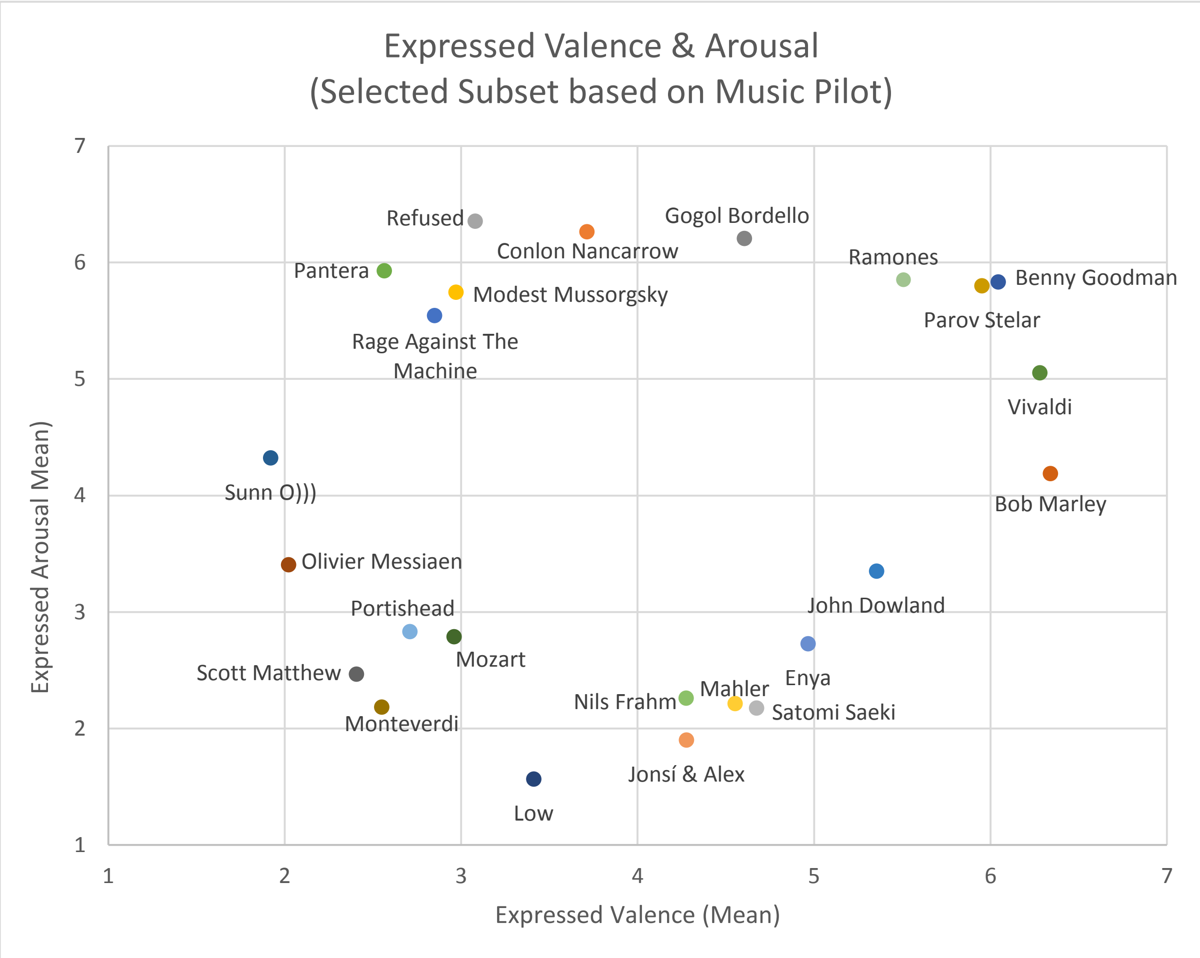


Fig. 7 – Mean Ratings of the selected stimuli in the circumplex model

3.3 Procedure

Participants were recruited via e-mail through Queen Mary's mailing lists of students (Ph.D. and Master) and research volunteers. All participants willing to enter their e-mail address, after completing the survey, were offered to be paid £5 and be entered into a draw to win a £100 Amazon gift card. Using the provided password and private link to the survey, participants could access the survey online from their personal computer. Given the length of the survey (average 1 hour, 30 min for the fastest and up to 2 hours, worst case scenario), Participants were invited to take as many breaks as they wanted as long as they completed the survey in 72 hours maximum.

