COMENIUS UNIVERSITY IN BRATISLAVA
FACULTY OF MATHEMATICS, PHYSICS AND INFORMATICS

NEUROPHYSIOLOGY OF EMOTION TRANSFER BETWEEN PROFESSIONAL DANCERS AND VIEWERS OF DANCE USING NEAR INFRA-RED SPECTROSCOPY

Master´s thesis

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Bc. Richard Leckéši

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Master´s thesis

Study Programme: Cognitive Science
Field of Study: 2503 Cognitive Science
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Supervisor: PhDr. Ing. Tomáš Gál, PhD.

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Názov: Neurophysiology of emotion transfer between professional dancers and viewers of dance using near-infrared spectroscopy
Neurofyziológia emocionálneho transferu medzi profesionálnymi tanečníkmi a pozorovateľmi tanca s pomocou infračervenej spektroskopie

Anotácia: Súčasný výskum emocionálneho transferu sa zameriava na niekoľké umelecké média akými sú napríklad hudba, film alebo opera. Existuje však malé množstvo empirických dát zameriavajúcich sa na emocionálny transfer pri tanci, ktorý je často považovaný za jeden z najlepších neverbálnych prostriedkov na prenesenie emócií jedného indivídua na druhé.

Cieľ: Analyzovať rozdiely v mozgovej aktivácii - v oblastiach spájaných s prežívaním empatie, empatizácie a emocionálneho transferu - profesionálneho tanečníka počas tanca vyjadrujúceho špecifické emócie a výsledky porovnať s mierou vcítenia sa publika na základe ich výpovedí.

Literatúra: Bläsing, B. et al. (2012). Neurocognitive control in dance perception and performance. Acta Psychologica, 139(2), 300–308.
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Orgs, G., Caspersen, D., & Haggard, P. (2016). You Move, I Watch, It Matters: Aesthetic Communication in Dance. V S. S. Obhi & E. S. Cross (Ed.), Shared Representations (s. 627–654). Cambridge: Cambridge University Press.

Vedúci: PhDr. Ing. Tomáš Gál, PhD.
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Title: Neurophysiology of emotion transfer between professional dancers and viewers of dance using near-infrared spectroscopy

Annotation: Present research has been focusing on emotion transmission in several artistic expression media such as music, film or opera but there is little empirical data concerning emotion transmission via dance which, one can argue, might be the most clear and direct way of, nonverbally, transmitting one's emotions.

Aim: The aim is to analyse differences in brain activities – in areas associated with experiencing empathy, empathising and emotional transfer – of a professional dancer during performing a specific emotion and compare those results with expectations of present audience.

Literature:
Bläsing, B. et al. (2012). Neurocognitive control in dance perception and performance. Acta Psychologica, 139(2), 300–308.
Calvo-Merino, B. et al. (2010). Extrastriate body area underlies aesthetic evaluation of body stimuli. Experimental Brain Research, 204(3), 447–456.
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Declaration

I hereby declare that I elaborate this diploma thesis by myself, independently using cited literature.

Bratislava, 2019

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Abstract

Recent studies have shown that an individual has an ability to routinely pick up and even feel emotions transmitted via several artistic media like music, film or opera. However, there is little empirical data on the medium of dance. Which is quite surprising due to dance being considered one of the most direct forms of, nonverbally communicating an emotion, although it is not known how well people can use movement to transmit an emotion and if the viewers respond similarly or correctly. In the theoretical part we focus on defining emotions, emotion transfer, cognitive an affective empathy and dance as a form of communication and as an aesthetic movement from philosophical, psychological and neurophysiological point of view. In the experimental part we try to determine if there are any patterns or correlations between the medial prefrontal cortex, inferior frontal gyrus and bilateral temporal parietal junction areas of the brain of a professional dancer while in attempt to communicate an emotion via dance and the evaluation of the performance by an audience. Our thesis consists of two experiments. In the first experiment 10 professional dancers were asked to communicate a specific emotion via movement while their brain activity was being measured by near infra-red spectroscopy and after each performance they were asked several questions concerning their dance. In the second experiment recordings of the dancer´s performance was shown to 15 non-dancer observers. Their task was to correctly guess the emotion being performed and answer a few questions concerning the performance. After data analysis no statistically, significant correlation was found between the brain activation of the dancer and the evaluation of the observers. However, correlations were found between the specific brain areas of our focus suggesting an interconnected system. Furthermore, correlations were also found between the evaluated expressiveness of the dance by the audience and their general liking of the performance and confidence of correct guessing of an emotion. Also, significant percentage of correct guesses of emotions by observers have been found suggesting an existence of information transfer between the observer and the dancer.

Key words: emotion, emotion transfer, emotion contagion, dance, aesthetics, communication, near infra-red spectroscopy, medial prefrontal cortex, inferior frontal gyrus, temporal parietal junction

Abstrakt

Doterajšie štúdie nám ukazujú, že jedinec je schopný rozpoznať a dokonca aj emócie vysielané cez média akými je napríklad film, opera alebo hudba. Avšak existuje minimálne množstvo empirických dát zaoberajúcich sa médiom tanca. Tento fakt je pomerne prekvapujúci, keďže tanec je často považovaný za jeden z najdirektívnejších foriem neverbálnej komunikácie emócií aj napriek tomu, že nie je úplne známe ako dobre dokáže jedinec využiť pohyb na prenesenie emócie a či pozorovatelia daného pohybu zareagujú podobne alebo správne. V teoretickej časti sa zameriavame na definovanie emócií, emocionálneho transferu, kognitívnej a afektívnej empatie a tancu ako forme komunikácie a ako estetickému pohybu z filozofického, psychologického aj neurofyziologického hľadiska. V experimentálnej časti sa snažíme determinovať, či existujú určité paterny alebo korelácie medzi aktiváciou pre-frontálneho kortexu, inferiórneho frontálneho gyrusu, bilaterálnej teporo-parietálnej medzery v mozgu profesionálneho tanečníka zatiaľ čo sa snaží vyjadriť emóciu pohybom a ohodnotením tohto výkonu pozorovateľom. Naša práca sa skladá z dvoch experimentov. V prvom experimente bolo 10 profesionálnych tanečníkov požiadaných, aby vyjadrili špecifickú emóciu pohybom zatiaľ, čo sme merali ich mozgovú aktivitu infra-červenou spektroskopiou. Po každom tanci bolo tanečníkom podaných zopár otázok ohľadne ich výkonu. V druhom experimente boli 15 participantom bez tanečných skúseností premietnuté nahrávky tanečníkov z prvého experimentu. Ich úlohou bolo uhádnuť akú emóciu tanečník na videu vyjadruje a odpovedať na pár otázok ohľadne daného tanca. Po analýze dát sme nenašli žiadne štatisticky signifikantné prepojenie medzi mozgovými aktiváciami tanečníkov a ohodnotením tanca pozorovateľmi. Avšak, korelácie boli nájdené medzi mozgovými oblasťami tanečníkov, na ktoré sme sa zameriavali čo naznačuje na určité prepojenie medzi týmito oblasťami. Korelácia bola taktiež nájdená medzi ohodnotením expresivity tanca pozorovateľmi, tým ako sa im daný tanec páčil a ich sebavedomím, že pri danom tanci uhádli emóciu správne. Taktiež signifikantné bolo aj percento správne uhádnutých emóciu pozorovateľmi, čo naznačuje na existenciu určitej výmeny informácií medzi pozorovateľom a tanečníkom.

Kľúčové slová: emócie, emocionálny transfer, tanec, komunikácia, infra-červená spektroskopia, mediálny prefrontálny kortex, inferiórny frontálny gyrus, temporo-parietálna medzera

Contents

Introduction

In this study we will focus on emotions and the emotional synchronicity between two individuals. In the theoretical part of this study we will be examining emotions from philosophical (theory of mind), psychological (types of emotions, empathy, emotion transmission) and neurophysiological (brain areas connected to emotions, empathy and emotion transmission) points of view based of latest theories and empirical studies. Next, we will describe research on transmission of emotions so far and present our hypotheses for our current research.

Dance has always been considered as one of the best nonverbal languages for transmitting emotions. It has been there throughout almost all our history and it´s deeply culturally based. Over time several branches of dance have been created with their own specific rules and their specific essence. Therefore, we can argue that dance as an aesthetic experience can be considered as a process of communication, if we put it in the simplest form, we can say that the performer, dancer serves as a transmitter of a given message by using complex or simple body movements as a message itself and the observer is the receiver of that message. There has been extensive behavioural and neurophysiological research on how aesthetic experience while observing a dance is processed by the observer but there is little to no empirical data concerning the dancer´s point of view both behavioural and neurophysiological. It is apparent that dancer use quite complex psychological strategies while training and also while performing. Communication or awareness of the audience has also been shown proving that the dancer creates a certain aesthetic space with the observer and they communicate in this space. So here comes the big question. Why is there so little empirical data on this topic when dance seems to be such a good form of nonverbal communication and emotion transfer? This question is the main motivation of our interest in this topic.

Research and basic definitions

In the first part of our thesis we will describe and define the basic terms that we will be using, and we will present recent research concerned with the psychology and neurophysiology of emotion transfer, aesthetics, dance as a form of communication and observation of dance. In the end we will briefly summarize the research on the dancer´s point of view.

1 Emotions

It is quite hard to define what emotions really are. Partially it is due to the broad spectrum of human feelings and emotions some of which are universal and some culturally based, some positive some negative, some occur with more intensity some with less. In psychology and neuroscience there are many types and definitions of emotions. In this chapter we are going to specify the basic definitions of emotions as we work with them.

1.1 Basic definitions

One of the first scientists to study emotions was William James. The first theory of emotions was the James-Lange theory which claimed that we do not cry because we are sad, and we do smile because we are happy but the direct opposite, we are sad because we cry, and we are happy because we smile. This theory was lately hugely criticised by Walter Cannon who proposed a theory with his colleague Philip Bard claiming that emotions have their centre in the thalamus. They argued that body and the mind are activated during the experience of emotions independently form one another. These two theories laid the foundation to future research of emotions, emotion contagion and empathy (Kassin, 2004). The dispute between these two theories laid the foundation of the investigation of what emotions are, how they work and what are the brain centres processing them.

As we said earlier there are many definitions of what an emotion is. The most basic definition as seen by most psychologists and neuroscientists is that emotion is a feeling combined with a physiological response and it is evoked by the individual's interaction with the environment. (Beech et al., 2018).

There are also many theories on how emotions are processed and in what manners are they expressed. Many argue that there needs to be a certain hierarchical structure of emotions, some claim that emotion processing is just a set of neurophysiological responses.

Kassin and other psychologists agree that emotions contain three co-dependent parts, the physiological arousal, the expressive part containing mimicry, behaviour and voice and the cognitive evaluation (Kassin, 2004).

According to Oatley and Jenkins there are several levels of emotion which have different time of lasting. The have created a hierarchy according to the time the emotion prevails. Expressions (seconds or minutes), autonomous changes (seconds or minutes), moods (hours or weeks), emotional damage/trauma (weeks or years) and personality traits/temperament (months or whole life) (Oatley & Jenkins, 1996).

Atkinson and her colleagues describe six components which underline emotion processing. Cognitive appraisal, the individual's judgement of the meaning of his current situation. Subjective experience as an affective state that colours subjective experience. Tendencies to think and act in particular ways. Internal changes of the body, the activation of autonomic nervous system (increased heart rate, skin conductibility etc.). Facial expressions and at the and the overall response to the emotion (Atkinson et al., 2009).

There are many types of emotions and even more words for emotions in all the different languages that people use. In the English dictionary alone, there are two thousand words for emotions. But there are several emotions which can be deemed as universal (Kassin, 2004). This arouses the question. Are emotions universal or are they culturally based, maybe even influenced by the language used in a certain culture?

One of the leading experts on emotions in general throughout the second half of 20th century is Paul Ekman. His multicultural research of emotions, gesticulation and mimicry has led him to believe that there are basic emotions that do not change throughout cultures and are universal. These emotions are fear, anger, sadness and happiness. Later on, this list has been expanded with surprise and disgust. Some psychologists also consider curiosity and contempt among the universal emotions (Ekman, 2007). Paul Ekmans work inspired many scientists to study and understand the universality of these emotions. But just these types of emotions did not describe the complexity in which a human being is able to feel and process the world on an emotional level. Human feelings are just too complex to be put under just 6 types of emotions. There are many feelings that cannot be described by these simple emotions. For instance, when an individual is feeling love it is not just happiness, it is a cascade of many different feelings pleasant and unpleasant ones with different intensity. This implies that emotions can be somehow combined and that a person is not always feeling just one emotion at a time.

