The Interface of Language, Music and the Brain:

The Healing Effect of Music on Aphasia

Diplomarbeit

zur Erlangung des akademischen Grades
einer/eines Magistra/Magisters der Philosophie

an der Karl-Franzens-Universität Graz

vorgelegt von

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Graz, 2018
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Danksagung

Ich widme diese Diplomarbeit allen, die der Aphasie erkrankt sind und spreche mein Mitgefühl für diejenigen aus, die es aufgrund ihres Schicksals nicht mehr können.

Der größte Dank gilt meiner Familie, aber vor allem meinen Eltern. Mama und Papa, danke, dass ihr mich nicht nur finanziell, sondern auch seelisch die letzten Jahre immer begleitet habt und mir bei jeglicher Entscheidungsfindung zur Seite gestanden seid. Ohne euch wären mein Leben in Graz, mein Studium und das Verfassen dieser Diplomarbeit mit Abschluss des Studiums nicht möglich gewesen. Danke an meine Schwester Katrin, die mich immer mit Humor aufheitern konnte, wenn mir mal nicht zum Lachen war. Ein besonderes Dankeschön geht an mein Patenkind Jakob, der mir immer wieder zeigt, dass die kleinen Momente das Leben lebenswert machen. Danke an Oma und Opa, die zwar nicht immer verstehen konnten, was ich auf der Universität so mache, aber dennoch eine große persönliche Unterstützung waren. Danke an Lusi, die stets um mich besorgt ist, dass es mir gut geht.

Ein herzliches Dankeschön spreche ich meinen ganzen Freunden aus, die mich immer unterstützen, die immer ein offenes Ohr für mich hatten und die mir auch in den schwierigsten Zeiten zur Seite standen.

Zum Abschluss gilt mein Dank Prof. Peltzer-Karpf, die mich bei jeder Idee unterstützt hat und sich immer Zeit für tiefgründige Gespräche nahm.
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1 Introduction

Language, music and the brain – books were named after this, lectures specialized on these topics and my personal interest was awakened when I immersed myself in this broad field of research and its fascinating connections. As a semi-professional musician, I have been particularly interested in how the human brain responds to musical stimuli. Beyond this personal enthusiasm, the relationship of music and language has gained more significance during my literature research, which marked the decision for my thesis topic.

In fact, the research field of language, music and the brain has been profoundly investigated in the last few decades with particular recent dedication of Mrs. Peretz and her colleagues. As broad as this specific area of research is, as varied are the research outcomes and results of numerous studies which have been carried out among pioneers of neurolinguistics. Thus, science has broadly discussed to what extent music has an impact on the human brain as well as on language production. Indeed, research has claimed that music can be beneficial for language learning such as aspects of motivation, learning environment, studying vocabulary etc. Moreover, fundamental hypotheses were put forth that intensive exposure to music, such as playing an instrument or singing professionally, changes structures within the brain, strengthens particular cerebral surfaces, and enhances cerebral activation within these parts.

Based on these scientific findings, it is possible to assume that music is beneficial for human development. First, it has been a sociocultural phenomenon ever since and second, it fosters brain growth. However, even though findings support the change of cerebral structures due to musical exposure, how does music affect language with particular regard to language disorders? To be more precise, can music heal language disorders? To answer these questions, this thesis outlines recent research based on this topic, trying to give plausible explanations and insights into this specific field of neurolinguistics.

The aim of this paper is to demonstrate the fascinating relationship of language, music and the brain focusing on the impact of music on aphasia. Despite some general information of the human brain, this thesis tries to outline profound research findings working on the healing effect of musical therapy on language disorders. As a state-of-the-art report, this thesis serves as an overview of recent research and provides investigations which can be taken into consideration for further research. Because of varied research findings, it should be considered that the interface of language, music and the brain is constantly altering and
therefore, it is beyond the bounds of possibility to approach one particular conclusion for this widespread research field.

To clarify, the first part of the paper starts with basic neurological information, giving an insight into the human brain. Thus, cerebral structures which are particularly important for both musical and linguistic processing will be explained and serve as a basis for understanding the interface of language, music and the brain. The paper continues with the broad topic of aphasiology, which refers to the study of aphasic disorders. Certain aspects of this subject matter are an official definition of aphasia, classifying frequent subtypes as well as discussing causes, signs and therapeutic procedures of the language disorder.

The second part of this thesis, which also contains empirical considerations, deals with the relationship of music and aphasia. In particular, it explains how music is perceived and processed, how language and music collaborate within the human brain and how music can be used for recovery. Focusing on the most common therapeutic possibility, the melodic intonation therapy and its adaptations are being discussed explicitly. Moreover, based on four important research studies, the effect of musical therapy is being discussed.

The thesis will be rounded off with two case studies of musicians that suffered from aphasia and its side effects influencing their musical expertise. Additionally, I will critically assess the problematic of research within this neurolinguistic field as well as demonstrate my view on future research.

In the concluding part of this thesis, the most important findings of this topic will be summarized providing a scientific overview of what has been found.
2 The Human Brain

2.1 Structure of the Brain

As Emily Dickinson says, “The brain is wider than the sky” (Dickinson 1924), this quotation speaks to the infinite qualities and functions of the complex human brain.

In general, the brain can be divided into several parts which are responsible for particular bodily functions. These components are the brainstem, cerebellum, diencephalon, mesencephalon, and, finally, the cerebrum, which is considered the largest part of the human brain. The cerebrum consists of two hemispheres, the left and the right, which are separated through a cerebral sulcus, called the longitudinal fissure (see Tesak 1997:38). Both hemispheres are connected through the corpus callosum, which comprises 200 million fibres and is responsible for the crossing of the neuronal connections and transferring information between hemispheres (see Tan/Pfordresher/Harré 2010:56).

The cortex, which surrounds the cerebrum, makes up all the multi-sensory and motoric functions, and can be categorized into different lobes, namely the frontal, parietal, temporal and occipital lobe. The lobes themselves are highly convoluted and divided into smaller lobes, sulci and gyri. Each lobe is associated with various cognitive and motor functions, which makes it possible to investigate specialization within the brain. The frontal lobe, for instance, is involved in essential high cognitive functions such as planning, making decisions, thinking and feeling. Furthermore, the two frontal lobes of the left and right hemisphere control the muscles of the opposite (contralateral) side of the body. The temporal lobe is mostly associated with auditory stimuli and their processing. The parietal lobe, on the other hand, is known for controlling emotions and feelings such as pain and touch, but it is also activated while reading and playing music. Last but not least, the occipital lobe is best known for its connection to visual stimuli (see Thompson 2009:154).

Furthermore, the cortex incorporates grey and white matter. The former is responsible for the multi-sensory wiring of the innumerable synapses, whereas the latter serves as a support system for a fast and smooth wiring (see Tesak 1997:38). Throughout my thesis, these cerebral structures will play an important role in the discussion of brain lesions and their progression.
3 Where can be Language Found in the Brain?

As the brain can be split into several parts, all of which are specialized for particular functions, there is also a “language area” or “speech center”, as Reinvang (1985:5) states. He explains that one cerebral hemisphere contains the essential structures for language, which is considered the left hemisphere in the human brain. Mostly, this is the dominant area for language production and reception; however, active brain parts can also be observed in the right hemisphere. Furthermore Reinvang explains:

Within the dominant hemisphere, there is also specialization, so that some areas are of critical importance to the language functions and some are not. The structures necessary for language (language areas) are commonly believed to be cortical, and to be located in the temporal and frontal lobes. (Reinvang 1985:5)

What is above referred to as specialization for language functions, is defined as the lateralization of language, according to Paul Broca (qtd. in Caplan 1987:345). Through his investigations of eight aphasic patients who suffered from lesions in the left hemisphere, Broca put forward the hypothesis of language and its left-hemispheric specialization. Still valid, his hypothesis has triggered a number of other hypotheses, which have remained at the centre of research concerning the study of cerebral dominance and language (345).

However, the left hemisphere itself also consists of several brain regions which interface when it comes to language processing. This explains why language is not located in a particular spot within the brain; rather, it is an interaction of several brain areas, which results in the various capabilities of speaking, writing, listening and reading. These specific areas, embedded in the temporal and frontal lobes, are known as the Broca and Wernicke area, and are particularly important for language in general. The American neurologist, Norman Geschwind, explains that Paul Broca was the first to note that damage in these frontal areas resulted in a disturbance of language output (1972:76). This scientific hypothesis has since triggered innumerable studies and language research on how language is represented in this area. To provide a summary of Broca’s findings, Broca’s area, or area 44 in Brodmann’s classification, is embedded in the frontal lobe, which is adjacent to the region of the motor cortex. This cortex is responsible for the movement of muscles such as the lips, the tongue, the jaw, as well as the palates and the vocal chords within the pharynx. Because these muscles are directly related to the coordination of speech, this region is often referred to as the “motor face area”. Thus, direct damage to this area results in slow and laboured speech, as the production of sounds is disturbed. In more detail, the speech of affected individuals is made
up of poorly articulated short phrases produced with hesitations and effort, particularly in initiation (see Reinvang 1985:5). However, the patient’s comprehension of language remains intact (see Geschwind 1972:78).

In contrast, the area responsible for language comprehension and which is, therefore, sensitive to perceptive damages, was investigated by Carl Wernicke. Wernicke’s area lies between Heschl’s gyrus - also known as the Brodmann area 41 - which is part of the primary auditory cortex and the angular gyrus, which is responsible for transferring visual stimuli to Wernicke’s area. Therefore, damage within this region results in the loss of language comprehension of both written and spoken language. However, speech is produced without effort and complex grammatical structures can still be used. In order to enable interaction between these two language areas, a nerve bundle called arcuate fasciculus, joins them and is responsible for switching information from one region to another. If this area is damaged, speech may be fluent but abnormal, and the patient can comprehend words but cannot repeat them (see Geschwind 1972:78).

Figure 1: Essential language regions (from Geschwind 1972)

As the figure above displays the essential language regions of the human brain, I would like to conclude this section by providing a summary of the important language processes that occur within the human brain. Norman Geschwind (1972) explains that when a word is heard, the output from the primary auditory cortex is received by Wernicke’s area. When a word is spoken, the information is transferred from Wernicke’s area to Broca’s area, “where the articulatory form is aroused and passed on to the motor area that controls the movement of the muscles of speech”. When the spoken word must be spelled, the auditory pattern is transferred to the angular gyrus, which triggers visual processing. Lastly, when the word is read, the
primary visual stimuli pass to the angular gyrus, which arouses the auditory pattern in Wernicke’s area (79).

4 Where can be Music Found in the Brain?

Music is a combination of melodies, harmonies, sounds and stimuli that need to be processed in order for human beings to understand a musical piece. A sound, which is the main part of music, begins by being processed in the inner ear, called the cochlea. It responds to sound waves and analyses them according to their frequencies. These split frequencies are conveyed to the auditory nerve, which is directly connected to the primary auditory cortex in the temporal lobe. Brain cells in the auditory cortex fire, responding to the stimulus, maximally to certain frequencies and show lack in responding to neighbouring frequencies. In order to rebalance these varying levels of frequency, neighbouring cells are tuned to similar frequencies, which allows the auditory cortex to disseminate a so-called frequency map (see Thompson 2009:155).

Because musical processing takes place within the temporal lobe, there have been many studies conducted on the dominant hemispheres in musical lateralization. Compared to the language areas, Broca’s and Wernicke’s areas were identified in the left hemisphere. Thus, language is dominant on the left side of the brain. Music, however, seems to be processed in another part of the brain. Milner (1962; qtd. in Thompson 2009:156) conducted a landmark study in which patients underwent the removal of their left or right temporal lobes as a treatment for severe epilepsy. The removal of the right temporal lobe resulted in impairments of “tonal memory, sensitivity to timbre, and sensitivity to intensity” (156), whereas the removal of the left temporal lobe did not show such results. Another study that highlights the importance of the right hemisphere’s involvement in musical processing was conducted by Kimura (1967; qtd. in Thompson 2009:156). She assigned a melody recognition task to right-handed research patients. The melodies were presented to patients’ one ear at a time; still, a left ear preference was identified in terms of accurate recognition. This preference can be supported by the fact that the left ear transfers auditory stimuli to the right hemisphere (contralateral), which further validates the hypothesis of right hemisphere dominance in musical processing. However, there have also been numerous studies on melody recognition that provided contradictory results, which means that a musical centre in the right hemisphere has not yet been identified. Rather, neural activation is spread over both hemispheres, depending on the subject’s musicality and other developed skills. While the right hemisphere
specializes in the recognition of pitch and timbre, performing music and feeling the metre, the left hemisphere dominates in terms of rhythmic skills, naming notes, and sight-reading music (see Thompson 2009:156f).

5 The Interface of Language and Music in the Brain

The question whether language and music share linked connections has been a much-debated issue. The philosopher Rousseau was a strong advocate of the notion that these two components share a common source in order to rationally organize human societies (see Rousseau 1781/1993). Moreover, Pinker (1994) makes an interesting point when comparing language to music. The cognitive psychologist states that:

“[l]anguage is a complex, specialized skill, which develops in a child spontaneously, without effort or formal instruction, is developed without awareness of its underlying logic, is qualitatively the same in every individual, and is distinct from more general abilities to process information or behave intelligently.” (18)

If someone substitutes “music” for “language”, the outcome will be much the same as music functions the same way. Both components start to develop in early childhood, as children begin applying linguistic and musical rules. From birth onwards, children are able to produce musical and verbal sentences using these abstract rules. Moreover, both music and language also require memory in order to recognize and reproduce songs, texts and melodies (see Besson/Schön 2009:272).

As stated above, language is found within the left hemisphere, whereas music seems to activate both hemispheres at the same time depending on which musical aspect is observed. This view was further proved by the scientists Ayotte, Peretz, Rousseau, Bard and Bojanowski (2000; qtd. in Thompson 2009:158), when they found that both sensory and perceptual dysfunctions can be linked to damage to the temporal lobe of either hemisphere. However, they found that in right-handed patients, pitch discrimination tasks could be linked to the dominant right hemisphere, whereas the left hemisphere was associated with rhythm. The scientists also proved that individuals who underwent the removal of their right temporal lobe had difficulties in pitch discrimination tasks, whereas the removal of the left temporal lobe did not result in such impairments (158).
Further findings by Koelsch and Friederici (2003) show that the coincident processing of music and language overlaps within cerebral structures. This data can be seen in Figure 2, which shows that the brain areas for language and music processing overlap. The scientists confirmed that “musical syntax is processed similarly as linguistic syntax. Using magnetoencephalography (MEG), it was found that a music-syntactically irregular chord […] is processed in brain structures that are also involved in the processing of linguistic syntax” (Maess et al. 2001). An fMRI has proven that human brains process unexpected chords not only in Broca’s language area, but also in the posterior temporal areas, which is partly defined as Wernicke’s area. This investigation supports the assumption that this language-network is not only responsible for processing linguistic stimuli; rather, it serves as a basis for musical processes as well (109).

Samson and Zatorre (1991) contributed an important study to the field of language and music research, which also, supports the argument that these two components work together. Their study involved patients who had undergone either a left or right temporal lobectomy and who were exposed to either spoken words, tunes without words, or to tunes and words which were combined within unfamiliar songs. Patients who had undergone a left lobectomy showed impairment in recognizing words, whereas patients who had had a right lobectomy lacked ability in the recognition of tunes alone. The novel finding of this study was that neither a left nor a right lobectomy resulted in impaired recognition of melody in combination with the presented words.