Before answering any questions, the content of the survey was explained to participants in a first introduction. Then, each part started with a brief introduction and explanation of the concepts used, such as valence and arousal. No bugs or misunderstandings were reported.

3.4 Participants

28 participants took part in this survey. Ages ranged from 18 to 31 years old (Mean: 23.3, SD: 3.5). Half of them (14) are females.

Different nationality are represented: British(9), French(4), Brazilian (2), Bangladeshi (2), Dutch(1), German(1), Ecuadorean(1), Turkish(1), Croatian(1), Welsh(1), Spanish(1), American(1), Portuguese(1), Ghanaian(1), and Iranian(1).

12 reported growing up in the United Kingdom, 3 in France, 2 in Brazil, one in the Netherlands, one in Germany, one in the United States, one in Ecuador, one in Portugal, one in Spain, one in Argentina, one in Turkey, one in Croatia, one in Iran and one in Ireland.

21 currently live in the United Kingdom, 2 in France, one in the Netherlands, one in Croatia, one in the United States, one in Spain and one in Ireland.
23 of them are students and the other 5 are employed.

3.5 Results

In this section, we look at the results for each of the main influences and some of their properties. We mostly look at the data from the "Situational ratings", since every participant was rating the same stimuli answered every question in this part of the survey. Making sense of the data concerning the listener and the nominated songs is still under investigation and left for future work.

3.5.1 Results about the music

In this section, we look at the properties of music, using the ratings of the experimenter selected music: our data set of 24 excerpts rated by our 28 participants.

Firstly, we look at potential correlations between mean liking, familiarity, and the emotional content (felt valence and arousal) using Pearson's correlation analyses (**Table 1**).

	Liking (Mean)
Familiarity (Mean)	0.67**
Felt Valence(Mean)	0.94**
Felt Arousal (Mean)	0.28*

Note, *p<0.5, **p<0.01, ***p<0.001 and df = 22.

Table 1 - Correlations between liking, familiarity, and the emotional content

We chose to look at "Liking & Familiarity" and "Liking & Felt Valence" further as they present positive significant correlations

- **<u>Liking & Familiarity</u>**

We asked listeners to rate both Liking & Familiarity on a 7-point Likert scale. For each excerpt, we look at the mean ratings of Liking & Familiarity (**Fig 8**)