According to Robert Plutchikem the universal, basic emotions are the main building stones upon which other, more complex emotions can be built. He claims that there are 8 basic emotions which all have different intensities and “tones” and all other, new, emotions are just combinations of the basic eight with different intensity for instance, as we described earlier, love like one of the most complex emotions (Plutchikem, 1980 in Kassin, 2004).

1.2 Neurophysiology of emotions

Emotions, combinations of emotions, evaluation of emotions and emotional response are a very complex mechanisms. Based on this statement it is safe to say that even the brain networks responsible for these mechanisms will be complex. There are several subcortical and cortical brain areas which are believed to be connected to emotions and there is a lot of research being conducted but we still do not understand fully how this brain areas work and how are they connected in order to process and create feelings.

Among the main subcortical brain areas that are being actively connected to emotion and emotion regulation is the amygdala which is believed to regulate and process fear and threat response. Connected to the amygdala is the stria terminalis which is believed to process anxiety, and a part of the basal ganglia called the striatum of which the ventral region processes motivational and emotional aspects of behaviour. Among the cortical regions included in the processing of emotions is the prefrontal cortex which is responsible for working memory, planning and supporting executive functions which leads us to believe it is the core brain region for emotional response strategies (Beech et al., 2018). This is just a basic description of the complex brain mechanism for processing and constructing emotions. From this model we can see that there are subcortical areas which are responsible for the basic emotions and distribution of hormones creating these emotions and that these areas are connected to the higher cortical areas of the brain, mainly the prefrontal cortex which enables us to recognise these emotions and evaluate them, to understand an emotion, to process it and to create an appropriate response given the situation.

1.3 Expressing an emotion

So far, we have been discussing the types of emotions, the basic definitions of emotions and the basic neurophysiology of emotion processing. In this chapter we will discuss in what ways can an individual express emotions to other people. Being able to nonverbally express one's emotional state is an evolutionary advantage because it enables humans to communicate without making any noise. There are several ways in which a person can nonverbally express an emotion. One of the most basic ones is the facial expression. Each of Paul Ekmans basic universal emotions also have a universal facial expression.

An important part of the nonverbal communication besides the facial expressions is the body language. There are a lot of forms of body language and their meaning. The way a person looks at you is one of the forms of body language. If a person avoids eye contact it can be translated as coldness or shyness or when a person is looking at you intently it can be translated as affection or sympathy but it also can mean hatred and strong disliking. It depends on the context and the relationship between the two individuals. Other forms of nonverbal communications are touch and gesticulation. Physical contact can be a sign of affection, caring or sexual interest (Kassin, 2004). Throughout the history we can see the development of expressing and communicating emotions via movement. One of the best ways to communicate an emotion nonverbally in our opinion is dance. Dance, in the combination with music, can be used to describe not only basic emotions but can be used to tell whole stories evoking strong and complex emotional states in the observers without the performer having to say a single word. We will discuss the influence of dance on the emotional state of the observer in later chapters.

1.4 Empathy

We were talking about emotions and the many ways how emotions can be communicated. Another part of emotions is how the other person receives them. This is called empathy. It is the ability to recognize an emotion in another person and to experience the same emotion with them. The ability to recognize emotions of another person and be able to experience the same feeling is an important part of human social interaction (Nákonečný, 2000).

Empathy is the one of the most essential abilities in social interaction a human possesses because it allows us to understand the feelings of others making it a key emotional component. Empathy motivates caring for others and prosocial behaviour in general (Beech et al., 2018).

1.4.1 Cognitive and affective empathy

Perceiving and processing the emotional state of another person can be divided into two separate systems. One system is responsible for mirroring the perceived emotion of an individual and the other is responsible for understanding the emotion. This is the affective and cognitive empathy.

Cognitive empathy is the individual's ability to accurately identify and understand what another person is feeling and thinking. While affective empathy or so-called emotional empathy is the ability to share those emotions with another person, sharing their happiness or pain and distress (Beech et al., 2018).

According to Mellisa Clark and her colleagues, affective empathy is evolutionary the earliest system of empathy (Clark et al., 2019). Preston and de Waal (2001) confirm this statement due to the subject having to project themselves into the place of the object in order to understand the situation which takes evolutionary later developed brain areas (Preston & de Waal, 2001).

Nákonečný also defines aesthetic empathy. He argues that this kind of empathy needs to be recognized as a separate form. It is the ability to emphasize with the content and form of an art piece or a landmark in a way that this experience creates feelings which are projected onto these objects (Nákonečný, 2000). This is quite interesting because Nákonečný is basically creating another category of empathy and is separating it completely from cognitive and affective empathy which are on some level connected.

1.4.2 Neurophysiology of empathy

Neurophysiological experiments have also been conducted to determine the main brain areas responsible for processing both cognitive and affective empathy.

Banissy and colleagues conducted a neuroimaging study to determine if variability in grey matter volume occurs in brain regions of participants who have differences in cognitive and affective empathy. They found decreased grey matter volume inferior frontal gyrus, precuneus and anterior cingulate cortex of individuals greater affective empathy. Participants with greater cognitive empathy had greater grey matter volume in the insula and anterior cingulate and less volume in the somatosensory cortex (Banissy, Kanai, Walsh, & Rees, 2012). This study shows that in every individual there seems to be a dominant type of empathy based on the amount of grey matter and active neurons. The cause of dominance of affective empathy in participants with less grey matter volume in the inferior frontal gyrus (IFG) is because the IFG is believed to be one of the core centres for processing of cognitive empathy.

Rojiani and colleagues tried to understand how the brain works when two individuals are trying to communicate an emotion. To test this, they have used drums as a form of communication and were measuring the neural activity of the participants by functional near infra-red spectroscopy. While drumming there was an activation of the sensorimotor areas of the sender but in the brain of the receiver the activation of temporo-parietal junction, a brain area connected to emotional and social functions (mainly processing of affective empathy), was observed. Furthermore, they have discovered that drumming is efficient in communicating both arousal and valence and that drumming there has been a greater cortical response while communicating via drumming than communicating via talking (Rojiani et al., 2018). The temporo-parietal junction area being active in the brain of the receiver during the drumming is a sign of successful attempt of communicating an emotion and shows a certain level of emotion synchronization based on nonverbal communication.

Kessler and Wang (2013) argue that for the humans to establish a shared view of the outside world visuo-spatial perspective taking is one of the essentials. They also argue that this perspective of the world is unique for a human being because of the ability to mentally adopt the point of view of others. Their behavioural studies are built on the theory of Flavell et al. (1981) who defined two levels of visuo-spatial perspective taking. The first level employs a line of sight mechanism which infers visibility and the second level allow the mental adoption of the view point of someone else, probably by mental rotation. Their studies suggest that the second level of visuo-spatial perception taking is greatly modulated by the transformation of body postures suggesting that the mental image of space is strongly reliable on multisensory representations (Kessler and Wang, 2013 in Antúnez, Palomino, Marfil, & Bandera, 2013).

1.5 Emotion contagion

A distinct phenomenon occurring in empathy is emotional contagion. It was defined as the ability to mimic and mirror expressions, gestures, posture and vocalizations of another person in order to emotionally converge. It is a concept of deliberately mirroring behaviour to be able to enhance affective empathy (Clark et al., 2019).

One of the first scientists to shed some light to the field of emotional convergence was LeBon (1985). His main interest was in the synchrony of emotions in crowds. His belief was that a small crowd can synchronize their emotions even if they do not share the same values and beliefs. He compared this emotional synchronicity to a disease, that the affective and cognitive states can be infectious when the circumstances are right. They behave like a contagion (Goodwin, Jasper, and Poletta, 2000 in von Scheve & Ismer, 2013).

Beyer et al. (2014) created a review on collective emotions in small groups on the basis of rituals and small gatherings but also large group gatherings like for example the world cup and nation-wide events. This review has shown that the collective emotions are important, if not crucial, in the reinforcing and maintaining of the group cohesion and, furthermore, social identification (Beyer, 2014). In Beyers review several studies have shown a very strong connection between the rituals and sharing of emotions in order to strengthen the bonds within a group or even within a nation. This suggest that emotion transfer is also culturally embodied in our thinking and is therefore a crucial part of our day to day lives.

These results show that emotion sharing, and emotion understanding does not have just the evolutionary advantage because of noiseless nonverbal communication but also because it strengthens the community and social interactions of the group no matter how big. The fact that, in the right circumstances, an emotional state can be shared by whole nations shows the significance and major importance of cognitive and affective empathy and their strong influence on our brains.

2 Aesthetics

2.1 Basic definitions

The word “aesthetics” comes from the original Greek term “aisthetikos” which means “I sense, I Feel.” The first empirical study about the cognition of aesthetics was conducted by Gustav Theodor Fechner in 1871 who studied the so called “golden ratio” or the optimal proportions in paintings. In the more recent time aesthetics and it´s neural basis has been investigated in music and the visual arts (Orgs et al., 2016).

What is “aesthetic” has become a notion in the philosophy of art in the 18th century. According to this notion when we perceive some form of beauty on artworks it is by means of some different, special, processes other than when we feel appraisal from ordinary objects, like food (Goldman, 2001 in Brown et al., 2011). The term aesthetics and aesthetic experience have not been redefined since the 18th century and some authors claim that the definition is still incomplete or that it is too general for the scientific community but there have been no upgrades to the basic definition of what it means for something to be aesthetic.

When we look far back in the ancient Greek we can see that even back then philosophers were contemplating the questions of art and aesthetic performance. Aristotle claimed that aesthetic experience is based on the individual’s ability to impersonate or to imitate and that the observer takes pleasure in witnessing the imitations of reality. This shows the importance of social interactions between the artist and the observer in order to create an aesthetic experience in the performing arts like dance (Orgs et al., 2016).

2.2 Aesthetic experience

The interaction between the observer and the receiver is what makes a so-called aesthetic space. This interaction is grounded in the way in which the information and the material is processed by the performer, in other words to what extent does the performer understand the message he or she is to communicate to the receiver and how well can she communicate it based on her expertise. Furthermore, the aesthetic space is also grounded in the cognition and perception of the embodied mind of the receiver (DeBeukelaer, Azevedo, Tsakiris, 2018). The performer needs to have a very clear idea about what message is he to communicate to the observer and if his expertise in the given art field is good enough for the information to be communicated and understood by the observer clearly. If the performer chooses an information requiring major expertise in his art field but does not possess this expertise, then the information may be only partially understood or completely lost and the observer will have no pleasure from the performance because he will be confused.

DeBeukelaer et al. (2018) argues that the spectator is to some extent influenced by his priors, their socioeconomic interests and expectations which puts the spectator in the aesthetic space in which some form of relatedness to the performance can be achieved. But for this to happen the spectator needs to focus and to immerse himself and distance himself repeatedly from the performance (DeBeukelaer, Azevedo, Tsakiris, 2018).

DeBeukelaer et al. (2018) build their notion of aesthetic space based on the work of Warburg. Warburg argues that the spectators mind is in a pendulum like state while observing a performance. This means that the observer is actively immersing into the detail of what the performer is doing, focusing on the key elements of the artwork which might lead to a feeling of relatedness or rejection, but also distancing themselves from the details to arrange the sensory input and to try and give a meaning for further action (Warburg, 2000 in DeBeukelaer, Azevedo, Tsakiris, 2018).

The extraction of the meaning of the performance and creating the feeling of rejection or relatedness is based in three basic steps in the embodied mind of the observer. The immersion, the distancing and the memory. In the immersion process, as we discussed above the spectator focuses on the key elements of the performance. According to DeBeukelaer et al. (2018) this immersion will create a mutual resonance between the performer and the spectator. A shared space between the two sensorimotor systems in interaction with one another which leads to a transfer of information of the artistic material that is conceived by the spectator in a similar sensorimotor situatedness (DeBeukelaer, Azevedo, Tsakiris, 2018). This state of focus in the aesthetic experience is somewhat enhanced by the spectator's ability of being still. What this means is that the actions of the spectator are, to some extent, cortically inhibited which boosts the ability of mapping the artistic performance leading to a state in which the spectator is fully able to absorb the key elements of the performance (Angelini et al., 2015 in DeBeukelaer, Azevedo, Tsakiris, 2018). According to this definition it is possible that the artistic information is able to influence the mechanisms responsible for the immersion abilities of the mind (DeBeukelaer, Azevedo, Tsakiris, 2018). The mechanisms of embodied simulation should create an uprising feeling in the spectator which would lead to approval or rejection of the performance. Maybe the best example of immersing and distancing focus from a performance can be seen on professional ballroom dancing competitions. In a standard competition there are about 6 to 8 judges and 6 to 8 pairs of dancers are performing a one-and-a-half-minute dance all at once. The judge has 90 seconds to evaluate each of the 8 pairs on the dance floor. This means that he or she needs to focus on a pair that is visible, focus on the technique in detail and then zoom out and focus on the pair as a whole, as one organism, then zoom out more and set focus on another pair.