In order to obtain the abovementioned results, the vast majority of studies used the dichotic listening technique, in which both ears are provided with simultaneous auditory stimuli. Scientists have found that musically naïve individuals have a left ear preference, which
indicates a dominant right hemisphere while listening to music. On the contrary, sophisticated musicians show a right ear preference, which is attributed to a dominant left hemisphere. Analysing this data confirms that musically naïve individuals focus on the emotional and gestalt components of music, whereas (semi-)professionals process a detailed analysis of musical stimuli (see Bever/Chiarello 1974).

These findings on the various components of the cerebral network working together also explain why music plays such an essential role in the early stages in life. Fernald (1989) put forth the hypothesis that the melodic aspects of adult speech have a major influence on the early connections between sound patterns and meaning for an infant. This phenomenon, furthermore, can be observed in every language. When people are using language, changes in pitch within this language can lead to changes in word meaning. Thus, prosody (melody and rhythm of speech) enables us to encode and decode messages and their intended meaning.

To conclude this chapter, it is possible to claim that language and music processes occur in a collaborating network and interface with each other in the same brain regions. Thus, a neurological connection between these two components can be proven but cannot be generalized due to clinical findings (e.g. acquired amusia without aphasia), which are being discussed later in this thesis.

6 Aphasiology

6.1 Definition of Aphasia

Aphasia is considered to be a language disorder due to brain damage. It originates from the Greek meaning “speechlessness”, and was coined by the French neurologist Armand Trousseau. With the invention of this term, other terms such as “aphemia”, “alalia” or “verbal amnesia” were replaced (Ryalls 1984: 358). Nadeau, Rothi and Crosson (2000: xiii) further explain:

Aphasia is an acquired disorder of language form, language structure, verbal elaboration, or communicative intention resulting from dysfunction of the brain. It can be caused by stroke, diseases affecting brain substance and function, or traumatic injury […] Twenty-five percent of strokes are associated with aphasia.

Thus, the term “aphasiology” refers to the study and research of such language disorders. Basically, this field studies the relationship between language and brain areas (see Caplan
1987:3). Neurologist Norman Geschwind (1972:82) distinguishes between two important types of disorders: speech and language disorders. The former refers to an impairment of the verbal output due to “weakness or incoordination of the muscles of articulation”. The latter refers to the linguistic incorrectness of the verbal output, which is the main impairment in every aphasia type. Furthermore, these disorders can also occur without impairments of other intellectual abilities.

In the next chapters, I will explain how aphasia can be caused and what subtypes of aphasia are common in literature. Discussing several types of aphasias, which differentiate themselves in terms of verbal output and neurological aspects, I intend to focus on Broca’s and Wernicke’s aphasia, as they are predominant in the studies of language, music, and the brain.

7 Causes of Aphasia

Generally the most important consideration for the prevention of aphasia is continuous cerebral blood supply. This ensues through the Arteria carotis and the Arteria vertebralis, which are responsible for supplying the human brain with enough blood to prevent neurogenic damage. However, sometimes damage occurs because of an imbalance in blood stream, the neurotransmitters or a sudden infarct. Thus, the brain suffers from neurogenic damage, which is most often triggered by a stroke, head injury, infections and tumours, or progressive degeneration of the central nervous system, as Gillam, Marquardt and Martin (2011:272) state.

7.1 Stroke

Among these causes for aphasia, the left-hemispheric ischemic infarct is the most frequently diagnosed one. These infarcts, also known as strokes, are due to an impaired cerebral blood flow. This disorder within the brain leads to the subsequent death of the tissue (see Tesak 1997:43). As this type of stroke happens within the left hemisphere, the tissue that occupies the language area will be damaged and thus, necrotize. Strokes can result either from an embolus, “a moving clot from another part of the body that lodges in the artery” (Gillam/Marquardt/Martin 2011:272) or a thrombosis, “which occurs when the artery has gradually filled in with plaque” (272). Both of these types result in the closure of one artery to the brain; therefore, the blood supply is inefficient and ends in the deprivation of oxygen to certain brain areas. Beside these causes, a haemorrhage – a bleeding in the brain - can also result in a stroke.
7.2 Trauma

As mentioned above, head injury can also play a particular role in the emergence of aphasia. Brain trauma, which is induced by a head injury, can also lead to neurological damage as investigated in aphasic patients. The trauma usually results in impairments to multiple brain areas, as well as damage to the connecting fibres, as noted by Gillam, Marquardt and Martin (2011:287). Brain trauma is considered a complex phenomenon and includes a multitude of impaired motor, speech, language, and high cognitive functions. Language dysfunctions can emerge if the left hemisphere of the brain is injured. However, most traumas result in the dysfunction of cognitive processes, such as a “black-out” (287).

7.3 Neurodegenerative Diseases

Progressive degeneration of the brain can also lead to the deterioration of cognitive and language abilities, which can result in Alzheimer’s disease, dementia, strokes or Parkinson’s. The predominant symptom in this case is the deficit of memory. As the disease progresses, memories of words and their meanings are also impaired, which can be linked to the aphasic symptomology (see Gillam/Marquardt/Martin 2011:288).

In comparison to acquired adult aphasia due to progressive degeneration, acquired childhood aphasia can also be diagnosed. This language deficit can follow a brain lesion around the age of 2, which may have been caused by vascular lesions, trauma, tumours or infections within the language-specialized brain regions. After several investigations of children, the predominant symptoms have been defined as logorrhoea, paraphasia and neologisms, which can also be seen in adults suffering from aphasia. Furthermore, the localization of the lesions in children’s brains often coincides with those of adults. In order to prevent educational difficulties, it is highly important to provide children with professional support for their rehabilitation (see Fabbro 2004:2).

Having given a general overview of the main causes of aphasias, I would now like to demonstrate the most common subtypes of this language disorder.

7.4 Classifications of Aphasia

In general, all types of aphasia can be categorized into fluent and non-fluent aphasia. Hereby, the terms fluent and non-fluent refer to the aspect of speech within the language disorder. Thus, Wernicke’s, conduction, anomia, and transcortical sensory aphasia are considered to be fluent types of aphasia. On the other hand, Broca’s, global, and transcortical motor aphasia
are non-fluent types of aphasia. Given this differentiation makes it is easier to examine the different type of aphasia as the aspect of speech plays an essential role in identifying the impaired part of the brain (see Gillam/Marquardt/Martin 2011:277f.).

7.4.1 Broca’s Aphasia

Paul Broca assumed that damage in the Broca’s area of the brain is the only factor responsible for Broca’s aphasia (see Damasio/Geschwind 1984:130). However, years later, scientists observed that there are other brain regions involved that are responsible for the symptoms of Broca’s aphasia; these include the insula, the lower motor cortex, as well as the subjacent subcortical and periventricular white matter (see Benson/Ardila 1996:45). This shows that this particular type of aphasia is one of the most complex language disorders in the human brain as it activates several parts within that organ. Broca’s aphasia, which is also referred to as motor or verbal aphasia, is characterized by reduced verbal output with intact but sparing auditory comprehension (see Goodglass 1993:209). Speech is slow, laboured and hesitant, using little intonation. Moreover, an impairment of word order as well as difficulties with articulation can be observed (see Harley 1995:266). The example below is intended to represent the speech of a client diagnosed with Broca’s aphasia (the dots indicate long pauses):

Ah ... Monday ... ah Dad and Paul...and Dad ... hospital. Two ... ah ... doctors ... and ah ... thirty minutes ... and yes ... ah ... hospital. And er Wednesday ... nine o’clock. And er Thursday, ten o’clock ... doctors. Two doctors ... and ah ... teeth. (Goodglass 1976:278)

This example shows that patients suffering from Broca’s aphasia are also lacking an awareness of grammar, also referred to as grammatism. Thus, their “speech output is characterized by the omission of grammatical words such as “the” and “is” as well as the incorrect usage of grammatical endings”. Although their sentences are mostly simple, their ability to name an object or repeat words is generally good. However, spontaneous speech is very difficult for these patients (see Damasio: 1991 qtd. in Blumstein 1994:30). Although their auditory comprehension is relatively intact, they do have some difficulties understanding sentences that contain function words. This lack of the necessary comprehension of function words indicates the disorder of apraxia, which is a common side effect of Broca’s aphasia (see Gillam/Marquardt/Martin 2011:277).
7.4.2 Wernicke’s Aphasia

Brain damage to Wernicke’s area, which is considered the temporal-parietal cortex, results in fluent verbal expression but deficits in auditory comprehension. Patients have difficulty understanding language, whether written or spoken. In contrast to Broca’s type, intonation and stress of words and syllables are normal. However, when it comes to verbal expressions, Wernicke’s patients fill their speech production with “paraphasias (mixing up sounds in words) and neologisms (making up new words)” (Yule 2010:163). Because these patients use neologisms so frequently, their speech sounds like jargon. For this reason, such individuals are described as having jargon aphasia (see Gillam/Marquardt/Martin 2011:279). The following excerpt presents the speech of a patient who is using several strategies to describe an object (“a kite”) in a picture because the speaker does not remember the right term for it:

[I]ts blowing, on the right and er there’s four letters in it, and I think it begins with a C -goes- when you start it then goes right up in the air – I would I would have to keep racking my brain how I would spell that word – that flies, that doesn’t fly, you pull it round, it goes up in the air. (Yule 2010: 163)

7.4.3 Conduction Aphasia

This type of aphasia refers to damage to the arcuate fasciculus, the part of the brain that builds the bridge between the two language areas. Individuals suffering from conduction aphasia do not exhibit difficulty in articulation, fluency or comprehension; rather, the task of repeating a word or phrase is difficult for these patients. The root of this inability lies in the transfer from hearing and understanding words to the speech production area (see Yule 2010:163). It is very common for patients to repeat words with phonemic paraphasias (e.g. pike/pipe) or substitute words in general. However, comprehension of the defectively repeated sentences is moderate. Many patients have also been observed to suffer from accompanying motor signs such as paresis of the right side of the face (e.g. weakness in voluntary movement) or an impairment of the right upper extremity. Hence, conduction aphasia is also referred to as an afferent motor conduction (coined by Luria) (see Damasio 1981:60f).

7.4.4 Transcortical Aphasia

Transcortical aphasia can be subdivided into three types: transcortical motor (TMA), transcortical sensory (TSA) and mixed aphasia. The first refers to patients who suffer from non-fluent speech, who experience paraphasias and the loss of connective words (see
Damasio 1981:61). In contrast, their comprehension and their abilities to name objects and repeat words remain intact (see Berthier 1999:37). Still, patients suffering from TMA want to communicate despite their verbal limitations and should, therefore, be differentiated from individuals with mutism as the localization of the lesion is different as is the intention of verbal expression (see Damasio 1981:61f).

The second subtype, transcortical sensory aphasia (TSA), is marked by a severe “auditory comprehension in the presence of preserved repetition” (Berthier 1999:75). Yet, in TSA sufferers, both fluent spontaneous speech and repetition are intact, which unlike to Wernicke’s aphasia; therefore, it is essential that these two types must be distinguished from one another (see Damasio 1981:61).

Lastly, the mixed transcortical aphasia (MTA) sufferer’s spontaneous speech is characterized by reduced verbal production. Either the patients suffering from it are mute or very limited in the sense that their verbal repertoire consists of only single words. Furthermore, their speech output also contains incomprehensible expressions, incomplete short phrases, as well as overlearned phrases. Thus, their verbal output is mostly effortful, but areas of articulation and grammar are normal. (see Berthier 1999:121).

7.4.5 Global Aphasia

The most severe type of aphasia, defined as global aphasia, encompasses both the Wernicke and Broca language areas. It is characterized by a complete loss in all language modalities, however, the patients are not mute and do speak. Mostly, they use “conventional phrases (swearing) or meaningless syllabic combinations […] There is also some ability to react to concrete words, particularly if they are emotionally significant for the patient” (Reinvang 1985:28).

7.4.6 Anomic Aphasia

The last subtype I want to mention is anomic aphasia, which must be strictly differentiated from anomia as a syndrome. The struggle to find words is common to every type of aphasia; yet, anomic aphasia is different. Individuals suffering from this type of aphasia have a pervasive impairment of word finding, however, their verbal expression is fluent, well-articulated and grammatically correct, which distinguishes the disorder from the syndrome. This subtype is also known as amnesic or nominal aphasia (see Damasio 1981:62).
To summarize, it is possible to observe that all aphasic disorders are associated with impaired language, in general. However, with regard to the subtypes of aphasia presented above, the syndromes distinguish the different types based on the localization of the brain lesions. Furthermore, the diversity of syndromes and signs varies as different brain impairments result in different language inabilities, which will be discussed further in the next chapter.

8 The Underlying Principles of Aphasia

8.1 Dimensions of Language Dysfunction

As mentioned above, aphasia is considered a language disorder. However, a language disorder or dysfunction can be examined in several dimensions because language itself can be divided into various aspects as well.

First, one of the major dimensions that can be investigated in language aphasias is speech fluency. Thus, all aphasic subtypes are categorized as either fluent or non-fluent disorders. The dimension of fluency also contains different aspects, such as the quantity of speech, which refers to the number of words per minute. The speaking rate of normal adults ranges from 100 to 175 words per minute, whereas aphasic patients may use anywhere from 12 to 220 words, depending on the aphasic type (see Howes 1964, qtd. in Nadeau/Rothi/Crosson 2000:32).

Another important aspect is thematic elaboration, which describes the aphasia sufferer’s ability to communicate on a particular topic and to elaborate on the theme of their communication. The disinclination to elaborate on themes, as Nadeau, Rothi and Crosson (2000:33) state, can be associated with all non-fluent language disorders. Thus, patients are not able to comment on chosen topics within a communicative situation.

The dimension of fluency also includes the ability to articulate oneself in spontaneous speech, for example. It refers to “the facility and accuracy with which one produces the motoric aspects of speech” (Nadeau/Rothi/Crosson 2000:34). Melody and prosody, which include stress, pitch, timbre and rhythm, are also important factors in examining language as well. In aphasic patients, for example, stressed syllables are far more often remembered than non-stressed ones.

Another aspect that can be investigated is the grammatical and syntactical form of language. Patients suffering from Broca’s aphasia, for instance, have difficulty producing functional
words, which are highly important for a solid grammatical structure in language. Goodglass et al. found that a “variety of grammatical form in language production was a reasonably good discriminator between fluent and non-fluent speech” (qtd. in Nadeau/Rothi/Crosson 2000:35).

The field of phonology also serves a basis for the investigation of aphasic disorders. Weaknesses in phonological processing, which refer to difficulties with the sounds of language, are observed in Broca’s, Wernicke’s and conduction aphasia. Thus, patients show an impairment with regard to the repetition of words as well as phoneme errors in spoken and written production (e.g. paraphasias) (see Nadeau/Rothi/Crosson 2000:40).

Thirdly, another feature that is characteristic of certain aphasic disorders is difficulty in word retrieval. Word retrieval is considered an obstacle in the speech production of every aphasic type. However, not all individuals experience this difficulty in the same way. There are patients who use the wrong nouns in context (e.g. horse instead of camel), while others try to name pictures using circumlocutions (e.g. semantic descriptions of the item they are striving for). Both examples can be investigated in terms of difficulties in word finding; however, they are distinct from each other (see Nadeau/Rothi/Crosson 2000:82f).

Finally, one of the most important dimensions with regard to aphasic dysfunctions is the aspect of grammar and agrammatism. Most patients who suffer from agrammatism are non-fluent, as functional words, for instance, are missing in production. Thus, their spontaneous speech is termed as “telegraphic” as they struggle with complex sentence structures. One of the main markers of this telegraphic speech is its lack of prepositions, articles and conjunctions (see Nadeau/Rothi/Crosson 2000:83).

### 8.2 Accompanying Behavioural Disturbances

Frequently, patients suffering from an aphasic disorder also exhibit behavioural disorders, which will be outlined briefly in this subchapter.