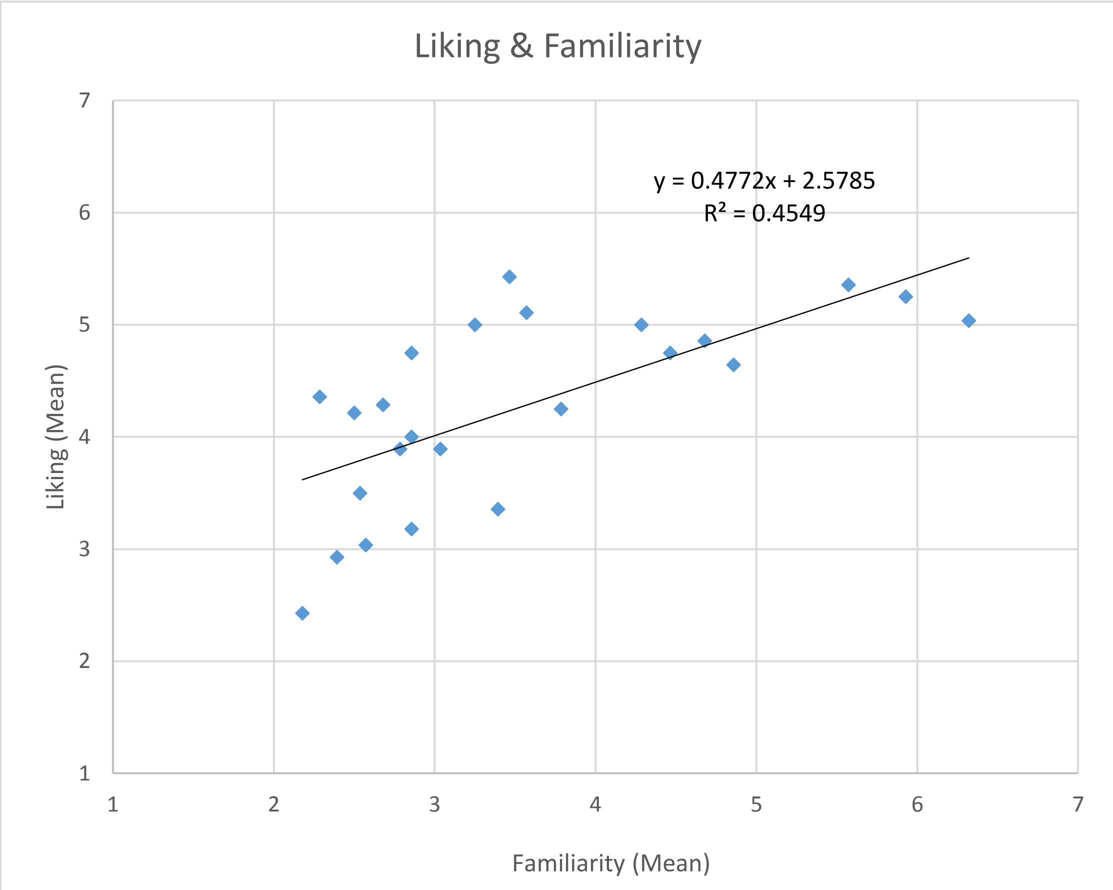


Fig 8 – Mean Ratings of Liking & Familiarity for experimenter-selected music

We observe a significant and positive relationship between liking and familiarity for our 24 excerpts, $r(22)=0.67$, $R^2=0.4549$, $p<0.001$. This result suggest that participants might prefer music with a greater familiarity. Although the correlation is not very strong, it clearly goes against Berlyne's theory [1] of an inverted-U shape introduced in 2.2.1. Indeed, our data does not seem to show any disliked familiar pieces. It is interesting to notice that we observe rather unfamiliar pieces with a great liking, causing the variance unexplained by our regression.

- **<u>Liking & Felt Valence</u>**

We asked listeners to rate both Liking & Felt Valence on a 7-point Likert scale. For each excerpt, we look at the mean ratings in both dimensions.(**Fig 9**)