Distancing, according to Warburg is also a necessary principle for the observer to make sense of performance. Distancing form the performance works based on associative processing. This means that, while observing a performance, the spectator creates personal associations from what is seen. Analogies are created from the performance based on past experience, spectator's prior knowledge and expertise of the performance which elicits associated feelings that enable the spectator to personally relate to the performance (DeBeukelaer, Azevedo, Tsakiris, 2018).

Based on neurophysiological data the process of associating is based in the spectator's ability to make predictions of the specific information coming to the sensory input. These predictions enable the brain to minimise the energy cost of allocating attention, promoting a rapid response to events and focus on the necessary aspects of the performance which are relevant to the spectator's current situation (DeBeukelaer, Azevedo, Tsakiris, 2018). This is very similar to the work of Andy Clark and his predictive brain theory which also states that the brain makes certain predictions about what information is it going to obtain on the specific situation that it is in and compares this prediction with the actual information coming from the sensory modalities. A part of the predictive brain theory is the so-called parity principle.

The parity principle as Andy Clark describes it is when focusing on an object or an entity in the external world, the entity becomes part of the thinking process therefore it becomes part of the cognitive process extending our cognition outside of the boundaries of our skull (Kiverstein & Clark, 2009). The extended cognition of an observer stretching to the performer can be viewed as DeBeukelers aesthetic space in which the observer immerses and distances himself from the performance in order to fully understand the information that the performer is trying to communicate.

Buzsáki looks at the brain activity in a hierarchical point of view very similar to Andy Clarks predictive brain theory. He claims that the brain is not just a mechanism to process information that just get imbedded in the cortex but in this process the brain also generates information. Therefore, what is perceived as the external reality is a continuous calibration of the brains generated information influenced by the outside world which is in psychological terms called experience (Buzsáki, 2006).

Based on these claims we can argue that the essence of aesthetic experience is divided into two major roles from the perspective of the performer. First is to communicate a certain information as clearly as possible for the observer to fully grasp it and second, based on that information create a feeling of pleasantness or relatedness in the observer. If the performer manages to do this than the observer will achieve a full aesthetic experience of the art piece.

2.3 Neurophysiology of aesthetics

It is thought that artistic activity is specifically a human behaviour and can be pinpointed to specific cortical networks. These brain networks are able to generate aesthetic experience.

However, according to the neuroscientific studies conducted in the last 15 years show that there seem to be more brain networks associated with aesthetic experiences. Some authors found correlates in the reward areas of the brain, specifically the orbitofrontal cortex (Kawabata & Zeki, 2004), some found activity in dorsolateral prefrontal areas believed to be connected with higher executive functions (Cela-Conde et al., 2004), activity in the fronto-median regions as the centre for moral and social judgement (Jacobsen et al. 2006) or activity in the amygdala and other brain areas concerning emotions (Di Dio et al., 2007). These findings suggest that that aesthetic experience is not just one neural network processing sensory information but several major networks working together. It makes sense, after all, if we break it down, the performance needs to be captured by sensory modalities meaning that an individual needs to focus on the performance, and he needs to capture the essence, the information within the performance, understand that information, understand the feeling that message is giving him and appropriately respond to the whole stimulus. This is to complex for just one network to handle on its own. Therefore, there has been extensive research in the neuroscience field focused on processing of an aesthetic experience.

In his meta-analysis, Brown et al. (2011) tried to distinguish specific brain areas linked to aesthetic appraisal for vision and for audition. The patterns showed activation in the fusiform gyri (bilaterally), inferior frontal gyri (bilaterally), hypothalamus and amygdala (bilaterally) for the vision modality and midbrain and posterior cerebellum for audition (Brown et al., 2011).

When looking at the data from the visual and auditory modalities, Brown and his colleagues also found significant amount of brain areas activating in the areas of temporo-parietal junction, medial prefrontal cortex and orbitofrontal cortex. According to their findings it seems that the orbitofrontal cortex has a function of some kind of a gateway for conscious subjective experience with the main attention on experience of emotions (Brown et al., 2011).

Ticini et al. argued that there are two possible ways with which and individual is perceiving art, an aesthetic experience. When one perceives an object, which is pleasant, the object can elicit some degree of aesthetic pleasure suggesting that the pleasure is governed by the attributes of the object, the stimulus. These are implicit aesthetics. When we are in a museum we have an intention to find aesthetically pleasant objects therefore the stimulus (the object) is combined with our intention because it is set in a specific context (the museum). These are explicit aesthetics (Ticini, Urgesi, & Calvo-Merino, 2015). The concept of implicit and explicit aesthetics fits well with DeBeukelers theory of aesthetic space meaning that it doesn't have to be just a fictional cognitive space between the observer and the performer but also a physical space where the aesthetic is sought to be experienced.

Ticini et al. also reviewed some neurophysiological studies concerning the perception of aesthetic experience. They have focused on how the brain processes whole body parts or details of body parts and how it processes faces. According to their review the fusiform body area (FBA) is responsible for the processing of complex body movements and configurations in a similar matter as the fusiform face area (FFA) processes faces. In contrast to the FBA the extrastriate body area (EBA) is linked to the processing of details and single parts of the body. The results of their review suggest that there are specific body processing routes that contribute to the processing of body aesthetic perception (Taylor et al. 2007; Urgesi et al., 2007 in Ticini, Urgesi, & Calvo-Merino, 2015).

A neurophysiological structure was proposed by Chatterjee concerning visual aesthetics. In this framework emotional experience is at the very centre of aesthetic perception. He argues that visual stimuli of an art piece activates the fronto-parietal areas which focus the attention of the viewer towards features determining high valence and arousal (Chatterjee, 2003 in van Paasschen, Bacci, & Melcher, 2015).

Van Paasschens review of the literature summarises the difference in viewing art by a professional and a novice. Novices tend to like an art piece more if it more abstract but also like when there is information present for the art specific art piece (van Paasschen, Bacci, & Melcher, 2015). Van Paasschen and colleagues found that there are no differences in affective evaluation concerning valence and arousal between experts and novices, but experts rated artworks both from the laboratory and in the museum as more preferred and more beautiful than novices (van Paasschen, Bacci, & Melcher, 2015). This is quite a breakthrough because it is showing that when one has a certain degree of expertise in a given art field then he or she evaluates an art piece in a different manner, experiences it differently and maybe even different feelings are evoked than in a novice.

These neurophysiological studies concerned with the brain areas believed to be connected to processing aesthetic experience all gathered data which point to three major brain networks that are apparently interconnected. The subcortical areas around the limbic system and the areas for processing abstract and detailed movements, the prefrontal cortex which can be connected to decoding and understanding the art piece and the area around the temporo-parietal junction which is believed to be processing affective empathy and emotion synchronization.

3 Dance

We have been discussing emotions, emotion transfer and the complexity of an aesthetic experience. We have also proposed that dance is one of the best ways to nonverbally communicate. In this chapter we will describe the basic definitions concerning dancing and we will combine the emotional and cognitive aesthetic experience while observing dancing with dance as a form of communication.

3.1 Basic definitions

Dance is considered to be the universal language of human expression and has evolved into several various functions and forms over its history. Dance is generally described as one or multiple individuals moving in a specific rhythmical manner. These various forms of dance can be learned to a certain level of expertise and are judged according to the individual's strength, flexibility, coordination of movements, group synchronicity, keeping with the rhythm and other elements of performance of a specific dance. (this makes dance as a series of coordinated complex movements a good area for the investigation of integration of communicative, aesthetic and social elements in neuroscience studies) (Bläsing et al., 2012). According to the Oxford English Dictionary dance is a "series of steps and movements that match the speed and rhythm of a piece of music" (Orgs et al., 2016). In any type of dance if a dancer wants to become a professional he o she needs to learn a very complex set of movements, he also needs to know how to effectively combine these movements to create a flawless and pleasing string of movements referred to as choreography. This learning process involves a lot of visual and verbal information transfer which is transformed into movement. Dancers need to adjust their movements according to space, time, rhythm, their partner and possible other obstacles on the dance floor like for example other dancers. In professional ballroom dancing a dancer not just has to have full control of his movement and his environment but also needs to acknowledge his or her dancing partner with whom he needs to perfectly synchronise in order to execute the choreography successfully. Therefore, a dancer needs to observe, generate, execute and coordinate sometimes extremely complex movement patterns while being fully aware of his surroundings and his dancing partner which demands full activation of the physical and cognitive skills of the dancer.

3.2 Dance as a form of communication

Orgs and his colleagues argue that expressing a movement in dance has a purpose of communicating the exchange of ideas, emotions and intentions between the dancer and the observer (Orgs et al., 2016).

So, we can argue that dance as an aesthetic experience can be considered as a process of communication. If we put it in the simplest form, we can say that the performer, dancer serves as the transmitter of a given message by using complex or simple body movements as the message itself and the observer is the receiver of that message. So, by this definition Orgs argues that dance can be considered as another form of communication, similar to the other forms (Orgs et al., 2016).

When observing the choreography of a dancing group the interpersonal synchrony and spatial distribution of the dancers may also be aesthetically relevant (Loeb, 1986 in Orgs et al., 2016). This occurs mostly in group dancing in contemporary dance, ballet and some special symphonic groups of pairs choreographies in standard ballroom dance.

A number of implications arises when we consider dance as a communication process serving the passing of information. It separates dance from other different art forms like painting, film or music (Orgs et al., 2016). It can be much richer on information than information from a painting or music, furthermore it can use music as an amplifier of transferred information/emotion and it is separated from film in a way that it is nonverbal.

From this point of view, we can talk of a communication theory in dance. One thing needs to be considered and that is that as all forms of communications even dance needs to be constrained somehow. The complexity and richness of a message transmitted via dance is largely limited by the abilities of the dancer and the human body in general. The communication theory argues that to reduce these constraints one needs to train to communicate via this channel. The more a dancer trains the more complex information he can communicate. What is interesting about dance in the communication theory is that it is not restrained just to one form of dance (such as ballroom dancing, Hip-hop or contemporary dancing). The ability of the dancer to communicate intentions and emotions through movement is the only thing that matters (Orgs et al., 2016). No matter what form, we believe that dance is a universal language which can be understood in every culture. It does not matter if its ballet, contemporary dance, Flamenco, Tango Argentino, Japanese traditional dances or just a simple Waltz if the expertise of the performer is high enough he can communicate clear information and emotion to the audience. But for a dancer to communicate this information and evoke an emotion in the audience he needs to prepare, by creating a choreography.

Concerning the creation of a dance choreography for the purpose of communicating a specific message it needs to be stated that in most cases there is a second person involved in this process called a choreographer or a trainer. The dancer and the choreographer divide the labour in generating a message. This division of work varies in relationship to the methodology chosen for creating the choreography. There are a variety of elements that affect the communication of a message such as the type of sound, music chosen for the choreography, movement sequences, space in which the choreography takes place, time frame and others. Depending on the chosen methodology the combination and synchronization of these elements is the work of either the choreographer, the dancer or collaboration of the two on different levels of responsibility (Casparsen, 2004 in Orgs et al., 2016).

When a dancer is performing a choreography there is an exchange of information between him and the audience. Bidirectional communication is the essence of dance as a performing art. Continuous feedback from the audience is provided at every time point of the performance, even if it is a “passive” one. For example, even if the audience is quiet and there seems to be no feedback this can be viewed as a concentration of the observers at the performance. The reactions of the audience serve as a confirmation if the audience received the transmitted message and then further communicate if the dancer’s message was understood as the dancer intended. For example, if the dancer communicates a message that is intended as to be funny and the audience laughs than the transmission of the message by the dancer was successful. If there is no laughter than this feedback shows that the dancer failed in transmitting his intentions This feedback from the audience can be used by the performer to further adjust the process of communication. This kind of communication loop is unique in the performing arts and cannot be found in other forms of art (Orgs et al., 2016).