Acquired dyslexia (i.e. alexia) “is a common outcome of dementing illness and of ischemic infarctions due to occlusive cerebrovascular disease, but may also result from intracerebral haemorrhage […] multiple sclerosis, and migraine.” (Nadeau/Rothi/Crosson 2000:159). Some patients who have been diagnosed with a general impairment of the language system show reading disabilities (i.e. “aphasic alexia”); furthermore, impairments of the visual system can also be linked to a reading disorder (i.e. “agnostic alexia”). To examine the relationship between aphasia and reading impairments in more detail, an individual’s reading ability is
also tied to “spelling regularity, imageability, word frequency and novelty, word length, and grammatical class” (Nadeau/Rothi/Crosson 2000:160). These overlaps indicate the adjacent interface of these two disorders.

Secondly, agraphia, which is an acquired writing disorder caused by neurological damage, can also accompany aphasia. Writing, in general, consists of two major functional components: linguistic and motor functions. The former refers to the selection of appropriate words depending on the context, the latter to the process of writing itself (see Nadeau/Rothi/Crosson 2000:184). Aphasic patients experience difficulty with selecting and finding words in order to express themselves appropriately, and this problem is also part of the symptomology of agraphia.

Lastly, apraxia of speech can also be investigated in relation to aphasia. Apraxia is considered to be a motor programming disorder when it comes to producing spontaneous speech. Thus, patients are highly debilitated during voluntary and automatic speech. Therefore, apraxia of speech and aphasia can be linked closely together as both disorders result in difficulty expressing oneself, whether voluntarily or automatically (see Nadeau/Rothi/Crosson 2000:221ff.). Despite the links between aphasia and various other behavioural disorders, research is still lacking with regard to these combinations of disorders, even though it is not uncommon for both to occur simultaneously. This topic – the simultaneous occurrence of aphasia and other disorders – will be briefly discussed in the final part of this paper.

9 Diagnosis of Aphasia

Having covered the causes and classification of aphasic disorder, the question that now arises is: how can be a particular type of aphasia diagnosed? To answer this question, it is important to consider the clinical picture of a patient as well as their language condition.

In order to provide patients with professional support, it is important that a differentiated diagnosis be conducted before the patient can be provided with opportunities for suitable therapeutic options. To do this, doctors prioritize the syndrome-approach, which facilitates the diagnosis of the patient. Because aphasias are both a neurogenic multimodal disorder as well as a language expression disorder, both aspects have to be taken into consideration when making a diagnosis. The first can easily be investigated by perusing the patient’s medical records, while the latter must be examined by listening to verbal output of the patients. There are a few symptoms, such as non-fluent speech, preservation, jargon, as well as agrammatism
which can be linked to the various subtypes of aphasia, as discussed above. However, these essential symptoms have to be examined on every linguistic level and within all modalities - writing, speaking, listening and reading - in order to reach a fundamental diagnosis. This is integral to providing suitable and efficient therapy (see Tesak 1997:92f).

9.1 Testing Procedure

The basic aspects of a fundamental diagnosis include both an informal as well as a formal set of exercises. The informal exercises are based on the patient’s personal experience and are created individually for each patient. This round of exercises should enable the patient to express their opinion about something that is familiar to them. The formal exercises, on the other hand, are standardised tests such as the BDAE (Boston Diagnostic Aphasia Examination) or the AAT (Aachener Aphasie Test). In the German-language speaking part of the world, the AAT is predominant, which fulfils the various criteria for diagnosing aphasia. The test is divided into several subtests, such as spontaneous speech, token test, repetition, naming objects, language comprehension, and written language. In terms of spontaneous speech, patients are examined on the level of communication skills, articulation, prosody, semantics, phonology, and syntax. Taking all these aspects into consideration, patients are eventually evaluated on the basis of a points system in order to differentiate aphasic patients from the norm. More precisely, this testing procedure has the aim (i) to differentiate between aphasics and non-aphasics, (ii) to describe the aphasic disorders on a linguistic level, (iii) to evaluate the aphasic disorders in every modality, (iv) to assess the severity of the aphasic disorder and (v) to examine the subtype of aphasia for a particular patient (see Tesak 1999:29). In order to gain as much linguistically relevant information as possible, the AAT aims to provide a differentiated analysis of the patient’s language production. Concerning this testing procedure, language production and the component of spontaneous speech are integral to the diagnosis process. The spontaneous speech examination includes dialogic interaction with a doctor, a retelling of events, describing pictures as well as talking about their medical history. It is highly important to evaluate tokens such as paraphasia, agrammatism, neologism, sentence chunks, jargon, fluency and speech effort in order to create a coherent clinical picture. Concerning comprehension, aspects such as comprehension of yes/no questions, allocating words to pictures and comprehension of texts are also investigated in this part of the testing procedure. The third modality is written language, in which components such as reading, allocating sounds to words and writing are the prevailing factors. Gathering all of this
data about a patient serves to form the basis for an evaluation of the individual’s aphasic severity. Thus, this evaluation is considered a linguistic profile (see Tesak 1999:31-55).

The linguistic and the medical profile of an aphasic patient enable doctors and therapists to find appropriate therapeutic possibilities and to arrange treatment designs. To give an overview of common therapeutic possibilities, the next chapter serves as a basis for that.

10 How to Heal Aphasia? – Therapeutic Possibilities

There are as many therapeutic possibilities for aphasia as there are subtypes thereof; all of which aim to improve the physical and cerebral conditions of the patients. The following chapter will outline approaches that either focus on one specific linguistic feature or consider communicative skills in general.

10.1 Impairment-based Therapies

Impairment-based treatments usually work on one particular linguistic or motor feature, which requires highly concentrated and intensive training.

10.1.1 Constraint-Induced Movement Therapy (CIMT)

CIMT is a set of rehabilitation techniques that aims to train the functional abilities of the affected stroke patient’s upper extremities. This particular therapy focuses on constraining the movements of the less-affected arm, which is put into a sling, in order to induce movement in the more-affected arm. The overall aim is to “encourage forced use of the hemiparetic hand and arm in order to promote neuroplastic changes in the lesioned hemisphere contralateral to the weak arm/hand, with the ultimate goal of improved movement” (Galletta/Barrett 2014). This highly concentrated training is practised two to three weeks six hours each day. In general, the aim of this therapy is precise and repetitive sessions in order to rehabilitate the impaired extremity.

A milder therapeutic possibility is the modified CIMT (mCIMT) which is a less intense version of the practices mentioned above. It also aims to provide highly concentrated training of the more-affected arm and also uses restraint of the less-affected extremity. However, compared to normal CIMT, it is less time-intensive.

In order to demonstrate the positive outcomes of this therapy, neuro-imaging was used to show cortical reorganization within the brain area that is responsible for the more-affected
extremity. Thus, there are functional as well as neural improvements for stroke patients who undertake this treatment (see McDermott 2016).

10.1.2 Constraint-Induced Language Treatment (CILT)

CILT aims to improve the quantity and quality of the verbal linguistic output of aphasic patients. This treatment focuses on the extensive use of expressive communication skills, such as verbal means, instead of relying on gestures and writing. Galletta and Barrett (2014) believe when patients practice their oral production skills, it can enable neuroplasticity changes in the damaged hemisphere. Furthermore, they think that the use of nonverbal strategies reduces the patient’s capacity to recover of the neural networks that are specialized in verbal linguistic expression. Thus, patients are required to communicate verbally with other persons. If the patients do not know particular words or want to use compensatory strategies such as gestures, writing or drawing, they will be forced to express themselves verbally without the support of these compensational strategies. Most patients suffer from chronic aphasia use these facilitators to become more fluent in their language. Nevertheless, clinicians insist on the exclusive use of verbal expressions in order to exploit the verbal linguistic potential of every patient (see Galletta/Barrett 2014).

10.1.3 Word Retrieval

Word retrieval is a common symptom of every aphasic subtype. Therefore, it is a common treatment used in impairment-based techniques. In order to make the treatment as efficient as possible, it is important that clinicians decide whether the patient is suffering from a semantic (meaning-based) or a phonological (auditory/articulatory-based) dysfunction. Based on the patient’s particular dysfunction, the treatment process is adapted. The semantic approach, for instance, incorporates training with words that have similar semantic features in order to enhance generalization. In comparison, a phonomotor-based approach founded by Kendall et al. (qtd. in Galletta/Barrett 2014), puts forth the hypothesis that practicing both heard and produced speech sounds using a variety of phonomotor tasks results in fewer errors of phonological naming. The study outlined that, after an intense 60 hours of intervention treatment, patients showed an improvement in the accuracy of the trained items (see Galletta/Barrett 2014).
10.1.4 Brain Mechanism Recovery

In order to reduce the number of patients who suffer from speech and language restrictions after post-stroke therapy, brain mechanism recovery treatments focus on inter- and intra-hemispheric interactions within the human brain. Thus, imaging studies are used to observe the activation level of language-tasks within the brains of aphasic and non-aphasic patients. This is also to help therapists adapt the tasks and treatment strategies in order to stimulate the brain areas which most need to regenerate (see Galletta/Barrett 2014).

10.1.5 Non-invasive Brain Stimulation (NBS)

The application of behavioural strategies, such as CILT, is only one option for reactivating damaged brain areas. This is why clinicians recommend using strategies such as the NBS to functionally reorganize language-dominant brain areas. Stimulating Broca’s contralateral area in the right hemisphere through transcranial magnetic stimulation (TMS) can help decrease activation on the right side and increase left-hemispheric lateralization. In contrast, transcranial direct current stimulation (tDCS) enables the simultaneous stimulation of brain areas as well as language intervention with the aphasic patients. By applying a constant flow of low-intensive electrical currents through electrodes fixed on the surface of the scalp, the tDCS regulates cortical excitability (see Galletta/Barrett 2014).

10.2 Functional-based Therapies

10.2.1 Promoting Aphasics’ Communicative Effectiveness (PACE)

This treatment was introduced in 1978 by Wilcox and Davis. This technique is intended to turn a structured interaction between the clinician and their patient into an actual face-to-face conversation. PACE focuses on several components, including turn-taking, a variety of speech acts, solutions for communication breakdowns as well as the use of “linguistic, paralinguistic and extra linguistic contexts” (Davis/Wilcox 1985:89). In order to carry out PACE therapy as explained by the experts, it is essential to consider its four underlying principles:

1. The clinician and the client alternate between the roles of sender and receiver.
2. The interaction involves exchanging new information.
3. The client is allowed to choose between options of communicative channels in order to transfer messages.
4. The feedback given by the clinician is based on the client’s accomplishment in transferring a message.

The procedure itself begins with the clinician and the client sitting around a table, where stimulus items are placed face down. These items can be either pictured or written prompts and serve as a basis for the topics that will be discussed in brief conversations. One basic task for each participant is to take turns selecting a card and then to maintain a natural conversation about the topic that card presents. The aim of this procedure is to convey a particular message. Therefore, the clinician’s task is to observe and improve the client’s symbolic abilities to transfer messages and meaning. Because each participant alternates between the role of sender and receiver, the therapy itself seems to be relatively natural for the client. Moreover, the client can use certain strategies, using conversational components and different channels of communication (see Davis/Wilcox 1985:89f.).

10.2.2 Life Participation in One’s Own Life

This functional approach aims to improve the patient’s communicative situation within their daily activities. Highlighting the patient’s real-life goals enables the individual to reengage with their own life. Therefore, this approach is designed for each individual’s needs. One example of this intervention could be the patient’s own involvement in discharge planning for patients, soon to be released from hospital (see Galletta/Barrett 2014).

10.2.3 Conversation Analysis

This approach was born in 1964 when Harvey Sacks began to study recordings of telephone calls within the Suicide Prevention Center in Los Angeles. Given this natural data, he was able to examine the structures of conversation. This natural data base is still preserved and predominant in conversation analysis (CA). The difference between it and other approaches lies in the fact that CA does not require theoretical categories of analysis that need to be compared to the outcome of the patient. Rather, it contains three essential characteristics. First, all sounds uttered by the patients constitute data that needs to be evaluated, even if they are minimal utterances such as “uh” or “eh”, coughs, laughter or micro pauses. Each utterance has communicative value and serves a purpose within a particular conversation. Second, each utterance has a particular meaning depending on the context. Third, the clinician examines the outcome with regard to the participant’s own behaviour rather than by applying preconceived categories (see Lesser 2003:174f.).
10.2.4 Supported Conversation

This form of treatment puts the patient in the position of leading the conversation, while the clinician functions as a facilitator. Thus, the clinician provides language facilitation in the context of this particular conversation and follows the client’s way of expressing themselves. It is very common for a shared activity to serve as the basis for the conversation, which makes it easier for participants to smoothly follow the structure. Because of this natural clinician-client setting, the client is able to freely express him-/herself, which eases the burden of a formal-medical mode (see Galletta/Barrett 2014).

As outlined in this chapter, there are various therapeutic possibilities that focus primarily on language to meet the needs of aphasic patients and to help them make an efficient recovery. However, therapeutic options are not solely essential for an efficient and fast recovery; rather, the inclusion into society and social norms must be highlighted as well.

11 Psychosocial Consequences – The Important Role of Social Support

As discussed in previous chapters, aphasia, especially chronic aphasia, not only diminishes an individual’s communication skills; it also restricts their personal life, including work, social circle and lifestyle in general. When a person gets the diagnosis of aphasic disorder, many different parts of their life are challenged. Due to these tough circumstances, it is common for patients to struggle with problems within their friendships, marriages, jobs, and their own personality. Because these challenges and the tremendous burden they represent, it is common to see accompanying symptoms such as depression, anxiety, despair and aggressive behaviour (see Tesak 1999:16).

Furthermore, aphasia is often referred to as a “Familienkrankheit”, as Tesak (85) explains. The aphasic patient suffers from dependence and social stress, which can trigger conflict and aggression within family structures. Moreover, the point in life when aphasic patients realize the deep dimension of their diagnosis and its effects on their own life is the most critical one. From this time on, the impairment of language and speech no longer seems to be the predominant problem; rather, accepting one’s diagnosis and its impact on one’s personal and social life is the obstacle that needs to be overcome (86).
Because the patient’s psychosocial situation is relevant in the progression of aphasia, it needs to be taken into consideration within the evaluation process as well. The Code-Müller-protocols, named after their investigators, provide a useful basis for examining the psychosocial status of the patient as well as their relatives. They contain aspects such as the evaluation of the current emotional situation, the handling of the dominant issues, interests and hobbies as well as cultivating social contacts. Besides the precise language-based evaluation, these protocols provide interesting insight into the patient’s life which can help to adapt a suitable and efficient therapy (see Tesak 1999:86).

Having provided a theoretical background and conventional views on the broad topic of aphasia in the previous section, this second part aims to provide a more empirical perspective on a field of research that has been investigated deeply in recent years, and has shown an enormous positive impact on patients with aphasic disorder. Hence, the second part of this thesis deals with the broad topic of music and its captivating effect on patients suffering from aphasia, including sensory and motor dysfunction. Furthermore, it will shed light upon my hypothesis that music does have a healing effect on aphasia.

12 Music and Aphasia

12.1 From Perception to Pleasure - When the Brain Plays Fireworks

Music with its origin in ancient times, is still part of our “human mental machinery”, and serves the purpose of communication, regulation of emotions and enhancement, all of which are powerful reasons for human survival (see Hauser/McDermott 2003; qtd. in Zatorre/Salimpoor 2013:10430). But why do human beings expose themselves to musical sounds? Research has shown that one of the main reasons we love music is the communication of cognitive and internal states, including the emotional aspect as well (see Patel 2008; qtd. in Zatorre/Salimpoor 2013:10430). These structures are innate to human beings, and are, therefore, distributed among the majority of members of this particular species. One of the most interesting observations is that perceiving musical stimuli occurs very early in development and, thus, needs to draw on an already existing neural mechanism which allows musical perception, and which does not have to be learnt (10430f.).