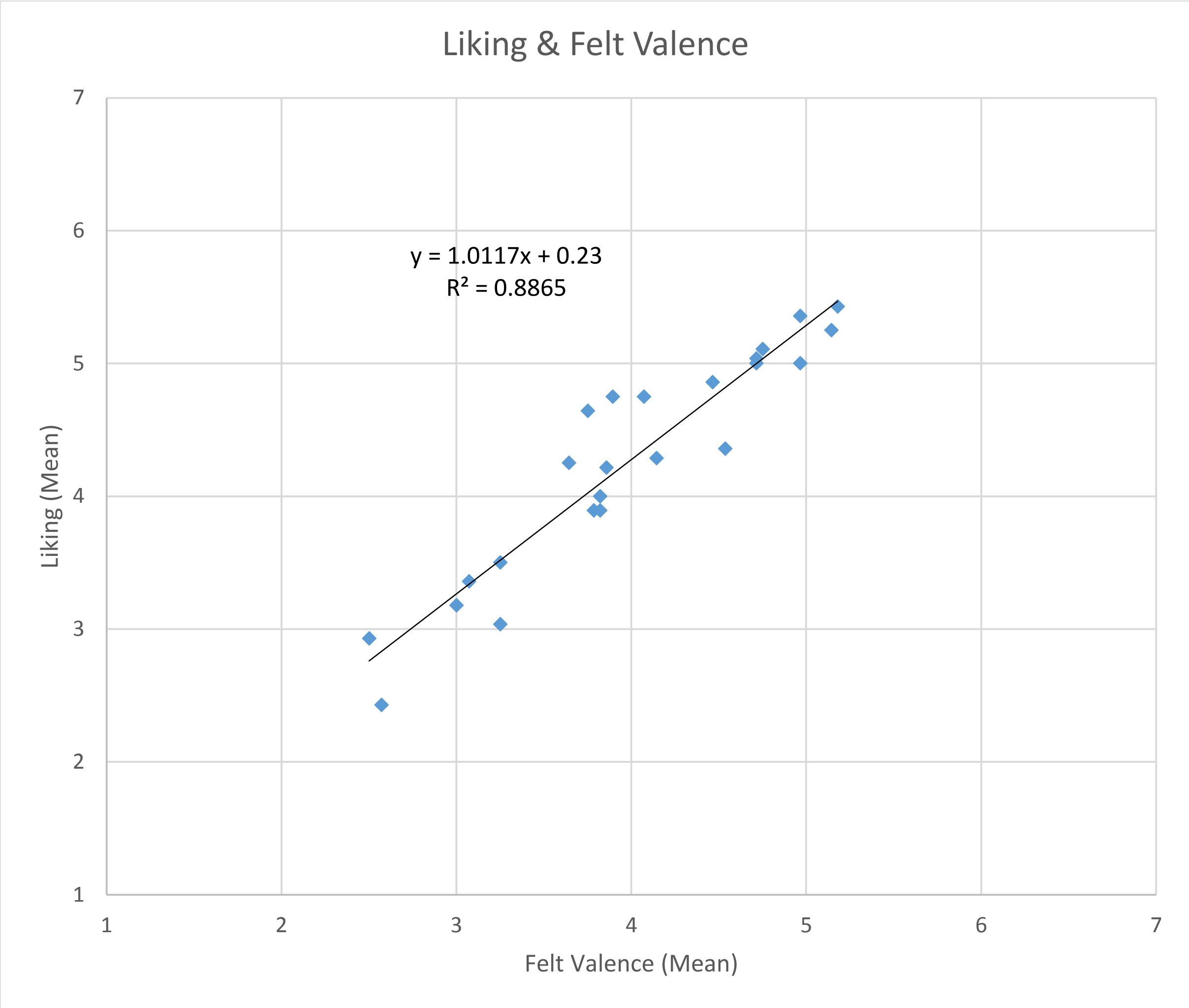


Fig 9 – Mean Ratings of Liking & Felt Valence for experimenter-selected music

We found a significant positive correlation between Liking & Felt Valence, r(22)=0.94, R^2=0.8865, p<0.001. This result suggests that the liking a piece of music gradually increases with the amount of felt valence.

3.5.1 Results about the context

- <u>Listeners, music selection & Frequency</u>

For each of our eleven situations, we asked all participants to report their frequency of listening to music on a 5-point Likert scale ranging from 1=Never to 3=Sometimes to 5=Always. We asked the reported listeners whether or not they selected specific music in this situations. We look at the number of listeners and listeners selecting music for each situation as well as Mean (SD) Frequency ratings (**Table 2**)

Situations	*Listeners (Nb)*	*Listeners Selecting Music (Nb)*	*Frequency (Mean)*	*Frequency (SD)*
At a House Party	27	9	4.14	1.04
Commuting	26	11	3.75	1.29
Listening to music	28	13	3.71	1.24
Housework	26	12	3.61	1.17
Walking down the street	23	8	3.07	1.25
Exercising	19	11	2.96	1.65
Reading	19	6	2.61	1.37
Chatting with Friends	17	5	2.04	1.07
At work	19	8	2.57	1.35
Getting ready in the Morning	16	7	2.25	1.35
Winding down to go to sleep	17	8	2.14	1.18

Table 2 – Number of Listeners, listeners selecting music, mean and SD frequency ratings

We noticed that participants more frequently listened to music in the situations "At a House Party" (M=4.14), "Commuting"(M=3.75), "At home, attentively and deliberately listening to music" (M=3.71) and " At home, doing Housework"(M=3.61). In contrary, less listening occurs during situations such as "Winding down to go to sleep"(M=2.14), "Getting Ready in the morning"(M=2.25) and "Chatting with Friends"(M=2.04).