Orgs further describes how the dancer communicates with the observer in more detail by applying the cooperative principles of successful conversation created by Grice (1989). According to Grice, there are 4 main cooperative principles, the quantity of information, the relation between batches of information, the manner of presentation of the information and the quality of information. Orgs and his colleagues believe that this Gricean approach will help to better understand the complexity of nonverbal communication between the performer and the receiver (Orgs et al., 2016).

Maxim	Manifestation in dance
Quantity	Movement vocabulary and dance style
Relation	Structural properties of the movement sequence, complexity and novelty of composition.
Quality	Congruency between observed movement and inferred movement intentions; stage presence
Manner	Semantic ambiguity and novelty of movement intentions

Table 1: Grice's maxims of successful communication applied to dance.

The quantity describes the amount of information that is communicated. Best case scenario is when a message carries just the right amount of information required for the intention to be clear. This quantity applied to dance would therefore determine the amount of movements potentially performed by the performer. For the message to be understood, the dancer and the receiver need to have a common vocabulary. The vocabulary of movement is constrained by the choreographic decisions of the dancer and by the physiological limitations of the human body which means that dance style can be regarded as a constraint on the vocabulary. If a dancer uses a small vocabulary of movements the communication between dancer and observer will be better facilitated but it will greatly limit the amount and complexity of information that can be transmitted whereas if the vocabulary is robust and capable of transmitting complex information it can initially became less accessible and more difficult for the spectator to understand (Orgs et al., 2016). This is why the performer needs to prepare before the performance by creating a choreography. He needs to know his audience and balance the complexity of movements with the expertise of the observers. If the dancer is performing on a competition he knows he will be observed by a group of skilled professionals therefore his movement vocabulary also can be robust but if he is performing for non-dancer audience he needs to find a balance between complexity which will keep the audience interested and will successfully transmit the information and emotion but he also needs to keep in mind that movements with small complexity and high repetition can become boring after a short while.

The next cooperative component is relation which refers to how appropriate the information is at a given time of the process of communication. The information should be on point and relevant in the specific situation. When a dance is communicating relevant information, he will fulfil the expectations of the audience. On the other hand, when the dancer is communicating irrelevant information he will violate expectations. Orgs and his colleagues argue that the performer needs to balance the violation of structural expectations because the aesthetic impact of the choreography depends on it. Too excessive violation of the expectations of the receiver is unrewarding whereas excessive conformity and repetition of the expected information can lead to monocity and a feeling of non-involvement from the side of the receiver (Orgs et al., 2016).

If we then combine the principles of quantity and relation in movement, we can talk about them as syntactic complexity and novelty of the information transferred through dance. That is, when a dancer performs a choreography with only a few restrictions and some or no repetitions of the movement (every figure/movement will be performed only once) the message will be maximally rich in information, but it may be quite hard for the receiver to follow. On the other hand, in a choreography which contains only one or few movements the message gets maximally redundant and only a small amount of information is transferred (Orgs et al., 2016). Therefore, as discussed above, the performer needs to balance these aspects in the choreography.

Manner, this cooperative component states that more clear messages are easier to understand then the unclear ones. This seems quite obvious but as we discussed earlier, clear and understandable movement may not always be aesthetically pleasing to the spectator. Dance movements have been characterised sometimes as abstract and hard to understand or with no obvious message. Some argue that ambiguity has an essential status in art. This means that the ambiguity of dance gives the spectator space for several possible interpretations, most likely the one personally most relevant. Or on the other hand the receiver can just enjoy the various choices of possible interpretations. The unclear nature of the message can give the spectator a feeling of involvement and creates an active role for him in trying to recover the intentions of the message (Orgs et al., 2016).

The ambiguity of a communicated message through dance is often the intention of the author and is a part of the content (Deborah Hay, 2000 in Orgs et al., 2016).

Quality, this cooperative component can be seen as a prerequisite for the remaining three components. It has two simple rules. If you believe something to be false, do not say it and the same goes for the lack of adequate evidence. Orgs argues that a dance is genuine if there is congruency between the performer’s movements and his intentions from the spectators point of view. In dancing competitions or other ranked dancing performance the jury and the dancers use specific vocabulary when ranking the performance such as “believable” or “authentic” in contrast to “fake” or “just doing the steps” or “just not feeling it”. This points out to the fact that inconsistency between what is intended and what is perceived is an important element when aesthetically evaluating a dance. This congruency has been previously emphasised by Sanislavski in his book "Creating a role". In this book Staniclavsky writes:

"Scenic action is the movement from the soul to the body, from the centre to periphery, from the internal to the external, from the thing an actor feels to its physical form. External action on the stage when not inspired, not justified, not called forth by inner activity, is only entertaining for the eyes and ears; it does not penetrate the heart, it has no significance in the life of a human spirit as whole." From this citation we can see that the connection between the dancer and the audience, the creation of aesthetic space where the dancer genuinely feels what he is performing and immerses into his role has major effect on how the performance affects the audience. If the dancer "just performs" and does not "feel" it the audience doesn't have the same level of intensity of the aesthetic experience from the performance.

Orgs argues that the most important part of the effect of the stimulus as a message sent by the performer is the manner in which his brain processes that given stimulus. They have identified several areas of processing which actions visual and emotion features of the movement are. Said features are communicated through the kinematics of movement and produce the relation and quantity of the information as a syntactic structure and the ambiguity and manner of information as the semantic content of the choreography. Of course, the expertise and familiarity of the movement on the motor and visual level also need to be taken into consideration as an important factor in which the brain processes dance as a complex set of movements (Orgs et al., 2016).

Studies reviewed by Bläsing et al. (2012) based mostly on use of fMRI and transcranial magnetic stimulation have shown that the more complex and difficult a dance sequence is the more the observer enjoys it. Also, an existence of a complementary neural system for the aesthetic evaluation of dance body movements and postures has been hypothesized according to these studies. Kilners review of neuroimaging studies has shown that inferior frontal gyrus plays a big role in action execution on several different levels of abstraction of the action from most abstract action to more solid representations (Kilner, 2011).

But here we talk about highly abstract performances where the dancer's sole purpose is to create an emotional experience as the only type of information. There is no story to the choreography.

Orgs takes into consideration several proposals of processing a stimulus in the brain in relation to the features of aesthetic experience. Berlyne (1974) identified two main dimensions which played an important role in aesthetic experience. First, he describes aesthetic judgements liked/disliked, beautiful/ugly, pleasant/unpleasant. Second, he describes judgements relative to the structure and information about the stimulus such as boring/interesting, simple, complex and orderly/disorderly. Berlyne was building on the work of Osgood, Suci, Trannenbaum (1957) who originally presented also a third dimension, potency which could be either strong or weak, but he did not include this dimension. Orgs argues that potency needs to be included and proposes that this dimension relates to the intensity on which the performer and the receiver communicate. Nevertheless, Orgs mostly focuses on the first two dimensions and proposes that the first dimension (valence) is dependent on processing fluency and the second dimension (aesthetic arousal) is dependent on the specific brain mechanisms for processing novelty detection in both semantic and syntactic domain (Orgs et al., 2016). That means that the more the observer understands the information and emotion transmitted the more he enjoys the performance and aesthetic arousal is higher when the movement is novel and more complex.

The effect the stimulus has on the observer is fully dependant on the way his brain processes a given message. Orgs and his colleagues call this aspect of processing messages “fluency” and refers to it as a major area for predicting aesthetic experiences. In simpler words fluency is the ease with which a certain stimulus is processed in the cognitive system of the brain. The idea is that fluent processing of a stimulus is possible when certain brain structures are specifically adjusted to the particular features of that given stimulus. Therefore, aesthetic experience does not rise from the objective stimulus features but from how these specific features are processed in the brain by the cognitive system (Orgs et al., 2016).

So, when an observer is watching a dance the fluency with which he observers it will resolute from the neural architecture which mediates the perception of movement. Therefore, when a stimulus optimally activates the specific brain mechanisms a fluent processing should be generated and therefore the stimulus should be aesthetically pleasing (Orgs et al., 2016).

3.3 The neurophysiology of aesthetic movement observation

From what we have discussed so far it is apparent that the neural background of observing an aesthetic movement such as dance will include several brain networks that collaborate with each other to create the complex cognitive and affective experience which we defined as aesthetic experience.

From several studies it seems to be clear that an observation of another person complex movement such as dance influences several bottom-up and top-down processes between the observer and the dancer (Blake & Shiffar, 2007 in Bläsing et al., 2012).

Several studies have shown that the observers infer expressions of emotions from both dynamic and static displays of movement. Superior temporal sulcus and the fusiform body area have been shown to increase their activity when observing expressive actions compared to the neutral ones. This finding suggests that these areas play a role in inferring emotions when observing a movement. When taking the expertise of the observer into account we can also observe activations in the premotor brain areas which are also believed to be a part of extracting intentions and emotions from observed action. Event-related potential studies have also shown that expressive body postures are processed in a faster rate than neutral body postures. From these findings Orgs and colleagues propose a link between the difficulty with which an observed movement is processed and the expressiveness of said movement. This suggests a high importance of the fluency of processing a stimulus as a predictor of aesthetic processing (Orgs et al., 2016). The fact that expressive body postures are processed faster than the neutral ones is a good argument that the more expertise the dancer has and the more expressive his choreography is the easier the emotion and information transfer takes place.

The aesthetic experience and judgement of dance movements and of dance postures according to Orgs are governed by principles of symmetry and balance but also by the "gestalt" of visual principles like the aesthetic judgement of the kinematics of movement and good continuation.

Calvo-Merino and colleagues found neural activity (using fMRI) in the occipital cortices and the mirror neuron system of subjects watching dance movements and rating them aesthetically (Calvo-Merino et al., 2008 in Bläasing, 2012).

Other neuroscientific studies found that observers of dance who do not have the motor expertise to perform complex dancing movements enjoy watching difficult dancing choreographies impossible for them to physically repeat more. (Bläsing et al., 2012).

Also, dance postures and movements can be regarded as beautiful or not so pleasing by the observer independently of the observers views on the personal or physical attractiveness of the dancer (Brown et al. 2004), showing that the observer does not focus on the gender of the performer or his or her physical attractiveness but rather on the performance itself. This finding is quite interesting due to the fact that looking for physical attractiveness is deeply evolutionary imbedded in our subcortical brain areas, but aesthetic experience of a performance is somehow strong enough to overlap this evolutionary tendency.

Calvo-merino et al. (2010) investigated the neural mechanism of the aesthetics of body perception in certain brain areas, specifically the ventral premotor cortex (vPMC) and the extrastriate body area (EBA) areas using repeated transcranial magnetic stimulation. They found out that apparently stimulating the EBA tended to dull the participants aesthetic sensitivity while the stimulation of vPMC enhanced it (Calvo-Merino et al., 2010). These results showed that EBA and vPMC are in some way connected but their individual inputs affect the aesthetic experience and judgement in its final form differently. The possible explanation why the aesthetic judgement was dulled in participants with stimulated EBA is that this area is responsible for processing details in body movements, therefore the observer was too focused on the details and was not able to immerse and see the aesthetic beauty of the whole performance.

Tipper and her colleagues conducted a study in which they were trying to identify specific brain areas responsible for the decoding and extracting of meaning from body movements. They have identified brain regions which extract meaning of movement by using repetition suppression and BOLD activity while the participants were watching repeated or novel themes of pantomime or modern dance. Repetition suppression while observing repeated themes has generally been observed bilaterally around superior temporal gyri, inferior temporal gyri, insula and orbitofrontal cortex with connections to the hippocampus and amygdala suggesting a whole system with the purpose of decoding and extracting meaning from the movement (Tipper, Signorini, & Grafton, 2015).