Over the last decades, emerging research has shown that long-term training in music and an accompanying training of the sensorimotor skills can have an enormous impact on the neuroplasticity of the human brain. Immersing oneself in music affects both the grey and
white matter, as well as frontal regions and the hindbrain consisting of the pons and the medulla oblongata. Thus, every form of musical training such as singing, dancing or playing an instrument triggers a firework of sensory, motor and multimodal brain activations. Furthermore, exposing oneself to music activates emotional and motivational regions, increases interactions and changes activity levels in the amygdala, the nucleus accumbens and other parts of the limbic system. As Schlaug, Altenmüller and Thaut (2010:249) describe:

Music is a strong multimodal stimulus that simultaneously transmits visual auditory, and motoric information to a specialized brain network consisting of fronto-temporo-parietal regions whose components are also part of the putative human mirror neuron system […] [T]his network of brain regions might support the coupling between perceptual events (visual or auditory) and motor actions (leg, arm/hand, or vocal/articulatory actions).

Furthermore, these interactions between frontal, temporal and parietal regions play an important part in working memory and maintaining information which humans perceive. Indeed, humans have an excellent ability to maintain auditory information, which facilitates the ability to relate sounds to each other. Besides memory, the organization of the frequency map needs to be highlighted as well. Thus, the perception of pitch is important when talking about music and language. Pitch, which refers to the low or high quality of a musical note, initializes navigation through the acoustic environment for the human organism and “serves an important information-bearing function” (Zatorre/Salimpoor 2013:10431). Depending on pitch, humans encode and transmit information differently, which enables communication and interaction. Going further, from single stimuli to melodies, which are combinations of individual pitches, neuro-imaging studies have shown that more cortical areas are activated. Besides the pitch-related regions, the anteroventral and posterodorsal pathways show excitation when stimuli become a sound pattern.

This perceptual progress just refers to the passive listening of music; the active component, however, considers the expectancies of the listener. Depending on the listener’s implicit knowledge about music, rules and sound patterns, melodies releases an expectation of continuations differing in probability (see Krumhansl 1990; qtd. in Zatorre/Salimpoor 2013:10432).

The final phenomenon which highlights the fascination of the musical brain is called musical imagery. It is considered “the experience of perception in the absence of a stimulus” (10432). Musical imagery is a pleasurable phenomenon as mostly everyone can imagine a musical piece in their mind’s ear. Neuro-imaging studies have shown that these experiences are real
because they share features with real musical perception, such as pitch acuity and temporal accuracy (see Janata 2012; qtd. in Zatorre/Salimpoor 2013:10432). Furthermore, studies have proven that parts of the auditory belt are still activated when people perform musical imagery tasks (see Zatorre/Halpern 2005; qtd. in Zatorre/Salimpoor 2013:10432).

Having covered the topic of musical perception, the next question is: how does pleasure come about? When we talk about pleasure with regard to music, reward is an important feature of human behaviour. “Because [reward] is a positive state, we tend to be reinforced to repeat the behaviour that leads to this desirable outcome.” (Thorndike 1911; qtd. in Zatorre/Salimpoor 2013:10432). In investigations with rats, electrical stimuli targeting particular pathways have been seen to carry on to the mesolimbic striatum, which was responsible for dopamine release and further triggered the reinforcement of certain behaviours (see Schultz 2007: qtd. in Zatorre/Salimpoor 2013:10432). So, can music reinforcement be seen as a desirable outcome?

Scientists widely believe that the pleasure people experience while listening to music is related to the emotions that are triggered while listening. Indeed, people report that their emotional state changes depending on the kind of music they expose themselves to (see Juslin/Sloboda 2001; qtd. in Zatorre/Salimpoor 2013:10433). To prove this claim, experiments were conducted evaluating self-reported pleasure and sympathetic nervous system activation simultaneously. This study showed that there is a positive correlation between individual pleasure and simultaneous changes in heart rate, respiration rate, body temperature and blood volume. In order to support the dopamine release hypothesis, another study was conducted, in which emotional responses to certain kinds of music were registered. Scientists discovered that the ventral striatum and other brain regions associated with emotional responses were activated and increased the intensity of the experienced “chills” (see Blood/Zatorre 2001; qtd. in Zatorre/Salimpoor 2013:10433). Moreover, they revealed that the neurotransmitter dopamine was released at a higher rate in the mesolimbic striatum when listening to pleasurable music compared to neutral music.

These experiments prove that listening to music is a rewarding activity, releasing dopamine, which perpetuates positive emotions and a state of well-being. Thus, at this point it is possible to assume that music triggers positive excitability that can be used as a beneficial and motivational component in language treatment. Still, these considerations will be more deeply discussed in the following chapters.
12.2 Music and Language – Formal Similarities and Differences

In speaking about the beginnings of both of language and music, Patel (2008:215) claims that humans use both components to communicate their cognitive representations, their internal states, as well as their emotional depiction. Moreover, language and music are both innate species-specific, and develop from early-childhood on. A similarity can also be observed in the phenomenon that a long sentence, for instance, cannot be entirely decoded until the last word is spoken. The same applies to a longer melody that can only be understood by the last sequence of tones (10431). Additionally, pitch, which was explained in the previous chapter, serves an information-bearing function that changes depending on the meaning it seeks to convey (see Zatorre/Baum 2012; qtd. in Zatorre/Salimpoor 2013:10431).

Scientists (Thompson-Schill et al. 2013:289) claim that there is one central feature that is characteristic of language and music and no other domains – their structure. Both systems arrive through the human ear, are processed within cerebral structures, and find their way out through the mouth or extremities. However, this processing cannot be thought of as within a black box. Rather, the human brain is able to relate musical and linguistic sounds to each other, groups them with following ones, and maintains the linear structure with which they entered the ear.

Patel (2008:264) describes the similar structure of language and music with a reference to the multiple organizational levels. To be more precise, the organization of language is based on syntactical rules and principles, such as the combination of lexical units (e.g. morphemes). These morphemes are linked to each other to produce words, phrases and sentences. The syntactic principles in music, on the other hand, determine how different tones can be formed into chords, chords progressions and how these resulting tonal keys are arranged in order to provide structural movement. Another parallel which Patel (265) outlines is the similarity between grammatical functions in language and music. Whereas the grammar of language is based on the arrangement of subject, verb and object, the grammatical function of music can be analysed in terms of harmonic functions. Thus, a particular chord can play a dominant or subdominant chord within a key, which, of course, changes the harmonic function.

Fritz et al. (2013:419) outlined more similarities between language and music. The so-called “elementary parts list” for language includes representational elements (phonemes, noun phrases, etc.) as well as computational elements (concatenation, dependency formation, etc.). Music also enacts representation in the form of tones and computation in the form of pitch.
detection. Another phenomenon that occurs is “discretization into auditory events” (426), which is simply the continuous stream of speech and music that requires chunking or discretization in order to identify meaning. Grouping, another similarity,

both in terms of establishing constituency (segmentation into groups) and hierarchy (establishing relationships between components), can occur in space (as in dance, orchestras, marching bands, choruses, and cocktail parties), in time (e.g., intricate polyrhythms in African drumming), and/or feature space (e.g., timbre). (Fritz et al. 2013:426)

Further similarities outlined by Fritz et al. (427f.) include the linking of multimodal objects within audio-visual speech, such as in songs (words and melody), the coordination of transformations (e.g. the balance between musical and motor information in dancing), and the organization of the structure for social partners (e.g. in orchestras or conversation situations).

To round off this chapter, Patel (2008:263) discusses formal differences based on linguistic and musical syntax. Whereas language contains grammatical categories, such as nouns, verbs and adjectives, musical syntax fails in this approach. Thus, language and its syntactic trees shows a more profound constituency compared to music. Patel argues that long-distance dependencies are more likely to be found within language than in music. For instance, relations between the words “girl” and “opened” in the sentence “The girl opened the door.” are omnipresent and can usually be perceived within the right context (Chomsky 1965; qtd. in Patel 2008:263). However, long-distance dependencies in music, displayed within a tension-relaxation tree cannot easily be perceived by the audience. In fact, a sequence of words is more likely to be perceived correctly than a sequence of chords because they lack essential syntactic features (264).

Given the evidence above, it is possible to state that music and language do share common links in terms of processing and structure, which could slightly indicate that music could have an impact on language and further language disorders. Still, this hypothesis will be verified more explicitly in the following chapters.

12.3 Impact of Music on Language

There have been numerous studies that have investigated the significance and impact of music on language learning in its various contexts. In particular, the impact of music on learning English as a second language (ESL) has been investigated in classrooms. The reason I have included language teaching within this thesis is that language disorders also occur in classrooms and within language teaching. To put it simply, teaching and learning a language
in all its modalities is a core aspect of every kind of aphasic speech therapy. On this basis, it is interesting to compare the classroom and therapeutic contexts.

Huy Le (2007; qtd. in Li/Brand 2009:74), a Vietnamese ESL teacher, observed that music is beneficial for students as well as teachers in all four modalities (speaking, writing, listening, reading). More precisely, music animates the teaching itself and creates enthusiasm and motivation within the learning environment. In order to show some of the benefits within the classroom, a study about embedding songs in language learning was conducted by Murphey (1992; qtd. in Li/Brand 2009:74f.). He found that the language of pop songs can be compared to the English level of 11-year-old native speakers. Thus, the simple vocabulary facilitates the language learning process. Additionally, the beat within a song helps the students become sensitive to musical rhythm, timing, and aids them in developing a feeling of flow while reading.

In addition to sparking pleasure, Maess and Koelsch (2001; qtd. in qtd. in Li/Brand 2009:74) further physiologically support the perspective that music impacts human cognitive abilities. They found that music and linguistic syntax are processed similarly as they are embedded within the same brain areas. Furthermore, Ayotte (2004; qtd. in Li/Brand 2009:74) claimed that language and music “share same auditory, perceptive, and cognitive mechanisms that impose a structure on auditory information received by the senses” (2004:10). Furthermore, Schlaug et al. (1995; qtd. in Haning 2016: 132) observed that musicians have more grey matter than non-musicians, particularly surrounding the predominant language areas of Broca and Wernicke. As mentioned in the beginning of this paper, grey matter consists of myriad neurons that are responsible for fast cognitive processing.

As mentioned, music has a beneficial impact on all four modalities. Researchers (see Anvari et al 2002; qtd. in Haning 2016: 133) investigated the relationship between musical training and reading comprehension to further support the improved cognitive processes of musical brains. They found that musical experiences and musical training can improve children’s reading ability. However, though literature is still lacking broader studies investigating the relationship between musical ability and reading ability, it can be said that an effect of music on reading is valid. In a meta-analysis of Standley (2008; qtd. in Haning 2016: 133f.), the overall impact of music instruction on reading comprehension was found to be dominant compared to computational instruction. Because of this positive effect, using music to train reading ability has become more important, especially for teachers and schools.
Musical rhythm can enhance one’s understanding of new language with its particular timing. Researchers have observed that rhythmic or rhyme material can facilitate the recall of items. An important aspect of this study was that rhymes enabled adult learners to remember things more efficiently; however, children were distracted by rhymes combined with learning (see Baechtold/Algier 1986:250). Taking this difference into consideration, Hayes, Chelmelski and Palmer (1982; qtd. in Baechtold/Algier 1986:250) concluded that adult can use rhyme as a “mnemonic devise”, whereas children do not yet possess this ability. Even though detailed descriptions of stories might be inhibited by rhyme, the psychologists Bradley and Bryant (1983; qtd in. Baechtold/Algier 1986:250) insisted on the positive impact of rhythmic and rhyme patters on language development and fluency. Furthermore, Taylor (1981; qtd. in Baechtold/Algier 1986:250) observed that, in addition to the previously mentioned positive effects, music motivates students, helps them to master speech articulation problems and to stabilize their listening and reading skills. Even though it seems easy to establish motivation within the classroom, the teacher’s ability to instil that motivation is important to enhance language development. Manzo and Sherk (1971; qtd. in Baechtold/Algier 1986:251) believe that “the single most significant factor in improving vocabulary is that excitement about words which the teacher can generate”. Thus, if the teacher is passionate about the learning language, teaching vocabulary, and structuring the children’s mindset, music, with all its facets, can support them tremendously in generating motivation in language learning.

One of the famous examples concerning the use of music for language learning is Eun-Hee Koo’s (2000) attempt to teach the Korean language using songs. She created a song to teach Korean greetings. The useful aspect of this is that Korean can be taught to every foreigner by singing this song. Moreover, the song contains both English and Korean elements, which makes it easier to keep track. First, she sings the song by herself, then her students are asked to hum along; next, they try to sing the English parts, and last, they try it in Korean. After several repetitions, the researcher was able to determine a positive effect and simplified reproduction of the song. In her study, she also points out how music is useful for language and speech development. First, the low and high pitch of music can help students become familiar with the intonation of a foreign language. Second, dynamics are another important aspect because if a language learner knows the dynamics (soft and loud parts) of a song, the pragmatics of the language can be learnt more easily. Indeed, the time to use loud and soft speech is important to understand the difference between them. Third, understanding rhythm in music can improve their language learning. Thus, it is essential to use rhythm efficiently and to know when to speak and when to pause in conversation. Last, the final element is the
mood of musical expression. Comprehending the status of mood within a song makes one aware of the different states of mood within language. This is important for understanding the meaning of words in a conversation, which serves the basis for successful human interaction (see Koo 2000).

To conclude this topic, music does have a beneficial effect on language learning, from teaching vocabulary to learning the dynamics of a new language. Music in all its varieties can help teachers create a successful learning environment, boost motivation, passion about language learning, and pleasure. As research still lacks a variety of studies solely based on musical impact on aphasia, it is important to broaden the context by also including general information of music and its positive impact on language. Thus, having presented research data on classroom experiences and having shown that music can be beneficial for all modalities of a language, this thesis will now turn on approaches the investigation of music and its impact on language disorders.

12.4 Co-Existence of Music and Language Deficits

The collaborating cerebral network of both hemispheres explained previously, can also be analysed within neurological disorders. Acquired amusia, for instance, is mostly the result of brain surgery or strokes. It is defined as an impairment in perceiving music, producing music, or both (see Cuddy, Balkwill, Peretz and Holden 2005; qtd. in Thompson 2009:159). Amusia and aphasia can coexist; however, their co-occurrence does not indicate that both domains are linked to shared brain regions. Rather, a brain injury can occur within several brain regions that can affect either musical or language skills, or both (161). As Peretz (2002; qtd. in Thompson 2009:159) investigated several cases of patients suffering from amusia but not aphasia, which is one of the indications that these two neurological disorders do not have to co-exist. Another important indication which supports the thesis that both domains do not necessary affect the same brain regions, is the first report of aphasia and a mostly intact musical ability in 1745 (see Dalin 1745). This patient suffered from a right hemiparesis, which is a left-sided weakness of the body, as well as from a tremendous limitation of speech to the word “yes”. However, the patient was able to sing along to hymns. As a result of this phenomenon, many studies have been conducted examining the interface of amusia and aphasia. Yamadori et al. (1977) presents his study of 24 patients suffering from Broca’s aphasia and a severity of verbal expression. Twenty-one out of 24 patients were able to sing excellently, while some individuals sang without using words or with paraphasic errors.
Still, there are also cases in which recorded amusia has been accompanied by aphasia. Patients within these studies perceived music as dissonant as well as voices, including their own, as too high pitched. Pötzl and Uiberall (1937) found that these patients were neither able to sing nor to reproduce the rhythmic patterns they were given.