However, if we look at the number of listeners, the ranking is slightly different: the situation with the most listeners is "At home, attentively and deliberately listening to music" with 100% of our participants, followed quickly by "At a House party" (Nb=27), "Commuting" (Nb=26) and "Housework"(Nb=26).

Situations in which participants select specific music more are "At home, attentively and deliberately listening to music" (Nb=13), "At home, doing Housework"(Nb=12), "Commuting"(Nb=11) and "Exercising" (Nb=11).

- <u>Situations, Liking and Familiarity</u>

We asked participants to rate each of the 24 selected excerpts for Liking, Familiarity and how likely they would be to listen to them in each of the 11 situations. Using Pearson's correlation analyses, we look at the mean liking, familiarity and "probability of listening" in each situation. (**Table 3**)

	Liking (Mean)	*Familiarity (Mean)*
S1 : Chatting with Friends (Mean)	0.73***	0.73***
S2 : Housework (Mean)	0.70***	0.65***
S3 : Exercising (Mean)	0.22*	0.39*
S4 : Listening to Music (Mean)	0.90***	0.50*
S5 : Commuting (Mean)	0.86***	0.64***
S6 : Morning (Mean)	0.77***	0.80***
S7 : Walking down the street (Mean)	0.79***	0.64***
S8 : At work (Mean)	0.85***	0.39*
S9 : At a house party (Mean)	0.27*	0.50*
S10 : Reading (Mean)	0.79***	0.27*
S11 : Sleep (Mean)	0.55**	-0.03

Note, *p<0.5, **p<0.01, ***p<0.001 and df = 22.

Table 3 – Correlations between the mean liking, familiarity and "probability of listening"

We notice, in **Table 3**, positive and significant correlations between Liking and the "probability of listening" in most situations. The strongest correlation is found in the situation "At home, attentively and deliberately listening to music"($r(22)=0.9$, $p<0.001$). It is not surprising, that people might listen to music they like in various situations, especially during a situation with no ongoing activities and dedicated to music listening only. In other situations, the listening strategies might be based on more crucial factors such as social context or arousal-based goals.

Mean ratings for familiarity and "probability of listening" are highly and positively correlated for situations such as "Getting ready in the morning"($r(22)=0.8, p<0.001$) and "Chatting with Friends"($r(22)=0.73, p<0.001$). In these situations, the more people know the songs, the more they are likely to listen to them. It is interesting to notice that for situations with intellectually demanding tasks such as "Reading" and "At work", the relationship stay positive but less important, as familiar music might be too distracting.

- <u>Situations and Emotional Response</u>

We asked participants to rate each of the 24 selected excerpts for felt valence, felt arousal and how likely they would be to listen to them in each of the 11 situations. Using Pearson's correlation analyses, we look at the mean felt arousal, felt valence, and the "probability of listening" in each situation (**Table 4**)

	Felt Valence(Mean)	*Felt Arousal (Mean)*
S1 : Chatting with Friends (Mean)	0.69***	0.66***
S2 : Housework (Mean)	0.71***	0.43*
S3 : Exercising (Mean)	0.17*	0.74***
S4 : Listening to Music (Mean)	0.84***	0.03
S5 : Commuting (Mean)	0.79***	0.42*
S6 : Morning (Mean)	0.79***	0.53**
S7 : Walking down the street (Mean)	0.78***	0.40*
S8 : At work (Mean)	0.81***	-0.10
S9 : At a house party (Mean)	0.29*	0.67***
S10 : Reading (Mean)	0.79***	-0.26*
S11 : Sleep (Mean)	0.59**	-0.53**

Note, *p<0.5, **p<0.01, ***p<0.001 and df = 22.