Tipper et al. argue that the decoding and extraction of meaning of a movement can be applied and explained by the predictive coding theory. They argue that the action observation network works as a recurrent mechanism with implemented Bayesian system which serves as a calculation mechanism of prediction error, it´s reduction, feedback processes and predictive neural coding on each level of the action observation system. This means that on each neural level of action observation the system generates predictions that guide the activation of lower levels of the hierarchy thus the predictions as neural signals are sent to the lower levels of the processing hierarchy where they meet the actual neural representations form the observed action for comparison. Any calculated discrepancy between these two neural codes is a prediction error which is for the update of existing predictive priors for the purpose of minimizing the prediction error in the future. This leads to an integration of action representations on each level of the hierarchy (Friston et al., 2011 in Tipper, Signorini, & Grafton, 2015). But Andy Clark also argues that we need to experience the object from every angle. Andy Clark claims that in some way we are sensorimotor dependent. What this means is, that for us to understand visually, we need to change our visual angles and move around the object, or grasp it and rotate it in our hands, for us to gain full perceptual experience of said object. This sensorimotor motion is strongly dependant on our past experiences with the given object (Clark, 2008). This is one aspect of the predictive brain theory which does not really fit to the suggestions of Tipper and her colleagues due to the fact that almost always when an audience is viewing a performance they are static, either sitting or standing, they do not move around the performance space to view it from every angle in order to understand it.

Furthermore, Tipper and her colleagues argue that their results contribute to the general results in other studies suggesting hemispherical asymmetry in processing of the semantics and the socio-emotional sensitivity. According to these findings they suggest that there may be shared brain areas or networks of brain areas which decode the meaning of language as well as movement (Tipper, Signorini, & Grafton, 2015). If this were true, then motoric movement and presumably aesthetic movement in particular would be on the same level of importance in the brain as spoken language putting it way above other artistic styles.

In the study conducted by Orgs, Hagura and Haggard they were investigating the perception of aesthetics concerning several continuous forms of body postures in a movement sequence represented by pictures. Concerning body postures, they have found out that participants rate higher in preference postures which have simple leg positions (straight legs higher bent legs lower ratings) but preferred more images that have shown more complex arm movements. Concerning movement, although no movement was visible to the participants because they were shown just a sequence of pictures, they have rated higher in likability those sequences of postures that showed good continuity of movement before those where the sequence showed a reversal of a movement. Also, participants preferred sequences showing symmetry then asymmetrical sequences. Only time when there was a slightly higher asymmetrical preference was when the participants were shown the asymmetrical sequences first so one can say that familiarity is a factor which need to be included in explaining this phenomenon. This phenomenon was not shown in the symmetrical sequences (Orgs, Hagura, & Haggard, 2013). The findings of this study are actually quite largely used in several dancing types including flamenco or ballroom dancing (specifically Latin-American dances) where the dancers distract their potential mistakes in steps and rhythm by, sometimes excessive, use of hand movements.

3.4 Role of expertise of the observer

We have already mentioned that the aesthetic experience of the observer can also be strongly influenced based on the expertise he has in the specific art field. This also concerns dance.

The aesthetic experience of the observer is determined by his affective, sensory and motor circuit responses to the dancer's body and expressive movements. However, observing a complex set of movements such as dance and the activation of specific brain areas during this observation is subjective to some extent and depends on the previous sensory and motor expertise of the viewer.

The aesthetic perception of movement will depend on the spectator's familiarity with the observed movements. The more familiar the observer is with the movements the more likely will this choreography be enjoyed. More frequently observed movements will be preferred to those less frequent (Orgs, Hagura, Haggard, 2013 in Orgs et al., 2016).

Orgs also argues that if the perception of visual motion is an embodied process then the observer must be able to make and imagine said movement if their brain is to make a full response to it. This is due to the fact that if the perceived movement is outside the receiver's motor repertoire than it cannot be fully mapped by the perceivers motor representations and is therefore motorically unfamiliar. That means that a less familiar movement should be less aesthetically appreciated than a movement which can be mapped onto the motor representations of the observer. Studies on this matter however have not been consistent and show different findings. Several studies show that the ability to perform a movement positively correlate with the aesthetic liking of the movement (Beilock and Holt, 2007; Topolonski, 2010; Kirch, Drommelschmidt, Cross, 2013 in Orgs et al, 2016) other studies show that novel and unfamiliar movements that are not in the observer's motor repertoire are preferred to the known movements (Cross et al., 2011; Daprati et al., 2009 in Orgs et al., 2016). Still, one needs to bear in mind that if the dancer has limited movement vocabulary and is repeating the movements too often it can lead to boredom and loss of interest from the spectator. Here, as mentioned above, the studies are not so consistent with one another. Some studies claim that the less expertise the observer has the more he will enjoy the experience, and some argue that if the observer has high expertise and experiences more frequent and known movements than the aesthetic experience will be more pleasing for him. We argue that the pleasantness or unpleasantness of the performance based on the expertise of the observer does not change that much. The intensity of the experience can, the expert can focus on the technique of the performer and leave out the "aesthetic" part completely or on the other hand he can see and "read" a lot more information from the process allowing him to have much deeper and more intense experience than a novice has. It all depends on the context of the performance and maybe even on the reasons of the observer for attending the performance.

Zajenkowski and colleagues conducted a study in which they were testing if and how dancing can influence the mood of an individual based on their expertise with dancing. He found quite high differences between professional dancers and novice dancers in mood changes. Professional dancers tended to have more anxiety and enjoyed dancing less due to competition compared to novice dancers who dance just for pleasure (Zajenkowski et al., 2015). The association of dance to a competition which can evoke some minor feeling of anxiety is also a good example of how expertise can influence the aesthetic experience.

The fluency of processing a stimulus is also dependant on the experience of the observer. The familiarity with an observed movement is a strong influence on the way in which the movement is observed and processed. According to fluency theory therefore when a movement is familiar there are stronger neural connections in the brain which resolute from learning said movement. This means that when the familiar movement is observed it´s processing is faster, does not use as much cognitive processing power and is more easily activated (Hebb, 1949 in Orgs et al., 2016). This means that a movement should be more aesthetically pleasant to the observer because of the activation of existing motor and visual representations (Orgs et al., 2016).

The familiarity with simple and even complex movements has been shown to be processed by specific brain networks which cooperate with one another in interesting ways. These networks are the mirror neuron system and motor resonance system.

Mirror neurons or the mirror neuron system was primarily discovered in the brains of macaque monkeys. Specifically, in the premotor area F5. They are also present in the inferior parietal lobules. There have been a lot of neuroimaging studies on humans showing that we also have brain areas that behave in a similar way than the mirror neuron system in the macaque monkeys when executing and observing movements (Kilner, 2011). These studies have shown that when a macaque monkey is observing a familiar movement its premotor and motor brain areas are activated even without the animal actually moving.

Another good example pf the motor resonance and the mirror neuron system and the complexity of these mechanisms in a study conducted by Calvo-Merino and her colleagues on professional ballet dancers and professional capoeira dancers. A short choreography was made by the ballet dancers and was recorded, afterwards the capoeira dance trainer imitated the ballet choreography by using the repertoire of capoeira dance movements. Both choreographies were recorded and a 3 second sequence of both dances was produced. This 3 second sequences were shown to the capoeira and ballet dancers while they were being measured by an fMRI machine. Results show significant activity in the parietal, premotor cortices, superior temporal sulcus and the classical mirror neuron areas in the temporal lobes (which are the main areas of the motor resonance and the mirror neuron systems) when the dancers were shown sequences of the dance from their own area of expertise (when ballet dancer were shown a video of ballet dance) (Calvo-Merino et al., 2005). This study shows how precise and detailed the motor resonance system is when determining if a movement is familiar or not. It can determine a familiar movement from one's own area of expertise even if shown two identical movement sequences just performed by two different professionals.

Aglioty and colleagues in their studies with basketball players and basketball commentators with just visual experience of the commentators may activate certain brain areas associated with the motor resonance and the mirror neuron systems but that a complete motor resonance system will develop only as a result of considerable motor practice (Aglioty et al., 2008).

Cross and her colleagues conducted a study in which they were trying to determine how long does it take for a novice dancer to develop a finetuned motor resonance system in a whole new area of expertise. Professional dancers were recruited for this study and were training completely new and complex dance movements out of their area of expertise for 5 hours a week 6 weeks in a row. After each week an fMRI scan was conducted to see if there are any changes in the brain activations. They found out that a complete motor resonance system takes only 5 weeks to fully develop (Cross et al., 2006).

Mahon and Caramazza present a motor theory of action recognition theory based on several neuroimaging studies that have found that mirror neuron systems and motor resonance activates not only by a visual stimulus but also for auditory stimulus. They argue that this process is thus multimodal because auditory stimulus is also represented in the motor cortex. The core of their theory comes from the theory of speech perception by Lieberman et al. (1967) in which is stated that in order to recognise the sound of speech one has to imagine or simulate the motor action which would lead to creations of such sounds (Mahon & Caramazza, 2005).

One of the studies supporting this theory is one conducted by Tettamanti et al. (2005) which demonstrated that the mirror neuron and motor resonance systems are activated even by just listening to sentences which describe actions of parts of the human body (Tettananati et al., 2005 in Mahon & Caramazza, 2005).

3.5 Dancers point of view

In the previous chapters we have discussed mainly the aesthetic experience of the observer of a given performance. In this chapter we will discuss what little is known of the performers point of view. There have not been many studies conducted on the performers point of view, if he or she feels the same emotions and is transmitting them to the observer, if and to what extent is the performer aware of the audience and how does it influence the performance? What kind of psychological strategies do they use in performing or creating a choreography if any? There are a lot of questions and little empirical data.

According to Paasscheen and colleagues, there is very little data which show if the performer is able to elicit similar or shared emotions in the observer or if the spectator is just experiencing a range of emotions while looking at the performance, thus showing that the experience is purely subjective (Paasschen et al., 2013).

Some studies show that detecting emotion from the artwork is developed even in children. Blank et al. (1984) conducted a study in which he found out that young children are able to detect emotions from a performance or an artwork even when they don't have the concept of art and artistic style fully developed. Furthermore, a study by Hasenfus et al. (1983) has shown that even preschool children have the ability to differentiate different styles of art which suggests a much deeper level of decoding of art or a performance by the observer that was previously thought (Blank et al., 1984; Hasenfus et al., 1983 in Paasschen et al., 2013).

From the view of cognitive neuroscience studies show that there seems to be a supramodal and central mechanisms underlining emotional expertise and evaluation. For example, the dorsomedial prefrontal cortex has been shown in several studies to be an area strongly connected to representations of emotions, emotional evaluation of a stimulus and the experience and appraisal of emotions (Kober et al., 2008; Lee and Siegle, 2012; Reiman et al., 1997 in Paasschen et al., 2013). Based on these studies we can argue that aesthetic experience is not learned so there arises the question if the performer feels the same things as the observer or if there are any similar patterns of brain activation in the two.

Stephanie Hanrahan argued that there is too little research on the dancer's point of view on the psychological implications of professional dancing on an individual, so she conducted a study in which she was interviewing professional dancers about their weaknesses and mental strengths that dance has brought them. Concerning anxiety, the dancers reported feeling anxious when waiting on a performance but when they started dancing the “fazed” out and just danced. Also, the presence of family or their trainer in the audience showed improved motivation to give out a better performance suggesting that the role of the audience is also quite important. Dancers also reported routine use of imagery most commonly before the performance to calm down or to rehearse the choreography in their mind one more time (Hanrahan, 2003).

In another study concerned with the mood improvements by dance showed that recreational dancers have more improved mood after dancing than professional dancers suggesting that the context of the dance also need to be taken into consideration (Lakes et al., 2016).

This study suggests that dancing improves the affective state in those with depression and other negative psychological symptoms, also improvements in self-esteem have been recorded. Lakes et al. (2016) think this might be due to the heightened levels of dopamine and serotonin (Lakes et al., 2016).

David Kirsh investigated a practice apparently most, if not all, dancers make, and it is called “marking”. Dancers use this technique while practicing and rehearsing their choreographies. It is basically an execution of a dance sequence in a simplified form. The performers use simplified movements with their body which represent full sequences in the actual performance. The dancers argue that there are two main reasons for marking as a form of rehearsal. It saves energy because they do not have to do the whole sequence of a dance and it helps to see if the whole choreography is good concerning special distribution of the figures or tempo. According to Kirsh it is a form of real-time reflection (Kirsh, 2011).

Kirsh distinguishes three main types of marking. Marking for self, marking for others and marking for coordination. Marking for coordination and marking for others basically serves as a special form of communication via movement for sharing of ones thought that creates common focus and helps the dancers to synchronize (Kirsh, 2011).