Finally, investigations of amusic patients without aphasia have also been carried out. Frequently reported symptoms included “the difficulty recognizing sounds as musical, loss of a sense of rhythm, hearing musical sounds ‘out of tune’, and hearing both voices and music as monotonal” (185). Furthermore, it was proven that lesions in right-handed patients frequently involved the right hemisphere of the brain.

One of the most cited cases of patients suffering from musical deficits without linguistic difficulties is the case of G.L., which was investigated by Peretz and her colleagues (1993). The patient G.L. suffered a bilateral damage of the temporal lobes, including cerebral infarcts due to strokes. Compared to other neurological cases, G.L.’s primary auditory cortex was not affected; rather, his rostral superior temporal gyri, which serve important auditory functions, were damaged. G.L. was an avid music listener, yet had not had any professional musical training. He started to have severe problems with musical perception some years after his stroke, and underwent several tests administered by Peretz and her colleagues (1993), in which he was able to notice pitch differences, differences within melodic contours, and in which he was sensitive to pitch patterns. However, his sensitivity to tonality was completely lacking. To give an example, G.L. could not differentiate between tonal and atonal melodies within short-term memory tasks. Hence, G.L. is one of the best known cases of acquired amusia without aphasia, as he scored an average score on standardised aphasia examinations, proving that he did not suffer from linguistic deficits.

Peretz, Belville and Fontaine (1997) investigated cases of amusic patients without aphasia in more detail. The patient Isabelle R., devoid of any particular musical or linguistic talents, underwent several surgeries to repair ruptured aneurysms in her left and right middle cerebral arteries. She survived this very complicated surgery with two brain lesions affecting the auditory cortex bilaterally as well as right-hemispheric frontal areas. Besides the remaining capability of language production, memory and intelligence, she could not recognize familiar music anymore, remember melodies as they faded away or carry a tune. Even though she had been capable of these skills before the occurrence of her brain lesions, she could not carry them out afterwards (376f.).
The major conclusion that can be drawn from cases of amusia without aphasia or vice versa, is that there are two distinct processing modules for language and for music. Thus, music-specific and linguistic-specific circuitries can be selectively damaged without impairing the other module. On the contrary, considering cases of amusia and aphasia, it can be said that:

Domain-specificity may arise at different levels in the processing of either language or music. There is no need for all processing components to be specialized for their respective domain […] Damage to only one or two pivotal processing components that are specialized for language (or music) may result in a dysfunction of the entire processing system. (Peretz/Belville/Fontaine 1997:377)

Thus, this quotation clearly states that not all processing components of both language and music have to be affected on the same level at the same time due to cerebral lesions. Therefore, these domain-specific circuitries can be partly affected and thus, also damaged, which results in different dysfunctions.

13 Music for Recovery

The use of music as a therapeutic tool has been proven to work, particularly in therapies for developmental disabilities. Thus, music therapy describes music as a:

therapeutic tool for restoration, maintenance, and improvement of psychological, mental and physiological health and for the habilitation, rehabilitation, and maintenance of behavioural, developmental, physical and social skills – all within the context of a client-therapist relationship (Boxill 1995:5).

Music can serve as a recreating and reinforcing tool that aims to develop motor skills, communication skills, social skills, and cognitive skills. Moreover, it is used to heal (see Stephenson 2006: 291). Whereas conventional musical therapy includes group sessions, singing and playing instruments, as well as dancing together (292), the therapies I discuss in this thesis are intended to treat particular language disorders, with the aim of improving verbal outcomes.

13.1 Melodic Intonation Therapy

As many clinicians provide clients suffering from speech and language disorders with appropriate speech therapy, a new scientific approach incorporates music into language treatments. As has already been demonstrated, language and music share common processing structures within the same brain areas. Thus, music can support the recovery of speech and language disorders, which will be more precisely proven within the next pages.
13.1.1 Defining MIT

Melodic Intonation Therapy, called MIT, is a treatment used by speech-language pathologists, which aims to rehabilitate patients with speech production disorders (see Albert/Sparks/Helm 1973) In general, this treatment consists of intoning and rhythmic practices (e.g. intoned speech, Sprechgesang, lip-reading and unison production with the speech therapist) to facilitate and repair language production. The beginning of the therapy is marked by the use of musical components to ease verbal production and expression. Within this setting, patients are encouraged to produce simple everyday sentences in a singing-like manner that broadens the natural prosody (pitch variation and rhythmic features) while tapping on each syllable with their left hand (1). Helm-Estabrooks (1983) claimed that the inclusion of the left hand helps to stimulate language-specialized areas within the right hemisphere.

13.1.2 The Rationale of MIT

The original idea behind MIT flourished as a result of the observation that aphasic people were to sing songs that were familiar to them. However, back then it was not believed that this kind of treatment was able to positively affect speech or language therapy (see Yamadori et al. 1977) Still, Sparks, Helm and Albert (1974) assumed that regions of the right hemisphere, which show activation in music processing, could control damaged regions of the left hemisphere if they were appropriately stimulated; this leads to the idea of learning a new way of expressing language/speaking through singing.

The central aim of MIT is to improve and restore propositional language (see Albert/Sparks/Helm 1973) as well as to facilitate everyday-language in order to help patients express their thoughts and ideas (see Jackson 1878). Propositional language is volitional and requires mental effort in order to produce a meaningful outcome, which has an intention behind it. It is a set of phonological, grammatical and morphological rules. In comparison, non-propositional language, also referred to as formulaic language, is effortless and an automated process, such as saying prayers or naming the weekdays. Thus, non-propositional language contains a repertoire of common sayings and over-learned expressions. Because of this ease of expression, the first levels of MIT consist of sessions using everyday sentences, which are part of the formulaic category. The scientists Van-Lancker-Sidtis and Rallon (2004) claim that it is particularly important to use formulaic expressions in speech and language therapy as they represent the average phrases of American English. Furthermore, the ability to
communicate with frequently used expressions maintains the clients’ motivation to actively participate in the therapy.

The main rationale behind MIT is to explore the similarities between language and music and to use these structural similarities to enhance and improve speech production in a natural way (see Cortese et al. 2015). In fact, prosodic aspects can be found in both language and music, which marks an important shared property. In music, to be more precise, prosodic elements refer to the rhythmic pattern, volume, and pitch variations (see Marotta 2009). In comparison to language, rhythm is associated with the syllable, and the variation between weak and strong syllables constructs the rhythmic pattern. Moreover, the accent of speech, which is considered “an increase of intensity, duration and height, with respect to the adjacent elements” (see Savy 2009; qtd. in Cortese et al. 2015) determines the dominance and force of this particular rhythmic pattern.

At the beginning of the therapy, the patient learns to speak everyday utterances with the use of “intoned speech”, which is a facilitation technique. Intoned speech contains the same elements of pitch and rhythm as normal speech; however, it is more exaggerated (see Sparks 2008). The pitch variation consists of two constant pitches, which are two musical notes. For stressed syllables, the high pitch is used, whereas unstressed syllables are indicated by the low pitch musical note. The rhythm is also exaggerated; thus, the tempo is lengthened, stressed syllables increase in volume, and the rhythmic pattern contains only quarter and eighth notes.

One of the relevant aspects of MIT is that the verbal material must offer a broad variation of different tasks, must be replicable, and performed differently in order to avoid rote memory (see Sparks 2008). The clinician and the patient go through the material very precisely, using the patient’s left hand to tap as well as intoned speech to stimulate the right hemisphere (see Helm-Estabrooks 1983). Throughout the treatment, the difficulty of the tasks increases, starting with intonation in unison with the clinician, to autonomous expression (e.g. free response to questions). As the client proceeds through the therapy and shows positive outcomes, the last level of MIT tries to remove the musical notes from their speech output. To do so, the clinician uses another facilitation technique called Sprechgesang, which is a combination of speech and singing. This facilitation technique has rhythmic features as well; however, the two constant pitches are substituted by varied pitches, which approach the natural speech of the patient (see Sparks 2008). As this treatment requires intense practice of speaking skills, the patient frequently attends therapy sessions for 3-6 weeks.
However, the scientists Zumbansen, Peretz and Hébert (2014), pioneers in the research field of music and language, have discovered issues within the original MIT method, as a meta-analysis proved that only 5 out of 14 studies have achieved the original rationale and therapeutic goals of the practice. Therefore, the scientists determined that it was necessary to improve the original MIT method and have adapted some of its practices in order to achieve better results. These adaptations will be discussed in the next sub-chapter.

13.1.3 Modifications of MIT

Although Zumbansen, Peretz and Hébert (2014) found that all studies of MIT led to the ability of the patient to form verbal material based on musical notes, and showed progress from the most assisted condition to an autonomous intoned speech production, they sought to modify MIT from its original form by incorporating several aspects.

First, aphasic patients were given a variety of verbal material which followed an intense training in order to learn a restricted set of sentences. Compared to the original MIT, this method does not aim to improve the patient’s generative language. Rather, it provides patients suffering from severe aphasia with a few pre-built sentences that can easily be used in daily communication. The scientists refer to these kinds of protocols as “palliative versions of MIT” (3), as this modification does not challenge the norm enormously. Rather, it contains a milder version of standardised materials of MIT for aphasic patients, “who do not fit the strict candidacy criteria for original MIT” (see Sparks/Helm/Albert 1974).

Second, the scientists prefer the French model of MIT, called thérapie mélodique et rythmée (TMR) (see Van Eeckhout/Bhatt 1984), which does not aim for a prebuilt return to normal speech like the original MIT. Rather, the French model is based on the free choice of patients to use the intoned facilitation technique as an odd assistance in case of need. Whereas the original MIT seeks to establish a new way of speaking through the use of melodic intonation, the French approach ends its therapy with a more extended, less intense period in which aphasic patients can exert facilitation techniques to master daily communication, if necessary. Figure 3 below presents the comparison of the MIT and TMR program that differentiate in their therapeutic procedure.
Third, TMR focuses on both prosodic components as well as the melodic aspect of the patient’s speech, which can moderate the speech deficit of the patients (see Van Eeckhout/Bhatt 1984). Moreover, in a palliative version of MIT, the sung phrases are supported by complex melodies, and the clinician uses an instrument to create a harmonic atmosphere (see Baker 2000). In contrast to the original MIT, the musical elements within TMR are intended to help patients remember trained sentences more easily, rather than improve their general verbal production (5).
Last, the tapping of the left hand in the original MIT is expanded to several other body parts in TMR because the French version of this therapy “does not consider cerebral hemisphere dominance for the treatment effect” (Van Eeckhout/Bhatt 1984).

Although the modifications to the original MIT do show positive outcomes, the study results cannot be generalized to the majority of clinical protocols for several reasons, which will be discussed in some of the next chapters. In fact, some of the MIT modifications reflect adjustments to the clinical profile of aphasia patients mostly suffering from Broca’s aphasia (see Baker 2000). Furthermore, clinicians support the idea of adapting protocols depending on the needs of the patient (see Sparks/Holland 1976).

To summarize, there are two effective adaptions of the original MIT: the TMR (French version of MIT) as well as the palliative version of MIT. However, reports of the effectiveness of modified MIT cannot be linked to the effectiveness of the original MIT as they differ in procedures. Therefore, researchers continue to encourage more profound investigations of the original MIT protocol.

13.1.4 Challenges in Applying MIT

The original MIT bases its goals on the hypothesis that right cerebral dominance plays an important role in the efficacy of the treatment. However, this claim is still being debated, as several study results will show. In fact, there are numerous studies that support the hypothesis (see Schlaug/Marchina/Norton 2008), while others fail to find evidence thereof (see Laine/Tuomainen/Ahonen 1994) or even suggest left peri-lesional dominance (see Belin et al. 1996). Thus, Zumbansen, Peretz and Hébert (2014) attempted to gather the disparate data of the last two decades in an effort to clarify these inconsistent findings. In this pursuit, the scientists outline some major factors that could be responsible for this lack of consistency.

First, the studies analysed used different modifications of the original MIT and sometimes also changed the therapeutic goals, which, of course, results in divergent clinical findings. Surprisingly, no study verifying the left hemisphere hypothesis made use of the original MIT (6).

Second, not all of the studies incorporated pre- and post-therapy. There are tests which show an improvement after TMR; however, no pre-data could be found. Therefore, these different results cannot solely be associated with the effect of the treatment (6).
Third, the studies did not use the same brain imaging paradigms. They ranged from lexical decision tasks to covert action naming tasks to repeating target words. Therefore, it is very important to make careful assumptions when comparing different paradigms. Indeed, within the same aphasic patient, brain activation can change depending on the type of task they have to fulfil (6).

Finally, the last explanation for the inconsistent findings is that the lateralization of brain activation linked to language tasks changes depending on the time that has passed since the patient’s stroke (see Saur et al. 2006). Furthermore, the reorganization of the brain after a stroke is highly dependent on the severity of the lesions (see Crosson et al. 2007). Thus, it is difficult to generalize clinical findings as they need to be analysed individually. Still, one more generalized finding that the researchers identified is that brain regions within the right hemisphere can facilitate language recovery if predominantly language-specialized areas within the left hemisphere are damaged (see Heiss/Thiel 2006). Moreover, they found a link between formulaic expressions (everyday sentences), the right frontotemporal regions, the right basal ganglia, as well as the right cerebellum (see Ackermann et al. 1998). Thus, scientists claimed that the repeated practice of formulaic material could lead to improvements in the right hemisphere circuits (see Stahl et al. 2013). In order to support the positive effect of right hemisphere activation, Zipse et al. (2012) analysed nine patients suffering from chronic aphasia and severe left-hemispheric lesions. They observed that the patients showed increased activation in the right hemisphere and increased white matter plasticity while undergoing the original MIT treatment.

13.1.5 Positive Impact of Music in MIT in Recent Research

Even though clinical generalizations cannot be made for the reasons mentioned above, there are still some reasons why incorporating music can be beneficial for the recipients of speech and language treatment. For this part of my thesis, I would like to present four case studies, each of which investigated the relationship between speech therapy and the use of melodic elements. At the end, I will give an overview based on these studies and outline the most important outcomes.

13.1.5.1 Research Study 1

One of the most fascinating reasons for the inclusion of singing as a facilitation technique in MIT is the fact that patients who are suffering from severe non-fluent aphasia are more likely to produce expressions in familiar songs compared to normal speech output (see Gerstman
1964). Thus, singing motivates aphasic patients to pronounce words. To further support this hypothesis, Racette, Peretz and Bard (2006) observed that singing along (also referred to as choral and unison singing) has a tremendous effect on verbal production. Moreover, the researchers discussed the difference of “singing along over singing alone” and “singing along over speaking along” (see Racette, Peretz and Bard 2006; qtd. Zumbansen/Peretz/Hébert 2014:7). According to the results, singing along promotes better speech improvement than singing alone as patients can rely on a model, and, thus, the intensity of song-associated memory is reduced. The study also discussed the effect of unison production on “the accuracy of motor speech planning and performance through the involvement of the mirror neuron system or the auditory-motor interface” (7). These investigations strengthen the relationship between music and action and perception in language (see Iacoboni et al. 1999; Callan et al. 2006). With regard to the second assumption (i.e. singing along over speaking along), Racette and his colleagues (2006) posited that imitations of an auditory model could facilitate verbal production when it is sung rather than spoken. They put forth their hypothesis with the claim that sung lyrics, compared to spoken words, have a more regular rhythm. Thus, “greater temporal regularity allows better synchronization” (Large/Peretz/Bard 2006).

Concerning rhythm and pitch variation, the natural rhythm of the patient’s mother tongue plays an essential role in facilitating effect of the singing facilitation technique. For instance, in TMR, patients produce intoned phrases on melodic rhythms, which combine natural and artificial stresses. The artificial stresses are created to emphasize usually unstressed speech, which should help patients to improve the production of these words within the intoned phrases (see Zumbansen/Peretz/Hébert 2014:8).