Table 4 - Correlations between the mean liking, familiarity and "probability of listening"

In **Table 4**, we notice a strong positive and significant correlation between felt valence and "the probability of listening to music" for situations such as "At home, attentively and deliberately listening to music" , "At work", "Commuting", "Getting ready in in the morning", "At home, attentively and deliberately listening to music". Unsurprisingly, "the probability of listening to" for "Sleep" presents a significative negative correlation to felt arousal

4 Conclusion

In this thesis, we presented the concepts and problematics of modelling musical preferences as well as the framework of music psychology in which there are studied. We presented a Web survey investigating the uses of music in everyday life. For the needs of this survey and the one to come in the next months, we created a data set of 104 songs and used 24 of them as stimuli.

However it appears that there is still quite some more data analysis left to do with the collected data as we only looked at a few factors and relationships.

In response to our 24 excerpts:

- We found a strong positive and significant relationship between liking and felt valence, indicating that people's preference for a piece of music gradually increases with the positivity of the emotion induced by the said piece.

- We found a moderate positive correlation between liking and familiarity. This is consistent to North & Hargreaves (1995)[15] and, therefore contrary to Berlyne's theory [1] of an inverted-U shape between liking and familiarity.

- Though more than 50% of our participants reported listening to music in each situation, ratings of frequency of listening seem more spread, showing that if, indeed, people listen to music in all kinds of everyday life situation, they do not always choose to do so. Frequency is context-based. Some contexts are more appropriate to music listening.

- The probability to listen to a piece of music seemed to be positively and strongly related to liking and felt valence for most situations and to familiarity and felt arousal to a more moderate extent.

5 Future Work

In this section, we present future perspectives for the conducted research and its context i.e. the Music Preference Project carried out at Queen Mary, University of London.

5.1 Further investigation of the collected data

As some of the collected data hasn't been analyzed yet, further analysis is left to do in the following months, such as the exact nature of each situations related to selection of music and making sense of the nominated songs and individual differences.

5.2 Mood-related lab study

For the purpose of creating an intelligent user-aware model, more studies, collecting behavioural data will be conducted. A more controlled lab-study looking at mood-based behaviors and inspired by one of the studies in Hunter & Schellenberg (2011) [6], has already been designed and will be conducted in the following months.

In this study, the liking for some excerpts selected from the Music Pilot Data Set will be investigated after 5 different mood induction. Each block of the experiment will correspond to an induced state: one for each quadrant and a neutral state for comparison. Blocks will be presented in a random order to the participants as well as musical excerpts. In each of these "mood blocks", the participant will listen to and rate musical excerpts from each quadrant as well as "neutral" ones.

Since it is impossible to have any real idea of the emotional state of the listener through a Web survey, we wish to have more control of the variable "current mood" by trying to induce it in a lab environment. This way, we hope to better understand the strategies based on this specific variable.

5.3 Neural correlates of musical preferences

Aside from behavioral data, neural-related data will be collected. Indeed, this project, when put back in its context, also investigates the relation between electrical brain responses recorded using Electroencephalography (EEG) and the listener's choice of music. While participants listen to musical excerpts and select them for future listening, features of the time-varying neural responses will be recorded prior to the actual decision-making.

Considering listener's responses in terms of liking, the emotional response, arousal level & judgement of valence in relation to musical preference, some relevant brain signatures will be recorded. So far, in the light of the already existing literature on the subject of music and brain responses, EEG spectral features (e.g. EEG beta Rhythm, Time-Frequency Analysis…), EEG temporal features such as ERP (event-related potential) and fMRI (Functional magnetic resonance imaging) are looked at. This part of the project, in relation to the behavioral studies, is being investigated by Dr. Yvonne Blokland.

5.4 Live Science at the Science Museum of London

Moreover, an experiment adapted to the visitors of the Science Museum in London, this fall. This would be a way to get more data from a wider range of listener by going out of the university context and refine our predictions. Appropriate experimental designs and activities related to our research topic are currently discussed.

5.5 Perspective of the Music Preference Project

Any knowledge of the psychological processes involved in musical choice gathered from the previously mentioned studies will be exploited to refine, parametrize and optimize predictions of musical preferences.