As we can see there is very little empirical data concerning the dancers. It is apparent that dancers use quite complex psychological strategies while training and also while performing. Communication or awareness of the audience has also been shown proving that the dancer creates a certain aesthetic space with the observer and they communicate in this space. But what are the brain activations of the dancer when communicating a certain emotion to the audience? Is the dancer experiencing the same emotions he is communicating to the audience and therefore are there same or similar brain activations as in the brain of the observer? Is there a difference in ease of communicating an emotion for the dancer when he is genuinely feeling that emotion or when he is just communicating it without feeling? These are all questions that have not been answered yet. In this thesis we will be focusing on these questions and try to find satisfying answers to them.

Practical part

In this chapter we discuss in detail the research sample, the experimental design and its procedure and we provide results of this experiment. In the end of this chapter we provide the discussion of our findings, the implications of this findings, limitations of our experiment and possible future steps in which the research of this topic could follow.

Based on the theoretical part we can see that there is a lot of empirical data concerning the observer of an aesthetic experience or more specifically of an aesthetic movement. Studies have shown that an individual has the ability to routinely pick up and even feel emotions transmitted via several aesthetic media. However, dance seems to be an area which has been neglected, because there are very little empirical data. It is quite curious due to the fact that many consider dance to be one of the best nonverbal media for transmission of emotion and meaning. When dancing, one literally involves one's body in attempt to transmit affect and a certain meaning. However, it is actually unknown if people are able to or good at using their bodies to transmit an emotion via dance or if the viewers respond similarly or correctly. Nor it is known how emotion sharing via dance is processed in the performers brain and if there are any patterns of the brain areas activation and the response of the audience. Therefore, our motivation in this thesis is to broaden this topic and provide empirical data on the neurophysiology of the performer compared to the response of the audience to the performance. This thesis aims to assess the ability to transmit emotions via dance.

For a part of the experiment a functional near infra-red spectroscopy hyporescanning (fNIRS) device was used. fNIRS consists of a cape on which laser diodes are placed which are connected to an amplifier. When put on an individual´s head the diodes proceed to shine through the skull of the participant using a light of a near infra-red frequency an wavelength of approximately 700 – 1000nm. The light can shine through roughly 8cm of tissue. Measurements are taken based on oxygen levels and blood flow in certain brain areas. The light travels in a form of an arc. It is transmitted from one channel, some of the light is absorbed and the rest is picked up by a second channel. Based on the returned amount of light the metabolic activity of a given brain area is calculated (Pellicer & Bravo, 2011).

4.1 Research sample

Our research sample consisted of two groups of participants. This is due to the fact that our experiment is divided into two parts. We will describe the methodology of both part of the experiments in the following chapters. For the first part of the experiment we have gathered 10 professional dancers, 5 males and 5 females with age between 24 and 30 years. The dancers were from a different branch of professional dancing varying from ballroom dancing through contemporary dance to breakdance. All the participants have been dancing professionally, meaning on a scale of competitions and professional performances, for at least 5 years. All the participants were right handed with no previous history of neurological illness and none were taking any medications when participating in this experiment. Recruitment process was done by two of the experimenters, who are professional dancers, one of ballroom dance and the other of contemporary dance. Three of the participants were students from Slovakia and seven were students from Austria. The participants received no reward for participating in our experiments, except of the participants from Slovakia who were financially compensated for the expenses of the trip to University of Vienna where this experiment took place.

For the second part of the experiment 15 participants were recruited. The participants were 7 males and 8 females with age between 20 and 30 years. All of the participants had no personal experience with any branch of professional dancing so their expertise in dance was purely observational. Recruitment process was done in Bratislava, specifically in the dorm city of Ľudovít Štúr of the Comenius University on Bratislava. All the participants were students of said University. The participants did not receive any reward for participating in the experiment.

4.2 Hypothesis and research question

Since our thesis is a pilot study and therefore it is designed to be purely exploratory our hypothesis is quite broad. Our aim in this thesis is to gather as much data as possible and try to look and them from several different angles to see if there are any patterns or correlations between the dancers and the observers. Our experiment is designed in a way to answer one broad research question: Does making a dance to express a specific emotion that is easier to guess by the observers or is more expressive show different brain patterns in the brain of the dancer or are there even such patterns in the brain activation of the dancer while performing that can be connected to the response of the audience? We are focusing on four major brain areas in this thesis. The medial prefrontal cortex (mPFC), responsible for executive functions, evaluation of one’s emotions and introspection. mPFC has also been argued to be connected with aesthetic appraisal. Next, we are focusing on right inferior frontal gyrus (rIFG) connected mainly to processing of affective empathy. And the last two brain area of our focus are temporal parietal junction (TPJ) bilaterally. These two brain areas are believed to be responsible mainly for cognitive empathy, processing social cues and inferring other´s intentions and believes.

Based on our research question we formulated our main hypothesis which is as follows:

H1: There is a correlation between the brain activity of the dancers while expressing an emotion via dance and the response and evaluation of said performance by the observers.

H0: There is not a correlation between the brain activity of the dancers while expressing an emotion via dance and the response and evaluation of said performance by the observers.

H0 describes a null hypothesis. If this hypothesis is confirmed, then the H1 hypothesis will have to be rejected. If the H1 hypothesis is confirmed than we have successfully completed the aim of this thesis. By this hypothesis we suggest that the professional dancers will be able to perform expressing a specific emotion and that the audience will be able to recognise the emotion and positively evaluate the performance based on its expressiveness and ability to communicate an emotion via dance by the performer.

4.3 Methodology of the experiment

As we have mentioned earlier, our experiment is divided into two parts. In this chapter we will thoroughly describe the exact procedure used in each of the experiments. Since our thesis is a part of a bigger project being conducted in the University of Vienna we will describe the whole procedure of the first part of the experiment but, for the purposes of our thesis, we will use only part of the gathered data.

4.3.1 Experiment one

In the first experiment we gathered data from the participants individually, one at a time. Before the participant came to the laboratory, we prepared the fNIRS and a camera on a tripod for recording of the whole experiment. The participant came to the laboratory of the University of Vienna, was introduced to the experimenting team consisting of 4 people and was asked to sit down on a chair. The participant was given a form describing the purpose of the experiment. After reading the form the participant signed the letter consenting to the experiment and analysis of gathered data. Next, fNIRS hyperscanning was prepared. A cape with a total of 16 channels covering the four main brain areas of our interest was placed on the head of the participant. On top of the first cape another, protective, cape was placed to prevent any light pollution since the main method of this machine is using near-infrared light. Once the cape was at its place, the participant was asked to stand in the square of a green circle on the floor while we connected the channels to the amplifier and calibrated the fNIRS. While calibrating, the participant was told that he will perform a series of activities involving movement within the boundaries of the green square. The participant was informed that he can take a break whenever necessary and that he can quit the experiment at any given time. Before performing any tasks the participant was given a mask to cover any facial expressions as the recorded videos of the dancer were later used in the second part of our experiment.

The participant performed six tasks. Throughout tasks 1 to 4 a metronome was played at 80 beats per minute except in task one when the participant was standing still. In the first task we were acquiring the baseline of brain activity. First, the participant was asked to stand still with eyes opened, head upright and hands at side for a total of 30 seconds. Then the participant was asked to walk forward and backward within the square with head upright and hands at side (the metronome was played). Next, the participant was asked to walk forward and backward again, but this time he was asked to hold up hands and altering them between holding up and down. Lastly, the participant was asked to do a box step a classical step in Waltz. If the participant did not know how to do the box step, he was shown by one of the experimenters. This was the end of task one.

In the second task the participant was told that he will be given an emotion cue. He then had 30 seconds to think and plan how to perform that emotion via movement with the goal of embodying and communicating/transmitting the emotion to an audience (the four experimenters). After each emotion cue and performance, the participant was asked a series of questions concerning the performance. The questions were: How technically proficient do you think your dance was; How aesthetically good do you think your dance was; How expressive do you think your dance was; How successfully do you think your dance will communicate the target emotion; How difficult did you find to execute the dance; How much did you think about other viewers (real or imagined audience) when dancing; how much did you personally feel the target emotion when making the dance; In general, how did you personally feel when dancing and In your opinion, was the target emotion itself positive or negative? Every question was answered on a 7-point Likert scale. This task has repeated 4 times with 4 different emotions, 2 positive and 2 negatives. We picked from a total of 16 emotions (anger, fear, shame, sadness, guilt, envy, disgust, anxiety, joy, gratitude, harmony, interest, admiration, relief, pride and surprise).

In the third task the dancer was asked to just make improvised movement for 30 seconds. This has repeated for two time and after each performance he was again asked the same questions as in task two.

Task four was the same as the previous task but the dancer now had 30 seconds to think about his movement without any instructions.

In task five the dancer was asked to recreate one of the baseline tasks from task 1, specifically walking with altering hand movements. The participant also got an emotional cue and was asked to try and embody and communicate the emotion by only doing said movements. This task repeated to times for a total of 30 seconds with one positive emotion (joy) and one negative emotion (anger).

In the last task the participant was again asked to recreate one of the baseline tasks, specifically just standing still with head upright, hands at side and eyes opened. Again, the participant was given an emotional cue and was asked to try to embody and transmit the emotion by just standing still. This task also repeated two times with emotions joy and anger.

After the last task was complete the fNIRS cape was put down from the participants and was washed and prepared for the next participant.

Average time of the procedure was around 50-60 minutes per participant.

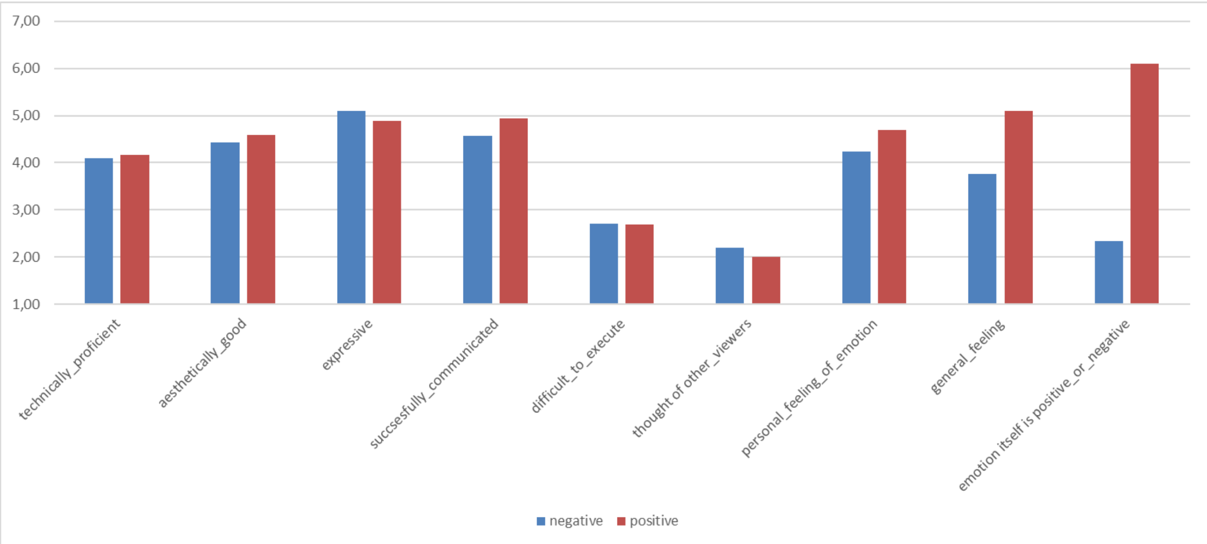
4.3.2 Experiment two

In the second experiment recordings of the professional dancers from the first experiment were used. The videos were cropped, set to black and white, sound was removed, and each video lasted for 30 seconds. In these videos the performance of the dancers was showed. For easier gathering of data, we used Open Sesame software to create a program which gave the participant instructions and played the videos without interference of the experimenter. The participant came to a quiet room and was seated before a 16-inch monitor laptop. The experimenter launched the program and asked the participant to carefully read the instructions on the screen. The participant was told that he will be shown a series of videos of professional dancers who are communicating a specific emotion via movement and that after each video he will be asked a couple of questions about the performance. The participant was informed that he can take a break from the experiment whenever necessary and that he can quit the experiment at any time. A 30 second video was played to the participant, after the video finished the participant received a couple of questions regarding the performance. The first task of the participant after a video was to pick one of 16 emotions on the screen which he thinks was communicated in that video by the dancer. Only one emotion from the 16 could be chosen. Afterwards the participant was asked these questions: How confident are you that you recognized the correct emotion; In your opinion, was this emotion positive or negative; In your opinion, how well was the emotion communicated; In your opinion, how expressive was the dance and How well did you like the performance? Each participant viewed a total of 34 videos of dancers. After the participant finished he was shown out of the room and the program was prepared for the next participant. Average time of the experiment was 40-60 minutes per participant.