Finally, decreasing the articulatory tempo establishes the same effect as singing. Indeed, slowing down the pace shows effective outcomes for patients who suffer from motor speech deficits (see Pilon/McIntosh/Thaut 1998). Furthermore, focusing on exaggerated syllable durations can have a beneficial impact on speech production (see Stahl et al. 2011).

13.1.5.2 Research Study 2

The investigations by Zumbansen, Peretz and Hébert (2014) also aroused my interest in the context of this thesis. As they found (see research study 1:2014) that rhythm plays a more predominant role in MIT than pitch, the aim of this study was a comparison between a
melodic therapy (containing rhythmic and pitch elements), a rhythmic therapy (rhythmic elements only) and a conventional spoken therapy (without melodic aspects).

Three native French-speaking, right-handed men with Broca’s aphasia were consulted and willing to undergo these varieties of treatment. In a cross-over design, the patients underwent hourly treatment sessions three days a week for a period of six weeks. The verbal material consisted of individual phrases that fit into the patients’ daily utterances. Moreover, they were also split into new phrases that were used for the interventions, as well as into test-phrases that served the purpose of assessing the direct and indirect effects of the treatment variations. Afterwards, all sentences were recorded in three different modes: intoned spoken, rhythmically spoken, and normally spoken, without rhythm or pitch variations. In order to provide a realistic setting, the stimuli were produced by a natural voice that could be compared to a clinician’s voice (3).

Beginning with the intoned mode, the stimuli presented varied in pitch on two notes. The high pitch was associated with produced syllables that are usually stressed in French natural prosody. The rhythmically spoken mode, in comparison, had to be expressed only with a rhythmic element. Lastly, in the normally spoken mode, the components of pitch and rhythm were absent. Rather, speech was produced in a slow and clear manner with naturally constructed prosody (4).

During the training sessions, the patient and the clinician communicated face-to-face. The patients had to produce 20 phrases from the verbal material, twice in unison, twice in unison with the clinician stopping half-way, once repeating and once responding freely to a question. The language outcomes were measured based on the repetition of trained and untrained items, in order to gauge to the direct and indirect effect of the treatment, as well as connected speech, in order to measure the generalization effect. In order to evaluate the patients’ ability to use connected speech, a picture-description task was used. Moreover, both the patients’ moods and their motor-speech ability were analysed by means of standardised tests, such as the visual analog mood scales (VAMS) (4f.).

The aim of this study was to compare three different therapeutic options in terms of “the relative contribution of rhythm and pitch in MIT’s generalization effect” (7). The three treatments, MT, RT and ST, differed only in terms of presence or absence of these two prosodic features. In general, it is possible to claim that all three treatment possibilities had an impact on the trained items that were associated with the direct effect of the therapy. The
indirect effect, however, which was displayed by the ability to repeat untrained items, varied depending on the treatment. In fact, melodic therapy using rhythm and pitch had an indirect effect on untrained items that was as large as its direct effect on the trained items. In contrast, the rhythmic and the spoken therapy only had an indirect effect in one or two patients, which was not as large as in melodic therapy. Thus, these findings support the hypothesis that using these prosodic elements has a positive impact. Furthermore, in terms of generalization effects, the MT also scored the highest. Zumbansen, Peretz and Hébert (2014:7) strengthened their findings and hypothesis with further study results, which were observed by Schlaug et al. (2008). They found that one patient showed improvement in connected speech using melodic therapy compared to control participants who received therapy without musical components (Zumbansen, Peretz and Hébert 2014:7).

An important side note, which further aroused the researchers’ interest, was the fact that only the co-existence of rhythm and pitch had an improving effect on language outcomes, in contrast to the use of rhythmic elements alone. Therefore, Zumbansen and her team sought to investigate the mysterious relationship between these prosodic elements and why the combination had a positive influence on the generalization effects of language. Peretz and Zatorre (2005) found that the processing of pitch activates right-hemispheric structures while the processing of rhythm and temporality in singing engages left-lateralized cerebral activity close to the language areas (see Jungblut et al. 2012). So far, research has shown that language recovery can be improved through left perilesional activation, rather than intrahemispheric compensation (see Anglade et al. 2014). In fact, intoned speech stimulates left perilesional areas to a more profound extent than normal speech (see Belin et al. 1996), which led Zumbansen and her team to the hypothesis that rhythmic elements in intoned speech could be beneficial for left-hemispheric activation. Furthermore, they suggest that the component of pitch “could act as a facilitator to effectively get access to reactivation of perilesional areas for language production. Pitch information, [they argue], adds a redundant cue to rhythmicity in the intoned-speech technique” (8). For example, high pitch is associated with stressed syllables and longer notes, whereas low pitch is associated with unstressed syllables and shorter notes. Therefore, the researchers suppose that pitch could help patients process rhythmic patterns and foster left-hemispheric activation of language- and rhythmic related brain areas through transcallosal routes. As the Hebbian axiom goes “neurons that fire together, wire together” (8); thus, the hypothesis mentioned above could play a crucial role in future research.
The aspect that was not significantly supported by MT was the patients’ mood. Thus, the researchers were not able to record any tremendous effects of the melodic components in MT on language recovery. Nevertheless, music and its influence on emotions has been one of the most investigated topics in research, and studies have shown that exposing oneself to music can have a huge impact on one’s emotional state (see Koelsch 2010). In fact, Särkämö et al. (2008) put forward that post-stroke depression and the accompanying cognitive impairment as well as mood instability can all be mitigated by listening to music. Even though it has been suggested that music and its influence on mood can be beneficial within singing therapies for language recovery, this claim has not been verified within MT. To exemplify, the musical context of singing therapies in enriched with a variety of patients singing, playing instruments or listening to musical pieces. MT, however, uses musical stimuli that consist of only a few pitches (typically two), basic rhythmic features, and which lack any harmonic structure. Therefore, the “music” in MT cannot be compared to the kind of music that is used for singing therapies, for instance.

This study was completed with an analysis of the effect of MT on motor-speech agility. Compared to the previous study, which noted the positive impact of MIT on apraxia, this study did not result in significant positive outcomes with regard to motor-speech agility. Thus, the team recommended further research on this matter (9).

13.1.5.3 Research Study 3

Another study, conducted by Cortese et al. (2015:3) used the French model of MIT, known as TMR, and applied its procedures to the Italian language. The purpose of this method was to evaluate the efficacy of this treatment on six patients with severe non-fluent aphasia. These particular patients had not been given previous treatment for aphasic disorders after their strokes. Rather, they underwent conventional speech therapy before being treated with MRT. The patients’ brain lesions were unilateral, resulting in impairment of spontaneous speech, word articulation, and the repetition of single words. Still, their comprehension of spoken language was not affected. The treatment consisted of intense sessions that took place four days a week for a period of four months. Each training session lasted 30-40 minutes. Each session was made up of three main parts: first, non-verbal melodic and rhythmic exercises were practised. Second, the clinician asked patients to repeat 25 frequently used sentences, varying in complexity and length. Third, individual phrases from the patients’ lives were practiced, using rhythmic-melodic patterns (4).
The results of the study were established by comparing the results of short AAT-tests (Aachener-Aphasia-Test) conducted at the beginning and at the end of the treatment. The results proved that the patients’ spontaneous speech was improved after TMR, particularly on the level of the semantic-lexical structure. Furthermore, the number of pronounced words increased per interval, and both the phonemic structure and syntax improved (5).

13.1.5.4 Research Study 4

The final study I want to mention was conducted by Van Der Meulen et al. in 2016. The aim of this study was to compare the clinical results of a pilot randomized controlled trial (RCT) on MIT in chronic aphasia with findings observed in subacute aphasia.

Their study was based on the multi-center waiting-list RCT design, which provided an experimental as well as a control group. Patients with chronic post-stroke aphasia that had lasted longer than one year were randomly assigned to one of these groups. Patients were selected for this study based on several other aspects: they had to have been an MIT candidate, right-handed before their stroke, between the ages of 18 and 80 years, native Dutch speakers, and be suffering from non-fluent aphasia, as a result of a unilateral left-hemispheric stroke with poor language repetition, poor articulatory speech, and moderate to good auditory language comprehension (2). These aspects were measured beforehand using the Aachen Aphasia Test and several of its subtests.

As outlined in Figure 4, the experimental group received intense MIT training five hours a week between T1 and T2, for a period of six weeks. The control group, on the other hand, did not receive any specific aphasia treatment. Between T2 and T3, the control group received six weeks of intense MIT training (five hours a week), while the experimental group did not. The important aspect in terms of the design of this study as the 6-week-waiting period the control group had before receiving their first specialized aphasia treatment (2).
The treatment itself followed the general principles of MIT. Thus, the protocol of this study outlined a list of Dutch utterances for each level, along with their intoned pattern. In addition to this set of standardised items, the therapist and patient developed an individual list of personally relevant items with information about the patients’ hobbies, favourite foods, family, etc. Because the training was so time-intensive, the therapists developed an iPod application which enabled patients to continue their daily practice at home. Patients received a minimum of three hours a week of face-to-face therapy with the clinician. The rest of the time could be used for home practice with this specialized application. Compared to the experimental group, the control group was not exposed to a specific aphasia language treatment. Still, patients within this group were able to interact socially in aphasia groups in order to improve their verbal and non-verbal communication.

In order to gather a variety of qualitative information, outcome measures were divided into several levels of treatment success: the improvement in repeating trained items, the generalization to untrained items, generalization to word retrieval, and generalization to
verbal communication. This precise fragmentation of outcome measures is crucial as the evaluation of aphasia therapy requires a distinction between improvement of trained items (that is the treatment’s direct effect), improvement of untrained items (the treatment’s indirect effect), and generalization to the use of functional language (e.g. ANELT and Sabadel) (see Zumbansen et al. 2014). In this study, outcome measures were evaluated at baseline (T1), after 6 weeks (T2) and after 12 weeks (T3). The evaluation consisted of an MIT repetition task, a story retell task, as well as the subtests on naming, repetition and auditory comprehension from the Aachen Aphasia Test.

In terms of the efficacy of MIT in this RCT, the experimental group showed significant improvement in their ability to repeat both trained and untrained items. However, other positive outcomes were not found. Compared to the control group, patients in the experimental group showed an improvement in terms of their trained utterances (4). Even the control group, which received MIT treatment between T2 and T3, displayed a similar pattern of efficacy compared to the experimental group (between T1 and T2). Thus, there was evidence that the MIT repetition task led to an improvement in both trained and untrained items, but no other outcome measures were registered. Although, a difference between the experimental and the control group was found; the improvement of the control group did not reach research-based significance. It is also important to mention that the experimental group was not able to maintain the beneficial effect of MIT - observed at T2 - six weeks later (T3). Rather, their performance at T3 was significantly worse than at T2. To conclude, the following table shows the general language improvement of all patients in this study using MIT.

\[
\begin{array}{|c|c|c|c|}
\hline
 & \text{Pre-MIT} & \text{Post-MIT} & \text{p} \\
\hline
\text{Sabadel} & 5.6 (11.2) & 5.8 (9.3) & 0.87 \\
\text{ANELT} & 15.2 (6.6) & 15.6 (8.0) & 0.67 \\
\text{Naming (AAT)} & 25.8 (31.7) & 27.3 (30.5) & 0.37 \\
\text{Repetition (AAT)} & 49.6 (27.2) & 54.9 (32.3) & 0.09 \\
\text{MIT task: trained items} & 16.8 (13.3) & 27.3 (16.7) & <0.01 \\
\text{MIT task: untrained items} & 12.8 (10.8) & 18.0 (13.7) & <0.01 \\
\text{Auditory comprehension (AAT)} & 41.1 (7.7) & 38.8 (9.4) & 0.17 \\
\hline
\end{array}
\]

\text{SD, standard deviation; ANELT, Amsterdam-Nijmegen Everyday Language Test; AAT, Aachen Aphasia Test. Bold values, significant.}
Additionally, the researchers found that the intensity of the treatment (face-to-face therapy as well as home practice with the iPod application) was the only variable that was significantly related to improvement on trained utterances. However, in this study, MIT seemed to only be beneficial to the repetition of trained material, without a generalization effect on untrained items, word retrieval, or daily verbal communication. Because this study did not continue over a longer period of time, the researchers propose that generalization effects to verbal communication may have been seen if a longer and more intensive treatment had been carried out. Thus, they recommend further research on this matter.

13.1.6 Overlaps in Recent Research

This subchapter will provide a summary of the dominant research findings that support the hypothesis that music has a healing effect on language disorders such as aphasia. Using the four studies outlined above as templates, the use of melodic components can generally be claimed to be beneficial to at least one criteria of language. Even though the intersection of language and music has received both profound and broad research-interest, it is difficult to generalize the clinical findings, as each study and the subsequent outcomes are the result of a variety of factors that cannot be easily compared.

Still, the four studies I have chosen for this thesis do show some scientifically relevant consensus. Furthermore, these links establish a stable basis for future research on this matter. To provide a compact overview of the outcomes of these studies, I want to summarize their clinical highlights.

As stated, the use of melodic elements had a positive impact on language treatment. To be more precise, singing along with a therapist, for example, enhances verbal expression and leads to better speech improvement as the patients were motivated to actively participate in therapy sessions. Compared to singing alone, unison singing serves as a supportive function for patients by letting them know that they will be bolstered if they need help. Within the same study, researchers found out that slow speaking and decreasing the articulatory tempo enables patients to express themselves more calmly and helps them to concentrate on their utterances.

Another important feature of MIT, generally, and which was addressed in all of the studies described, is the predominance of rhythm. From childhood on, the use of particular rhythmic patterns in one’s mother tongue initializes a conscious feeling of expressing oneself according to particular rhythmic structures. Furthermore, language depends on a variety of rhythms in
order to encode and decode messages the right way. Thus, rhythm serves as a supportive facilitator in rhythmic language therapy because patients can be guided through their verbal productions following particular pattern. Even though rhythm on its own contributes positive effects to language therapy, the combination of rhythm and pitch achieved the highest results. Pitch information, namely, was observed to be essential for rhythmicity in intoned-speech technique and helps patients to follow rhythmic patterns.

Last but not least, the use of MIT not only had a direct and indirect effect on trained and untrained items, it also resulted in both improved spontaneous and connected speech, which is the final level of language therapy. Compared to conventional spoken therapy and rhythmic therapy alone, melodic intonation therapy improves the semantic-lexical structure, in particular, which enables patients to use daily communicative utterances and facilitates their return from therapy to real life.

13.1.7 EXCURSUS: Improving Apraxia of Speech with MIT

To date, literature on MIT has highlighted the fact that MIT only has a beneficial effect on patients who are suffering from Broca’s aphasia. However, other aphasic syndromes are not officially known to be positively influenced by this treatment. Broca’s aphasia is marked by anomia, agrammatism and apraxia of speech (AAN 1994). Anomia is a core symptom of all aphasic subtypes; however, agrammatism and apraxia of speech are particular clinical findings which differentiate Broca’s aphasia from the other types. Because research has been conducted concerning the influence of MIT on agrammatism, to little effect, the scientists Zumbansen, Peretz and Hébert sought to investigate the impact of MIT on apraxia of speech (9).

Apraxia of speech (AOS) describes a deficit in motor planning and programming of speech movements (see McNeil/Robin/Schmidt 1997), as already explained in the first part of this thesis. Indeed, patients with AOS have an automatic-voluntary dissociation of the motoric system and display this impairment with dissociation in their speech output. An important aspect of AOS is that it is referred to as a speech disorder, rather than a language disorder. AAN (1994) further explains that the deficit disturbs the transition from a phonological to a phonetic representation. Compared to aphasic patients, AOS patients also suffer from anomia, which is difficulty with word-retrieval. In fact, they experience difficulty in producing words as their speech is slow and sometimes hard to understand. Therefore, Zumbansen, Peretz and Hébert (2014) propose that MIT can also be used as a treatment for motor speech deficits,
additionally to language disorders. In fact, numerous treatments for AOS recommend techniques similar to those found in MIT, such as hand tapping, singing or rhythmic sequences However, MIT has not been tested on AOS patients so far (9).