Combining research in neuroscience, music cognition and machine learning, we hope to understand the mapping between neural signals, musical structure and song selections. The final stage of this project will develop an integrated predictive model of musical choice by combining predictive models using the musical signal with those making predictions from the neural signal. The development of such a model, considered alone, is highly innovative. Furthermore, thanks to recent progress in the domain of EEG devices these past years, we can contemplate the possibility of using these new devices to control media players and other interactive systems according to musical preferences.

Appendix

A Stimuli

Artist(s)	Song Title	Nb of ratings	Arousal (Mean)	Arousal (SD)	Valence (Mean)	Valence (SD)
Conlon Nancarrow	Study for Player Piano no. 21	14	6.26	0.89	3.71	1.28
Refused	The Shape Of Punk To Come	15	6.35	1.06	3.08	1.43
Modest Mussorgsky	Night on Bald Mountain	18	5.74	1.29	2.97	1.48
Rage Against The Machine	Bulls On Parade	18	5.54	1.74	2.85	1.64
Pantera	Walk	14	5.93	0.92	2.56	1.65
Sunn O)))	It Took the Night to Believe	14	4.32	1.95	1.92	1.44
Olivier Messiaen	The Celestial Banquet	18	3.41	1.88	2.02	0.94
Scott Matthew	White Horse	14	2.46	1.17	2.41	1.04
Monteverdi	L'Orfeo: Act III	18	2.18	0.82	2.55	1.21
Portishead	Mysterons	19	2.83	1.30	2.71	1.64
Mozart	String Quartet in G Minor	15	2.79	1.39	2.96	1.51
Low	Laser Beam	17	1.56	0.64	3.41	1.56
Jonsí & Alex	Daníell in the Sea	18	1.90	1.00	4.28	1.16
Satomi Saeki	Chidori No Kyoku	16	2.18	1.14	4.68	0.95
Mahler	Symphony no. 5 in C-Sharp	15	2.21	0.91	4.55	1.72
Enya	Only Time	15	2.73	1.58	4.97	1.38
Nils Frahm	Ambre	17	2.26	1.09	4.28	1.19
John Dowland	Mrs. Winter's Jump, P.55	18	3.35	1.13	5.36	1.06
Bob Marley	Three Little Birds	15	4.19	1.60	6.34	0.66
Parov Stelar	Libella Swing	19	5.80	0.74	5.95	0.78
Benny Goodman	Sing, Sing, Sing	18	5.83	1.01	6.04	0.68
Vivaldi	Le Quattro Stagioni (La Primavera)	15	5.05	1.23	6.28	0.83
The Ramones	Blitzkrieg Bop	14	5.85	0.65	5.51	0.82
Gogol Bordello	Sally	15	6.21	0.73	4.61	1.89

Table A.1 - List and mean ratings of Stimuli

References

[1] Berlyne, D. E. (1971). Aesthetics and psychobiology. New York: Appleton-Century-Crofts

[2] Chamorro-Premuzic, T., Gomà-i-Freixanet, M., Furnham, A., & Muro, A. (2009). Personality, self-estimated intelligence, and uses of music: A Spanish replication and extension using structural equation modeling. *Psychology of Aesthetics, Creativity, and the Arts*, *3*(3), 149.

[3] Garrido, S., & Schubert, E. (2011). Individual differences in the enjoyment of negative emotion in music: A literature review and experiment.

[4] Hargreaves, D. J., MacDonald, R. A. R., & Miell, D. E. (2005). How do people communicate using music? In D. E. Miell, R. A. R. MacDonald, & D. J. Hargreaves (Eds.), Musical communication (pp. 1–25). Oxford, UK: Oxford University Press

[5] Hunter, P. G., Schellenberg, E. G., & Schimmack, U. (2010). Feelings and perceptions of happiness and sadness induced by music: Similarities, differences, and mixed emotions. *Psychology of Aesthetics, Creativity, and the Arts*, *4*(1), 47.

[6] Hunter, P. G., Schellenberg, E. G., & Griffith, A. T. (2011). Misery loves company: mood-congruent emotional responding to music. *Emotion*, *11*(5), 1068.