4.4 Results

In this chapter we will be focusing on the results from both experiments. First, we will present behavioural data from the first experiment, then we will look on the behavioural data from the second experiment and lastly, we will talk about the neurophysiological data from the dancers combined with evaluation of the observers. Graphs and tables were obtained by Open Office Excel spread sheets and IBM SPSS software version 25. One of the dancer´s neurophysiological data from fNIRS scanning have been damaged and have therefore been excluded.

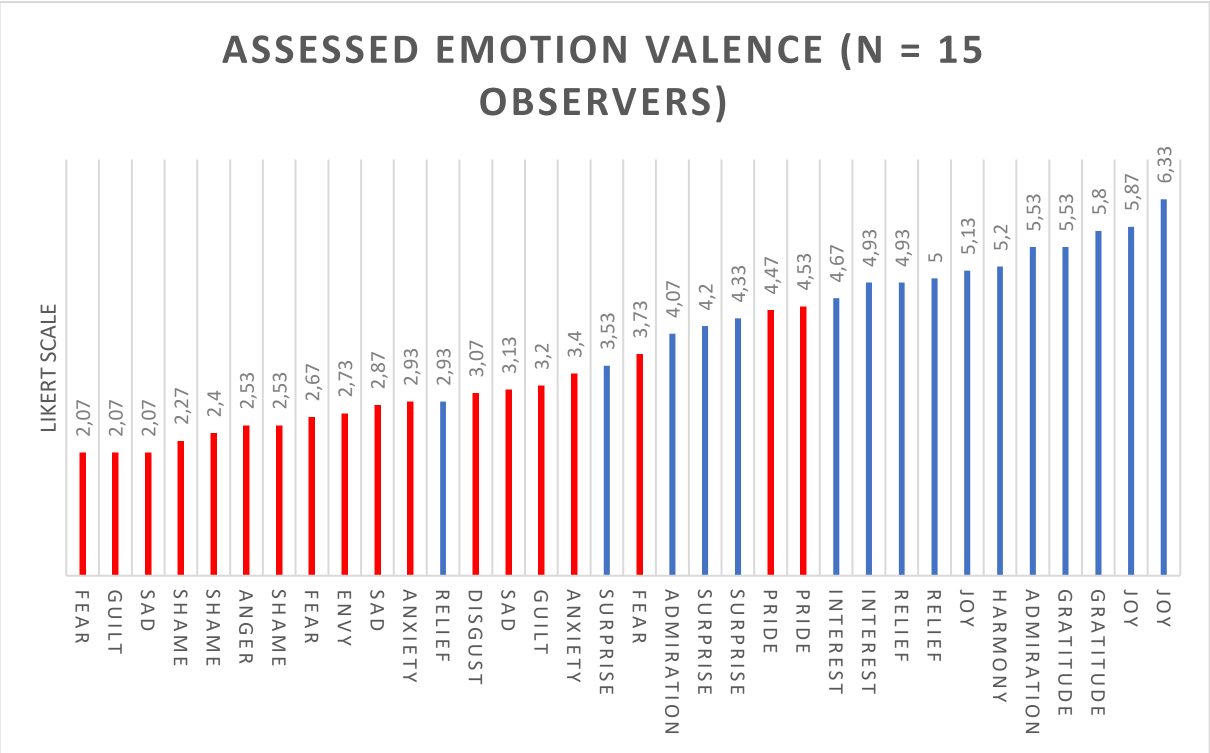
4.4.1 Behavioural data experiment one



Graph 1. Mean of the professional dancers rating of their own performance. Blue bars represent the negative emotions and red bars represent the positive emotions. Each question was rated on a 7-point Likert scale. The answers for questions of technical proficiency, aesthetical appearance, expressiveness, successful communication, difficulty to execute the dance and thinking about other viewers during the performance ranked from 1 – not at all to 7 – very. The ranking of questions concerning personal feeling of a given emotion, general feeling and valence of a given emotion ranked from 1 – very negative to 7 – very positive.

As can be seen on this graph there is no significant difference between the negative and the positive emotions throughout all the questions except for one when the dancers have been asked whether the specific emotion that they were given is, in their opinion, positive or negative. Overall dancers rated their performances as more technically proficient (negative emotions mean = 4,10; positive emotions mean = 4,16), aesthetically good (negative emotions mean = 4,43; positive emotions mean = 4,58), expressive (negative emotions mean = 5,10; positive emotions mean = 4,89) and successfully communicated the given emotion (negative emotions mean = 4,57; positive emotions mean = 4,95). Furthermore, the dancers reported little difficulties with executing each performance (negative emotions mean = 2,71; positive emotions mean = 2,68) and little attention to the viewers of the performance (negative emotions mean = 2,19; positive emotions mean = 2). Also, they have reported quite high personal feeling of the emotion that they were given (negative emotion mean = 4,24; positive emotions mean = 4,68) and, generally, they were slightly affected by the emotion with mean of negative emotions 3,76 and mean of positive emotions 5,11.

4.4.2 Behavioural data experiment two

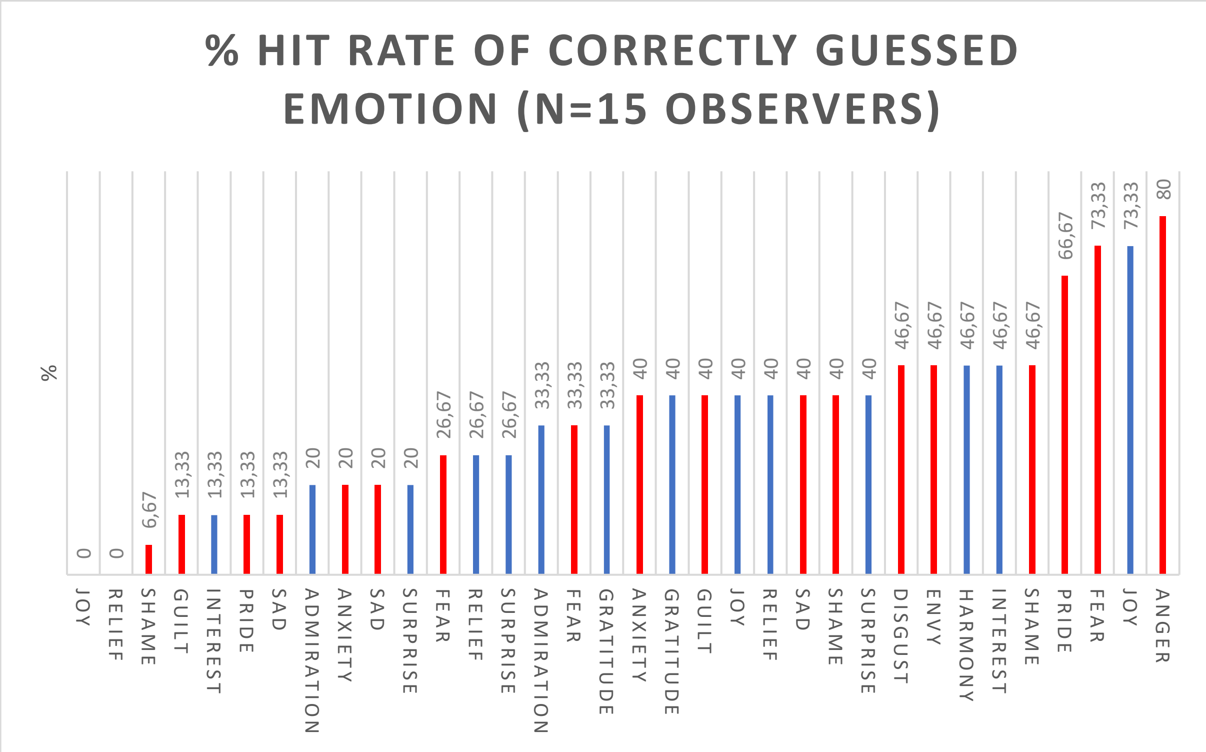


Graph 2. Means of assessed emotional valence of each dancer and each dance by the observer. Red bars represent negative emotions and blue bars represent positive emotions. Rated on a 7 – point Likert scale from 1 – very negative to 7 – very positive.

Graph 2 shows us how audience ranked each dance of every professional dancer based on the positivity or negativity of chosen emotion. Here a clear ascending can be seen with negative emotions with lower valence and positive emotions with higher valence. Also, this graph shows, that some positive emotions appear with generally less valence (relief = 2,93; surprise = 3,53) than others and some negative emotions are rated with higher valence (pride = 4,53).

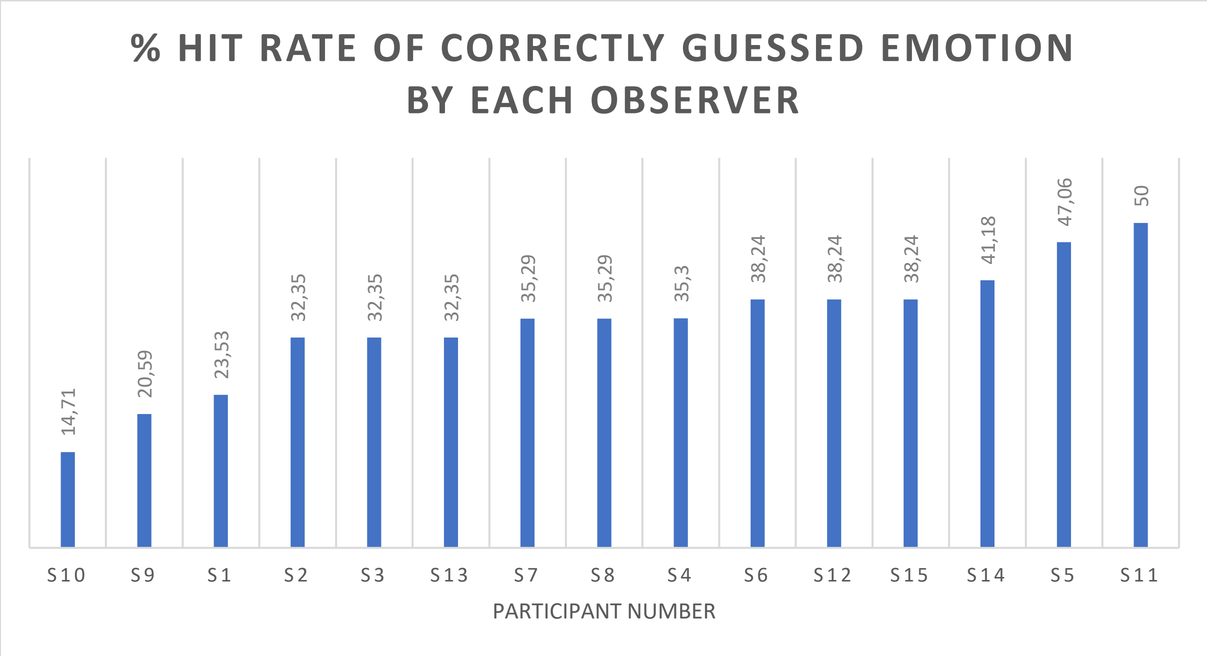
% Hit Rate Emotion	Dancer	Dance	Emotion	Valence
0	3	1	joy	positive
0	10	2	relief	positive
6,67	9	3	shame	negative
13,33	4	3	guilt	negative
13,33	5	4	interest	positive
13,33	2	4	pride	negative
13,33	2	3	sad	negative
20	4	1	admiration	positive
20	4	2	anxiety	negative
20	10	3	sad	negative
20	3	3	surprise	positive
26,67	3	2	fear	negative
26,67	7	4	relief	positive
26,67	10	4	surprise	positive
33,33	6	2	admiration	positive
33,33	7	1	fear	negative
33,33	5	3	gratitude	positive
40	7	3	anxiety	negative
40	8	2	gratitude	positive
40	8	1	guilt	negative
40	7	2	joy	positive
40	4	4	relief	positive
40	5	1	sad	negative
40	6	1	shame	negative
40	6	4	surprise	positive
46,67	2	1	disgust	negative
46,67	8	3	envy	negative
46,67	2	2	harmony	positive
46,67	8	4	interest	positive
46,67	3	4	shame	negative
66,67	9	4	pride	negative
73,33	10	1	fear	negative
73,33	9	2	joy	positive
80	9	1	anger	negative

Table 1. Percentage of correct emotion hit-rate by the observers for every dancer, every dance and emotion. Every dancer performed four dances (2 positive and 2 negative emotions).