13.2 Further Research on the Healing Effect of Music

Words and their meanings do not only affect thought processes, ideologies and emotion, but provoke action … Music has an even stronger power than the spoken word. In addition to affecting thinking and emotion it also affects the spirit. (Altshuler; qtd. in Gilliland 1944:18)

This quotation highlights the unique power of music and its incomparable value in healing processes within mind and body. The healing effect of music has been known for hundreds of years and was also practiced in primitive societies. In these times, magic and music were accompanying trades, both of were thought to help people with mental and physical diseases (Gilliland 1944:18). Moving forward to the 20th century, Gilliland discusses music therapy and its tremendous positive impact during and after World War I. At that time, “music was prescribed for war neurosis, aphasia, temporary insanity and paralyzed muscles. As a sedative in place of drugs and as a cure for insomnia it certainly proved its value” (18).

Doctors, therapists, and psychiatrists found that music triggers important physiological effects: music increases metabolism, it in- or decreases muscular energy, it accelerates respiration, it influences blood pressure, pulse and volume, it adapts sensory stimuli depending on mood and it activates the glands within the body.

Figure 5: Neuropsychiatric patients playing instruments (from Gilliland 1944)
This photograph shows a musical-therapy session in a neuropsychiatry ward during World War I. At that time, psychiatrists believed that playing an instrument and exposing oneself to music helped patients to process their trauma.

Since then, research on music and its healing power has been much debated. In this chapter, I want to draw on further investigations which support my thesis that music has a healing effect. Not only aphasia is mentioned explicitly, but also further frequent neurological disorders.

The first article by Wan et al. (2010:287) deals with the therapeutic effects of singing in patients with neurological disorders such as stuttering, acquired brain lesions and autism. It has already been observed that listening to music can improve cognitive and emotional functions in patients suffering from neurological conditions (see Chan et al. 2009). Even though listening to music enhances certain cognitive structures, active interaction with music, such as playing an instrument or singing, creates a huge interplay of sensory, motor and multimodal integrative regions. The fronto-temporo-parietal network, which has been discussed in previous chapters, overlaps with the mirror neuron system, which is responsible for perception and executing actions. In fact, many neurological disorders are defined by poor conditions in the execution of motor and articulation tasks. Gaser and Schlaug (2003) found that long-term exposure to music, such as learning an instrument or singing, can generate plastic changes in the human brain and, thus, prevent necrotizing of brain cells.

The following Figure 6 (Wan et al. 2010:288) proves the effect of active music exposure. Within these images, structural differences in the right arcuate fasciculus (AF) can be observed. The AF connects auditory and motor regions within the human brain and can be trained and strengthened actively as seen in Picture B. The AF of the professional singer is thicker than the one in Picture A, which resembles the AF of a healthy non-musician, who may only sing occasionally. The Pictures C and D reflect the structure of the right AF before and after melodic intonation therapy. The left-hemispheric AF is lacking because the patient suffered a left-hemispheric stroke (288).
Based on these images, it is possible to claim that singing does something to the human brain that is beneficial, and which can rebuild structures that had been damaged before. Moreover, singing has a valuable effect on musical therapy as it is very neutral to spoken language and, therefore, more natural for patients to use. Compared to other music making activities, such as playing an instrument, research has shown that singing alone triggers the most intense auditory-motor feedback loop in the brain (see Kleber et al. 2009). This loop is first activated within early years of childhood. Babies produce vocalizations and sounds that can be seen as their first steps towards music and speech intonation (see Welch 2006). This musical immersion continues in kindergarten, where children learn to sing songs and dance with other children. Moreover, some children display “intermediate vocalizations” (Mang 2001; qtd in. Wan et al. 2010), which are a vocal behaviour that lies at the intermediate level between speaking and singing. The overlapping of this boundary strengthens the shared network of music and language in the human brain as well (see Kleber et al. 2009).

Because researchers have highlighted the shared neural network of language and music, singing is a common feature in many therapies for speech abnormalities. One of the main reasons for including singing in speech therapy is that singing requires and stimulates similar musculature as speaking, in addition to similar respiration, phonation, articulation and resonance as observed in speaking (see Wan et al. 2010:288). To further demonstrate the
physical effects of singing, research has shown that intense practice can lead to long-lasting changes in the pulmonary and cardio-vascular system. Grape et al. (2003) found that professional singers have better cardio-vascular fitness than amateur singers, which furthermore supports the long-term health benefits of music.

With regard to the speech-motor deficit of stuttering, singing enhances speech fluency, which has been shown by various experiments. Compared to conventional reading comprehensions lacking musical support, singing decreased the intensity of stuttering, particularly, when familiar songs were sung by the patients. A neuroimaging study (see Stager/Jeffries/Braun 2003; qtd. in Wan et al. 2010) compared stuttering participants with a control group. In this study, patients’ brain activation was measured while carrying out fluency tasks (e.g. singing) versus tasks that induced dysfluent speech (e.g. event narration), by means of positron emission tomography. The results showed that primarily the auditory areas for speech processing and sensory feedback as well as motor areas involved in articulatory motor actions were activated. Researchers suggest that cerebral auditory-motor regions might affect fluency when it comes to stuttering. Furthermore, fluency-induced tasks resulted in more activation within the left hemisphere of stuttering patients compared to the control group, which further indicates compensatory mechanisms.

Another common neurological impairment is autism, which affects around 1% of the population (see Williams/Higgins/Brayne 2006; qtd. in Wan et al. 2010). Autism is considered to be an impairment in expressive language and communication, in some cases resulting in a complete lack of functional speech (see Tager-Flusberg 1997; qtd. in Wan et al. 2010). Even though autistic people lack communication abilities, their auditory processing abilities are generally above average (see Heaton 2003). This is why many autistic people have a strong interest in learning and actively making music (see Hairston 1990).

To date, profound studies of autism and the impact of music in a controlled design are lacking. However, there are two studies which are registered as single cases rather than significant investigations. The first used an adaptation of the original MIT involving intoned questions and statements (see Miller/Toca 1979). The second used pitch matching and singing to encourage patients to use vocalizations, which occasionally trigger the articulations of words (see Hoelzley 1993). Nevertheless, neither of these two cases can be generalized to a larger group of people as they lack controlled designs in their methods. Because more research is needed to investigate the role of music in treating people with autism, Wan et al. (2009) established a design called auditory-motor mapping training (AMMT). This
intervention is intended to help autistic children develop expressive language. To do so, this design includes three main components: singing, motor activity and imitation. AMMT engages interactions of the motor and auditory systems, which could be beneficial for autistic children and their development of expressive language functions. Still, this particularly designed intervention needs further study designs in order to prove its efficacy.

The second article by Ferreri et al. (2013) deals with the topic of music and its impact on encoding verbal memory while decreasing PFC (prefrontal cortex) activity. To date, research has shown that short auditory stimulation (e.g. background music during a memory task) and long auditory stimulations (e.g. in a musical therapy) improve the fluency of Alzheimer’s patients in verbal fluency tasks (see Thompson et al. 2005) as well as fluency and speech content in dementia patients (see Brotons/Koger 2000). Furthermore, the use of music enhances verbal memory in stroke patients (see Särkämö et al. 2008) and recaptures verbal material better when sung than spoken in patients suffering from multiple sclerosis (see Thaut/Peterson/McIntosh 2005), aphasia and Alzheimer’s. Verbal memory, in particular, is essential in aphasia therapy and patients are forced to remember both trained and untrained items and to retrieve them in various tasks.

Further research has shown that stimulating the context of encoding through emotional stimuli, for example, can improve memory performance and recall (see Ferreri et al. 2013). Memory encoding and recall processes involve a broad cerebral network activating medio-temporal and posterior parietal areas, the hippocampus and the prefrontal cortex (PFC). Tulving et al. (1994) found that different subregions of the prefrontal cortex are activated during encoding. Indeed, HERA, the hemispheric encoding/retrieval asymmetry model by Tulving et al. proved this; activation in the left PFC is greater for encoding, whereas activation in the right PFC is greater in retrieval.

Given this scientific evidence, Ferreri et al. (2013) conducted a study to verify their hypothesis that “music may enhance verbal encoding by providing a helpful context which can facilitate organizational, associative, and semantic processes. [This] facilitating effect of music during verbal encoding should result in better recognition performance and deactivation of DLPFC activity” (2). For their study, twenty-two French-native speaking, right-handed non-musicians with normal vision were chosen. Each participant was given a memory encoding task to complete while fNIRS neuroimaging monitored their PFC activation. After adjusting the eight fNIRS probe-set on the forehead, participants were presented lists of words either in silence or with music playing in the background.
The researchers observed that the presence of background music during the encoding of verbal material decreased activation in DLPFC and facilitated the recall of the encoded material compared to encoding done in silence. To date, a corpus of literature has shown (see Ferreri et al. 2013) that music triggers positive effects on the memory of both healthy and clinical populations. To be more precise, the activation rate in DLPFC was significantly higher during silence encoding than music encoding. Because music has a facilitating effect, better recognition was achieved during verbal encoding and decreasing DLPFC activation was recorded. The figure below summarizes the clinical findings of this study. To clarify the key of Figure 7, fNIRS (functional near-infrared spectroscopy) is a neuroimaging technique that is able to non-invasively monitor cortical tissue oxygenation (haemoglobin concentration status) during cognitive, sensory, and motor stimulation. As displayed in Figure 7, the oxygenated O2Hb and the deoxygenated HHb is significantly higher during silence encoding than during musical encoding, which indicates the decreased activation of the PFC during musical tasks. Thus, the researcher’s hypothesis was verified.

![Figure 7: Change of oxygenation in haemoglobin concentration during stimulation (from Ferreri et al. 2013)](image)

The third article which caught my interest covers the topic of neuromusicology. Neuromusicology is primarily the study of the brain functions involved in music processing; it furthermore includes music performance, music perception, and neurological lesions that are responsible for disorders in its definition (125f.).

Written by Hofman (1993), the article demonstrates a study which was conducted with aphasics and non-aphasics as well as musicians and non-musicians. To be more precise, the participants were categorized into the following groups:
- 40 aphasic patients,
- 20 non-aphasic music lovers who had never played an instrument or had never been in a choir before,
- 20 professional musicians (either vocalists or instrumentalists), and
- 16 non-professional instrumentalists, who had had a moderate musical training in their lives.

The study included two dichotic listening tasks, the first with pairs of spondaic words and the second with pairs of musical excerpts (see Figures 8 and 9). The listening units of both the linguistic and the musical material were divided into three temporal parts, whereas simultaneous presentation of stimuli was only conducted in the second part.

Figure 8: Examples of spondaic words (from Hofman 1993)
Figure 9: Example of musical excerpts (from Hofman 1993)

The results of the study showed that the right ear dominates in left-hemispheric processing, and the left ear is dominant for both language and music. This result was valid for 86% of the tested participants who showed the same linguistic and musical dominance for both the right and the left ear. As a result of these investigations, research has dealt more profoundly with the important matter of hemispheric dominance as well as a common shared hemisphere for both music and language, which furthermore indicates a mutual healing effect (see Hofman 1993:134).

In the same article, four cases are described that all share a common theme: language and music faculties interacting with each other, and thus, healing damage to the other.

The first case describes an 18-year-old, right-handed, passionate music lover and piano player, who suffered a left-hemispheric temporal intra-cerebral hematoma, which is a swelling filled with blood. As a result of this hematoma, he suffered from dysgraphia, a mixed type of aphasia, disorientation in time and space and a right-hand paresis. Furthermore, he was not able to sing songs he had known well, or to compose music. After he underwent surgery, he also participated in a rehabilitation program that also focused on music processing. While of language and music processing were simultaneously stimulated, the patient recovered both his writing and reading skills as well as the ability to compose music and to actively play the piano (137).
The second case describes a 79-year-old professional musician and piano player, who was afflicted with the complete paralysis of half his body, severe sensory aphasia, agraphia, alexia, acalculia and retro- and anterograde amnesia. When his amusia was nearly total, he could not repeat simple phrases containing 3-4 words. Additionally, he was unable to intone musical motifs or to recognize excerpts of his own musical pieces. This example shows that both the faculties of language and music were severely impaired simultaneously (138f.).

The third case discusses a 72-year-old, right-handed auditor suffering from Parkinson’s disease. He had previously sung frequently before he was afflicted with palilalia, which is a disorder characterized by involuntary repetitions of syllables, words, or phrases. Still passionate about singing favourite songs, his ability to sing was impaired by the severity of his speech disorder. Throughout his rehabilitation, his singing became steadier, as did his speaking (139).

The last case describes a polyglot musician who admired poetry and western music. His strong affinity for elements of repetition, meter, melodic and pace structures in music was also present his poetry. This example thus shows a strong correlation between these two faculties (139).

After analysing these cases, Hofman (139f.) draws the conclusion that music and language share common structures such as rhythm, pace, metre, and volume. In addition to evoking emotional responses, music is decoded and encoded by both language and music cerebral areas, which further supports the idea of the shared cerebral network.

The article that rounds off this chapter focuses mainly on fine motor skills and suggests that music-supported training is more efficient than conventional motor training in stroke patients. Altenmüller et al. (2009) designed a therapy program that uses active music-making to train the fine motor skills of stroke patients. The program includes repetition tasks (repeating simple finger and arm movements), auditory feedback tasks (receiving immediate feedback on movements), shaping tasks (adaptation of movements depending on individual progress), and emotional tasks (increasing motivation due to the emotional impact of making music). The experimental group in this program received (alongside their conventional physiotherapy) daily sessions of music therapy in which they had to produce tones, scales and simple melodies on an electronic drum set or piano for a period of three weeks long. The control group, on the other hand, received functional motor training in addition to their conventional physiotherapy. The results of the study showed that patients receiving additional
music-supported training improved the most in terms of their fine motor skills. Furthermore, daily sessions of music-supported training, in addition to conventional physiotherapy, improved not only the performance of patients, but also the recovery of fine motor functions, in comparison to CIT (constraint-induced therapy).

To conclude this chapter, there is evidence in literature that music-supported treatment shows beneficial outcomes, whether for language or motor-training. Even though not every study discussed in this chapter deals with the topic of aphasia, music-based literature can be used to broaden the context of music and its positive influence on disorders in general.

14 Musical Tragedies

The world is full of creative minds, living for their passion and creating pieces to entertain large groups of people. Composers and musicians fill our lives with beautiful masterpieces, devoting their hearts to music. Unfortunately, professional musicians are not exempted from diseases and their devastating progression. Now, I would like to discuss two important and famous musicians who enjoyed their passion for music until their deaths.

14.1 A Case Study of Maurice Ravel

One of the most famous cases of aphasia and amusia is that of a pioneer of music composition – Maurice Ravel. When Ravel, one of the greatest composers, turned 52, he developed progressive neurological symptoms, which resulted in atrophy with bilateral ventricular enlargement. Maurice Ravel (1872-1937), was a leading French exponent of impressionist music before he was diagnosed with aphasia, apraxia, agraphia and alexia. Because neither neurological analysis nor brain imaging were available in the 1930s, the accuracy of his clinical history has been largely debated. However, with the latest technology, it is now possible to identify Ravel’s neurological disorders.