[7] Hunter, P. G., & Schellenberg, E. G. (2011). Interactive effects of personality and frequency of exposure on liking for music. *Personality and Individual Differences*, *50*(2), 175-179.

[8] John, O. P., & Srivastava, S. (1999). The Big Five trait taxonomy: History, measurement, and theoretical perspectives. *Handbook of personality: Theory and research*, *2*(1999), 102-138.

[9] Kamalzadeh, M., Baur, D., & Möller, T. (2012). A survey on music listening and management behaviours.

[10] Krause, A. E., & North, A. C. (2014). Contextualized music listening: playlists and the Mehrabian and Russell model. Psychology of Well-Being, 4(1), 1-16.

[11] Ladinig, O., & Schellenberg, E. G. (2012). Liking unfamiliar music: Effects of felt emotion and individual differences. *Psychology of Aesthetics, Creativity, and the Arts*, *6*(2), 146.

[12] Langmeyer, A., Guglhör-Rudan, A., & Tarnai, C. (2015). What Do Music Preferences Reveal About Personality?. *Journal of Individual Differences*.

[13] Martindale, C., & Moore, K. (1988). Priming, prototypicality, and preference.Journal of Experimental Psychology: Human Perception and Performance, 14(4), 661.

[14] Müllensiefen, D., Gingras, B., Musil, J., & Stewart, L. (2014). The musicality of non-musicians: an index for assessing musical sophistication in the general population. *PloS one*, *9*(2), e89642.

[15] North, A. C., & Hargreaves, D. J. (1995). Subjective complexity, familiarity, and liking for popular music. Psychomusicology: A Journal of Research in Music Cognition, 14(1-2), 77.

[16] North, A. C., & Hargreaves, D. J. (1996). Situational influences on reported musical preference. *Psychomusicology: A Journal of Research in Music Cognition*, *15*(1-2), 30.

[17] North, A. C., & Hargreaves, D. J. (1997). Liking, arousal potential, and the emotions expressed by music. *Scandinavian journal of psychology*, *38*(1), 45-53.

[18] North, A. C., & Hargreaves, D. J. (2000). Musical preferences during and after relaxation and exercise. *The American journal of psychology*, *113*(1), 43.

[19] North, A. C., & Hargreaves, D. J. (2002). Age variations in judgments of 'great'art works. *British Journal of Psychology*, *93*(3), 397-405.

[20] North, A. C., Hargreaves, D. J., & Hargreaves, J. J. (2004). Uses of music in everyday life. *Music perception*, *22*(1), 41-77.

[21] North, A. C., Hargreaves, D. J., & O'Neill, S. A. (2000). The importance of music to adolescents. *British Journal of Educational Psychology*, *70*, 255.

[22] Rawlings, D., & Ciancarelli, V. (1997). Music preference and the five-factor model of the NEO Personality Inventory. *Psychology of Music*, *25*(2), 120-132.

[23] Robinson, T. O., Weaver, J. B., & Zillmann, D. (1996). Exploring the relation between personality and the appreciation of rock music. *Psychological Reports*, *78*(1), 259-269.

[24] Russell, J. A. (1980). A circumplex model of affect. *Journal of personality and social psychology*, *39*(6), 1161.

[25] Sloboda, J. A., & Juslin, P. N. (2001). Psychological perspectives on music and emotion.

[26] Sloboda, J. A., Lamont, A., and Greasley, A. E. (2009). Choosing to hear music: Motivation, process, and effect. In Hallam, S., Cross, I., and Thaut, M., editors, Oxford Handbook of Music Psychology, chapter 40, pages 431–439. Oxford University Press, Oxford, UK.

[27] Sloboda, J. A., O'Neill, S. A., & Ivaldi, A. (2001). Functions of music in everyday life: An exploratory study using the experience sampling method.Musicae scientiae, 5(1), 9-32.

[28] Zentner, M., Grandjean, D., & Scherer, K. R. (2008). Emotions evoked by the sound of music: characterization, classification, and measurement. Emotion, 8(4), 494.