Graph 3. Percentage of correct emotion hit-rate by the observers for every dancer, every dance and emotion. Red bars represent negative emotions and blue bars represent positive emotions.

Table 1 along with graph 3 show us how successful was the audience in guessing the correct emotion from the performance of the dancer. It also shows us how successful were the dancers in their attempt to communicate a given emotion via dance. By using 16 different emotion from which the observers could pick the chance of picking the correct one randomly is 6,25%. Table one shows that dancers number 9, 8 and 7 were the most successful in expressing the emotions given the fact that each of these dancers has 3 or 4 dances in the second half of the table therefore dominating in percentage of hit rate. Table 1 also shows that there seems to be no difference between the successfulness of guessing basic emotions like joy, anger or fear and guessing more complex emotions like harmony, relief, interest or admiration. Furthermore, there appear to be no differences between positive and negative emotions when concerning hit rate due to their, more or less, even distribution throughout the graph.



Graph 4. Percentage of correctly guessed emotion by each observer.

Graph 4 shows us how successful each participant from experiment two was when guessing the correct emotion from the dancer´s performance. Most of the participants ranked somewhere between 30% and 40% successful rate. Every participant guessed at least 5 emotions out of 34 right and the best performance was 17 correctly guessed emotion out of 34 resulting in 50% success rate by participant number 11. Average success rate of the observers was 34,31%. As we mentioned earlier the chance of choosing a correct emotion randomly is 6,25%. Binominal test has been conducted in the IBM SPSS software to ensure that 34,41% is a significant result when considering a 6,25% chance. The test showed high significance of our result with $p < 0,001$.

4.4.3 Neurophysiological data and observer evaluation

		confidance	comminication	expressivness	performance	mean_PFC	mean_rIFG	mean_rTPJ	mean_lTPJ
confidance	Pearson	1	,767**	,724**	,583**	0,006	0,066	-0,022	0,023
	Sig. (2-tailed)		0,000	0,000	0,000	0,960	0,595	0,858	0,851
comminication	Pearson	,767**	1	,731**	,622**	-0,011	0,127	0,000	-0,006
	Sig. (2-tailed)	0,000		0,000	0,000	0,932	0,301	0,998	0,960
expressivness	Pearson	,724**	,731**	1	,810**	-0,034	0,041	-0,037	-0,123
	Sig. (2-tailed)	0,000	0,000		0,000	0,786	0,742	0,765	0,316
performance	Pearson	,583**	,622**	,810**	1	-0,039	0,095	-0,029	-0,068
	Sig. (2-tailed)	0,000	0,000	0,000		0,750	0,443	0,812	0,579
mean_PFC	Pearson	0,006	-0,011	-0,034	-0,039	1	,625**	,842**	,802**
	Sig. (2-tailed)	0,960	0,932	0,786	0,750		0,000	0,000	0,000
mean_rIFG	Pearson	0,066	0,127	0,041	0,095	,625**	1	,647**	,610**
	Sig. (2-tailed)	0,595	0,301	0,742	0,443	0,000		0,000	0,000
	N								
mean_rTPJ	Pearson	-0,022	0,000	-0,037	-0,029	,842**	,647**	1	,869**
	Sig. (2-tailed)	0,858	0,998	0,765	0,812	0,000	0,000		0,000
mean_lTPJ	Pearson	0,023	-0,006	-0,123	-0,068	,802**	,610**	,869**	1
	Sig. (2-tailed)	0,851	0,960	0,316	0,579	0,000	0,000	0,000	

Table 2. Mean cross table of Pearson two tailed correlation between observer´s confidence of successful guessing of emotion, level of communicating of the emotion, expressiveness of the performance, general likeness of the performance and four brain areas activations of the dancers. Fields highlighted green are significant correlations at the 0,01 level.

Table two shows us the correlations between the observer´s evaluation of the dancer's performance and the brain activation in the mPFC, rIFG and bilateral TPJ. Pearson's two tailed correlation showed no significant correlations between these two batches of data. Moreover, table 2 also shows that there is statistical significance between all four brain areas activations of the dancers while performing. Furthermore, we found statistical significance between al the evaluations of the observers as well.

4.5 Discussion

In our thesis we were trying to broaden the lack of empirical data concerning aesthetic movement such as dance as a communication language and we were trying to determine if there are any correlations between the brain activity of dancers while they were trying to communicate a specific emotion and the evaluation of that performance by the audience. Our experimental design was mainly inspired by the studied literature on aesthetic experience and observing movement. With our approach we were trying to create an original experiment that would yield as many data for analysis as possible.

Concerning the research sample, for both experiments we used university students and we tried both groups to be as homogeneous as possible. This was due to the fact that we were gathering neurophysiological data therefore we wanted a group of people around the same age with no previous history of neural trauma or any medications that could alter the state of the brain in any way.

Both groups of participants generally enjoyed the experiment although there were some complaints mainly due to the fNIRS cap being uncomfortable. The fNIRS data combined with the evaluations of the observers show us that there is no statistical correlation between the brain activity of the dancer while performing and the evaluation of the performance by an audience which forces us to reject our primary hypothesis and go with our null hypothesis. There can be several reasons why any correlation was not found. We have to take into consideration that throughout the experiment the dancers had an uncomfortable tight cap on their head and their movement was restricted by the cord of the spectroscopy amplifier and the green square in which they were standing. Furthermore, they were in a new environment and did not really know what to expect from the experiment. Also, we have to take into consideration the general mood the dancer had on the day of the measurement. All these factors can affect the brain activity of the performer. On the other hand, the laboratory setting has to be kept for this kind of experiment because any uncontrolled environment could affect the emotional state of the participant even more.

Although our hypothesis was not confirmed, the considerable amount of data we gathered showed us more. According to correlations of emotion evaluation by the observers and the brain activity of the dancer in table 2 we have discovered correlation between all the brain areas of the dancers. This shows that these areas seem to be on some level connected while a dancer is performing an aesthetic movement or communicating an emotion by movement. Therefore, the brain activity of the dancer while performing seems to activate the same network of brain areas as when an individual is observing an aesthetic movement as we have seen from Browns (2011) meta-analysis study. This, in our opinion, is significant finding prompting further research in this topic. Also, according to table 2, there are correlations between the evaluation questions given to the observers. The data suggest that dances ranked higher in expressiveness also rank higher in quality of communication of a given emotion, general liking of the performance and confidence of picking the right emotion. This seems to go along with the Orgs, Hagura & Haggard (2013) study claiming more expressive dances are ranked more aesthetically pleasing and seem to speed up the processing of the performance by the observer. That means that the more expressive the dance is the faster the observer can process it and distinguish the communicated emotion resulting in higher confidence of picked emotion and higher pleasure from the performance.

Other gathered behavioural data also show us that there seem to be no significant difference between performing positive or negative emotions. Both were ranked more or less the same by the dancers (graph 1). Furthermore, the dancers payed very little attention to the audience while performing. This can be explained by the assumption that when a dancer starts to perform he phases out and focuses only on the dance and the music. This assumption was confirmed by some of the participants when asked.

Behavioural data from experiment two show us that that the observers did not choose the emotions of the performance by mere chance but there has been established a certain form of connection, and some form of aesthetic space was created in which transfer of information happened. We back this statement by 34,41% success rate of choosing the correct emotion when random chance was 6,25% and by a binominal test showing a significant result of $p < 0,001$ confirming the significance of our result. Furthermore, we have discovered that there is no difference between negative and positive emotions while concerning successfully guessing an emotion (graph 3) and surprisingly there seem to be no differences between basic emotions (fear, joy, anger, disgust,…) and more complex emotions (harmony, interest, anxiety,…). This finding is quite interesting due to the fact that several dancers reported some small difficulties expressing more complex emotions and even observers reported difficulties determining some of the more complex emotions. Some observers showed visible frustration with some of the performances. Although there seem to be no differences between positive and negative emotions and no differences between basic emotion and more complex ones, a clear importance of dancer’s abilities and expertise can be seen in table 1. It is visible that some dancers have clearly more experience in their field and are more expressive therefore their performance of an emotion is easier guessed by the observer. But we argue that expertise and experience alone does not fully account for the dancer's low percentage of correctly guessed emotions from the audience. In our research sample of professional dancer three major dancing techniques were present. Ballroom dance, modern/contemporary dance and breakdance. It is possible that a specific technique also affects the way in which the dancer communicates a certain emotion. Ballroom dance is based on a pair of dancers telling a story to the audience via dance therefore a single ballroom dancer may have some problems expressing emotions via movement without a partner. The technique of a break dancer on the other involves a lot of time spent spinning and on the ground which we could not provide due to the fNIRS cord being connected to the dancer. Modern/contemporary dance seem to be the best type of aesthetic movement to communicate emotions due to the fact that this dance is quite free and spontaneous with very little rules and contemporary dancers are used to perform in theatres and tell a whole story and emotions behind that story just by movement. In our opinion this type of dance could be the best for emotion transfer via movement, but further research would need to be conducted to prove this hypothesis.

Although our hypothesis was not confirmed we have gathered range of data and therefore fulfilled our intention to broaden the empirical data concerning this topic. With certainty we can say that there are connections in the mPFC, rIFG and bilateral TPJ of the dancer while performing a movement in order to communicate an emotion suggesting, that there is a connection between the expressiveness of the movement, the ability to communicate an emotion, general pleasure from the performance and confidence of the observer that the correct emotion was picked. We have also proven that there is a form of aesthetic space created between the observer and the performer and that some information is being transferred within this space. We think that we set a good foundation for further research in this topic.

4.6 Experiment limitations and further research

There are several limitations to this experiment that we would like to pint out. We already started to discus in the previous chapter that one of the limitations is the environment in which the experiment was conducted and a quite uncomfortable fNIRS cape which reportedly caused slight pain after around 30 minutes into the experiment. The laboratory environment can cause some form of discomfort also to the participant although we do not know how these discomforts could be prevented since we need to completely control the experiment setting. These discomforts could, in some way, alter or spoil the neural data. Another limitation is the number of participants, although experiment one being mainly neurophysiological the ideal number would be around 15-20 professional dancers and 25-30 participants in experiment two.

Since this is a pilot exploratory study there can be a lot changed an improved either in the experiment design or in the research sample. Further research in this topic could be focus on different branches of professional dance, gender differences and cultural differences regarding this topic. Project in University of Vienna, of which this thesis is a part of, is conducting further research concerning neural correlations between brain activations of the dancers and of the observers of the dance.

Conclusion

Our thesis consists of two parts. A theoretical part and a practical part. In the theoretical part we described the basic concepts and definitions with which we were going to work throughout the whole thesis. We provided detailed descriptions of emotions, emotion transfer, emotion contagion, cognitive and affective empathy and dance from both philosophical, psychological and neurophysiological points of view. Next, we described aesthetics and aesthetic experience. Furthermore, we provided theoretical insight into dance as a form of nonverbal communication, combined this communication form with the aesthetic experience and thoroughly described the neurophysiology of aesthetic movement and the role of expertise in when observing such a movement. In the last chapter of the theoretical part we described the little empirical data there were on the dancer's point of view. In the practical part of this thesis we described our motivation behind conducting this experiment. Further on we described, in detail, our research sample of both experiments and continued to present our research question along with our main hypothesis and the null hypothesis. Our hypothesis was mainly based on the theoretical part of this thesis and on our general knowledge of the topic. Next, we provided as much detailed description of the procedure of both our experiments as possible to ensure good reproducibility. In the first experiment we measured professional dancers by fNIRS hyperscanning machine while they were communicating an emotion via movement and then asked them several questions about their performance. In the second experiment we played recorded videos of the dancers to non-dancer participants, asked them to recognise the emotion which was being communicated and, again, asked them a few questions regarding the performance. Concerning our hypothesis, insignificant results have been found but a lot of other conclusions could be made by the empirical data gathered. Significance has been found between the four main brain areas of focus of the dancers suggesting their interconnectedness when processing aesthetic movement and evaluating emotions. Furthermore, significant correlations have been found between the evaluated expressiveness of a performance by the audience and the general likeability of the dance along with higher confidence of correctly guessed emotion by the observer. Finally, a significant result of correctly guessed emotions by the observers showed that there exists a form of information transfer between the dancer and the observer. We believe this experiment had set a good foundation of empirical data in this topic and we hope it will prompt more research in this area.

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