Generally, it is hard to ascertain the exact beginning of Ravel’s progressive brain disease; yet, 1927 seems to mark an important point in his medical records. Doctor Jourdain-Morhange noticed that Ravel had difficulty finding words, which was declared to be a first sign of aphasia. More indications of a condition arose when he lost his place while playing Sonatine in Madrid. He made a huge mistake while performing when he jumped from the exposition of the first movement to the finale coda. From this moment on, Ravel’s memory was said to be defective and his mental processes began to decline. Though he began receiving serum
injections, Maurice Ravel had a car accident in 1932. Even though there is no evidence that this light head injury had any impact on the progress of his neurological disease, it has been found that even minor head injuries can cause those suffering from existing brain diseases to deteriorate further. In 1933, Ravel ended his creative activity of composing as his diagnosis became worse. The impairments to his writing were severe, and he could no longer even sign his own name. In November of the same year, Ravel made his last public appearance conducting Bolero and his piano concerto. In the following years, his largely preserved auditory imagery led him to believe that he could still hear music in his head (see Henson 1988:1585f).

14.1.1 Clinical Findings

Theophile Alajouanine, a French psychiatrist, recorded Ravel’s neurological diseases. The loss of Ravel’s creativity began with progressive aphasia including ideomotor apraxia, which affected his ability to write and to play piano. His production and comprehension of the spoken word were moderately impaired, while reading and jotting down musical notations became particularly difficult. Moreover, Ravel’s ability to copy notes as well or play the piano were lost. Nevertheless, his auditory perception was relatively undisturbed. Thus, recognizing familiar works, especially his own, and his ability to identify incorrect tuned instruments remained intact.

Alajouanine claimed that Ravel suffered from a cerebral atrophy as well as a bilateral ventricular enlargement, which could be observed with radiological techniques. Furthermore, Ravel experienced aphasia, apraxia, apraphia and alexia. On the one hand, his musical notation, piano playing and ability to read notes were impaired; on the other hand, his tonal recognition and musical imagery were mostly preserved. Considering all these dysfunctions in combination, Ravel’s dominant perisylvian brain region was deemed to be affected, which is located in the left hemisphere. As mentioned above, Ravel’s musical thinking was still intact; however, he could not express himself to others and, therefore, was not able to write down the composition ideas he had in his head.

Even though a necropsy was not conducted after his death, and these diagnoses are not entirely trustworthy, Ravel’s deterioration can be ascribed to a progressive degenerative disorder. He exhibited “a focal, spongiform cortical degeneration involving the left inferior frontal gyrus, while in one the left superior temporal gyrus was also affected” (1588). His doctor concluded: “to conceive is nothing, to express is all”, which highlighted Ravel’s
failure. His case was particularly dramatic, given that he was an important composer who suffered the indignity of amusia (see Henson 1988:1587f).

14.2 A Case Study of Vissarion Shebalin

As discussed in previous chapters, aphasia can coexist with amusia; however, they can occur separately as well. More precisely, aphasia without amusia refers to clinical cases in which patients experience an impairment in the processing of language without interfering music processing in the brain (see Peretz et al. 2004: 375).

The Russian composer, Vissarion Shebalin, considered a famous example of aphasia without amusia, having suffered two vascular left-hemispheric haemorrhages. After his stroke he was not able to speak or hear. Although Shebalin could not communicate with people around him, he continued teaching and composing music until his death. Indeed, he was a passionate music lover and composer, who created fourteen chorales, two sonatas, two quatuors, eleven songs, and one symphony. Luria, Tsevetkova and Futer (1965; qtd. in Peretz et al. 2004: 376) claim that the music he wrote after incurring his vast left-hemispheric lesion was indistinguishable from musical pieces composed before his illness. What makes this particular case special is the fact that Shebalin found balance and satisfaction in his passionate love for music, despite not being able to communicate or transfer thoughts to next generations (376).

Although these two examples of outstanding musicians were not able to regain their former abilities, there is hope and also scientific evidence that the brain can compensate for severe lesions on its own, which is the topic of the following chapter.

15 Brain Plasticity – How Music Heals the Brain

Considering the variety and severity of lesions, it seems to be a phenomenon that the human brain is able to heal damaged areas by itself. Musical expertise and intensive musical training seem to be fruitful options to foster brain plasticity. Thus, research has been carried out on musicians and non-musicians in order to demonstrate the learning effects of musical training starting in early childhood (see Habib/Besson 2009:279).

Professional musicians are of particular interest to neuroscientists for two special reasons: first, while practicing their instrument, musicians require intensive and durable motor mechanisms including several fingers. Second, musicians are more sensitive than non-musicians when it comes to discriminating sounds. It seems to be simple to understand: the
more musicians practice, the more their brains differ from non-musicians; thus, this group serves as a fascinating base for research. Schlaug et al. (1995) observed that intensive motor exercise changes the brain anatomically. Indeed, they found that the corpus callosum, the dense bridge of white matter connecting both hemispheres, showed larger structures in musicians than non-musicians. Thus, the forwarding of neurons becomes faster and more intensive. The researchers suggest that this larger corpus callosum is the result of the intensive and repeated sensory-motor information transfer between both hemispheres. In fact, practicing an instrument requires the coordination and interaction of both hemispheres, and thus, that the size of the corpus callosum depends on time spent practicing. The most interesting result of this study was that these anatomical changes were only found in human brains that had been exposed to musical training before the age of seven. Therefore, Schlaug et al. (1995) put forward the hypothesis that there is a critical period for intense brain plasticity.

This critical period, which is mainly associated with language acquisition, has subsequently been investigated in further detail since the investigations of Schlaug et al. (1995). Witelson and Kigar (1992; qtd. in see Habib/Besson 2009:280) discovered that the asymmetry of the planum temporale, “a triangular surface of cortex located caudally relative to the primary auditory cortex of Herschl” (280), was present. This part of the brain is responsible for supplying “integrative functions between different types of auditory stimuli primarily processed in Herschl’s gyri” (280). According to the researchers, the left planum temporale shows larger structures than the right-hemispheric one. The asymmetry of this cerebral structure was also found in musicians’ brains, with the observation that their left-hemispheric planum temporale was larger in surface area than that of in non-musicians (see Schlaug et al. 1995). Moreover, this claim was only verified in musicians possessing perfect pitch. The perfect pitch, called “das absolute Gehör” in German, is “the ability to identify or recreate a musical note without a known reference” (Habib/Besson 2009:280). This extravagant ability, furthermore, is only found in musicians who started their musical training before age seven (see Schlaug 2001). Thus, the hypothesis of the critical period is proven again.

Bermudez and Zatorre (2005), who also investigated the brain area of the planum temporale, observed that this cerebral structure showed more grey matter density in the right hemisphere than the left one. As grey matter plays an important role in the interactions and firing of neurons, Gaser and Schlaug (2003) conducted studies that showed that the increased amount of grey matter within musicians’ brains is also found in sensory-motor regions, in areas within
the left anterior prefrontal lobe as well as in the cerebellum. Moreover, they suggest that these anatomical changes are due to their intensive sensory-motor experience with their instruments.

As several studies have shown, professional musicians have anatomical differences in their brain morphology compared to non-musicians and amateurs. These differences concern motor regions (motor and premotor cortex, cerebellum and anterior part of the corpus callosum) as well as auditory-associated regions (Herschl’s gyrus, planum temporale). Research suggests that these cerebral differences are clearly related to musical expertise, and that the intensive practice of an instrument, which includes motor and sensory stimulation, leads to changes in the brain. More precisely, repeated practice fosters neuronal circuits that involve a greater number of neurons and increases the excitatory and inhibitory synaptic connections between neurons (Habib/Besson 2009:281). Hence, the mere exposure to music and an enriched acoustic environment fosters auditory cortical responses and improves the functioning of neurons within these cerebral areas. Additionally, researchers also suggest that exposure to an enriched acoustic environment should be particularly highlighted in early childhood as the human brain is very sensitive to stimuli within its first years. Thus, similar to language acquisition, the concept of the critical period suggests that musical practice, such as learning an instrument, does not have as strong an impact on brain anatomy after the age of seven. The findings supporting the long-lasting benefits of musical performance originate from investigations, which found that musicians who received early training (before the age of seven) performed better than those who trained later (after the age of seven). These findings thus support the notion of a critical period. Not only does early musical exposure result in better performance later in life, it also improves reading abilities, particularly in children with dyslexia, and helps with spelling, phonological processing and increased sensitivity to pitch changes in speech (see Moreno et al. 2008; Habib/Besson 2009:281).

Musical exposure and early musical training not only increase motor and sensory activation, but also enhance the brain’s general plasticity, which can be generalized to other learning and cognitive domains beyond the musical one.

16 My Critical View on Future Research

This chapter is devoted to my personal opinion on the progression of future research on topics of music and its impact on language, especially language disorders. When I chose this topic
for my thesis, I did not imagine that I would find myself dealing with contradictory research findings, a lack literature that supported my thesis directly, or literature that was so diverse in terms of their methods, participants and procedures employed. This is why I would like to share my personal views on current as well as future research in this highly complex and diverse topic.

First, one of the major difficulties I encountered throughout my research was the fact that participants in various studies, who were mainly clinical patients, differed in so many aspects. In fact, individual factors such as age, gender, economic and social backgrounds, education as well as musical expertise affect both the treatment and the results, and, thus, make it challenging to relate research findings to one another. Clinical studies interested in brain lesions and localization of damages, in particular, are difficult to collate as every brain lesion affects the individual’s brain in a different way. Hence, various brain lesions result in various research results.

Second, based on the studies that I compared with one another, I was not able to identify identical methods or procedures which made it possible to compare research findings. Indeed, the study designs can vary greatly in terms of treatment intensity, the range of methods, the expert team and therapists, as well as what the outcome of the study should be, i.e. what researchers hope to find out. Considering all these different aspects, it is challenging to generalize the outcomes of one study on the impact of music on language disorders. For example, the original version of melodic intonation therapy has fixed procedures that have been implemented within several studies. However, individual factors in terms of the participants have led to vastly different outcomes. In fact, MIT affects patients with professional musical skills differently compared to amateurs or non-musicians, even if the patients are suffering from identical language disorders or show same brain lesions. This musical expertise does not even need to have been cultivated through intensive training; rather, musical talent that cannot be found explicitly in the brain can also play an extraordinary role. Considering MIT further, results can also be biased because of the role of the therapists. In comparison to normal speech therapy, MIT therapists involved in the musical context so as to foster greater motivation in the patients, which can further shape the outcomes.

All of the factors mentioned above lead to difficulties comparing of study designs, and, hence, make it challenging to generalize research findings onto particular population groups. Still, I
would like to discuss some aspects for future research which could mitigate some of the obstacles I faced, and thus, facilitate generalizations.

First, more studies with the same study design should be conducted in order to ease the verification of hypotheses and allow researchers to compare results. In particular, the modules of language and music should be found themselves within the same task conditions in order for researchers to observe domain-specific activations, for example. This could also verify or disprove one of the major questions within this research field; namely, if language and music are processed in the same way within the human brain.

Second, even though treatments are mostly designed to take place over a period of several weeks, I recommend repeated treatments for the same participants. More precisely, researchers know that language disorders need continuous therapy in order to establish stability and learning conditions including memorization. What if research needs to focus on broader longitudinal studies, which provide patients with continuous therapy, for more than just a few weeks? It is possible that this will make research outcomes more reliable and easier to generalize. In fact, I criticize the fact that generalizations of research findings are vague, and thus, that research outcomes can only be used to measure the effect on trained items. Thus, to be able to make predictions and to generalize language, it is important to set up continuous and stable measurements and therapeutic possibilities.

Third, considering aphasia, in particular, research should be expanded to consider the disorder of apraxia within aphasia as well, as this motor-speech disorder is directly linked to the language disorder. Furthermore, most studies are based on patients suffering from Broca’s aphasia. However, future research still needs more investigations of musical therapy on other kinds of aphasia and accompanying dysfunctions in order to compare these subtypes with one another.

Fourth, as language disorders result not only due to brain lesions, but also as developmental disorders in early childhood, it is my firm belief that musical therapy should be a foundational aspect of schools and kindergartens. Researchers have found that the influence of music from childhood on can be beneficial for anatomical structures, as well as social and personal development. Thus, an intensive and lifelong exposure to music can serve as the basis for brain plasticity, i.e. the healing of the brain itself as essential cerebral structures are strengthened. Furthermore, I also recommend to future research on music in language teaching and its effect on learning outcomes.
Last but not least, most studies referred to male participants, which made generalizations of research outcomes particularly difficult. For future research, female patients should be included as well since their brains are anatomically different, and thus, would provide broader insight into neurology. Furthermore, comparisons based on gender could also be investigated.

To conclude this chapter, my opinion is that current research on the impact of music on language disorders will result in milestone findings in the field of language and music. However, there are many aspects which could additionally be taken into consideration to narrow consistent hypotheses, which are reliable, and which would serve as the basis for further hypotheses. Even though today, technology allows human beings to investigate almost everything in our world, the human brain is still a source of the unexpected and the uncertain, which I believe cannot be entirely revealed in its magnificence.

17 Conclusion

As already stated in the introductory chapter, researchers have more profoundly investigated the field of language, music and the brain in the last few decades. They have found out that specific cerebral structures and brain areas are activated in both music and linguistic processing, which furthermore suggested a connection between these two properties. Still, one question which remains mainly unacknowledged is if music and language are similar properties being processed within the same cerebral structures or if they are entirely separate in the human brain. Taking all the above mentioned studies and observations into consideration, the question is difficult to answer. Indeed, language and music activate both hemispheric temporal lobes and there are clinical findings, which show that same brain areas are activated for linguistic and musical tasks. Furthermore, it has also been investigated that professional musicians show a right ear preference, which indicates the inclusion of the left hemisphere for musical processing. This collaboration of both hemispheres working together is confirmed as well with the inclusion of motor-specific tasks, such as moving your fingers on the instrument, during musical training. However, these observations vary depending on diverse aspects such as the musical expertise of the patient, for example. Thus, generalizations seem to be impossible.

Yet, considering this thesis, the discussed studies do show a beneficial effect of music in speech- and language-therapy with regard to aphasia treatment. Researchers have found out that using melodic intonation therapy improves and restores patients’ propositional language
as well as facilitates their everyday language, which depicts the aim of this language treatment. Furthermore, music shows its positive outcomes on all four language modalities, i.e. speaking, reading, writing and listening. Indeed, research has proven that reading comprehensions can be positively supported with the use of music, as recognizing language rhythm, tempo and stresses can be facilitated through songs, for example. This consideration highlights the importance of the musical elements pitch and rhythm. Applying MIT to various patients, researchers found that these elements are connected as they are present in language and in music. Thus, aphasic patients who are undergoing speech-treatment including rhythmic and pitch variation are able to produce words and simple sentences more easily as the support of music enhances their verbal outcomes. These findings do support my hypothesis of the healing effect of music on aphasia.

Still, as already claimed, generalization cannot be easily put forward as study designs differ in their procedures, methods as well as their choice of patients. Therefore, it is difficult to generalize any findings as brain lesions, treatment duration and effects cannot be entirely compared. Nevertheless, music and language do share same cerebral structures and activated brain areas. This claim is supported by case studies of musicians who do suffer simultaneous linguistic and musical impairments. On the contrary, research also supports the hypothesis of separate cerebral structures for music and language as cases of patients have been recorded who suffer linguistic impairment without musical impairment and vice versa.

To conclude this thesis, it can be assumed that music can heal damaged brain areas referring to brain plasticity studies, for example. It is possible to claim that music beneficially influences human development as either in creating pleasure or serving as a healing power. It is my firm belief that future research is able to work beyond the proved hypothesis that musical exposure can enhance verbal production in aphasia and move further to investigations observing the impact of music on language generalizations.
18 References


19 Appendix

Figure 1:


Figure 2:


Figure 3:

Figure 4:

Figure 5:

Figure 6:

Figure 7:

Figure 8:

Figure 9:

Table 1: