

***Horses as Healers -  
Positive Effects of Equine Based Therapy on Patients with a Brain Injury:  
A Review***

**THESIS**

Submitted for the Degree of

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Submitted by

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*“Horses carry the wisdom of healing in their hearts and offer it to any humans who possess the humility to listen.” – Unknown*

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He was suffering a severe traumatic brain injury in June 2019, which turned our life’s upside down. After witnessing many physiotherapy sessions without significant results, we researched alternative therapies to aid his recovery. Five months after the accident we found a suitable therapy horse “Gippy” for ridden therapy and a miniature Shetland pony “Rossi” for unmounted horse-related activities. I could watch the positive physical effects the horse riding was doing for Martin; I could see his joyous nature beginning to return and the grief begin to wane. Once I witnessed how Martin interacted with the horses, with compassion and respect, free from judgement, limitations or pity, the topic of my thesis was born.

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## Summary

Different types of equine based therapy are used in the rehabilitation and therapy of patients with physical or mental diseases, for example hippotherapy or therapeutic horseback riding. Here, the motion transfer from the horse to the patient shows physiotherapeutic effects. Furthermore, the communication between horse and patient through body language and the growth of a horse-human relationship show psychotherapeutic effects. This thesis examines the current studies of different types of equine based therapy and their positive effects on patients with brain injuries. This examination is carried out through a systematic literature review. Experimental studies relevant to the topic were searched through the database PubMed, based on set inclusion and exclusion criteria. The final result includes five studies on the topic. Four studies examine hippotherapy as a type of equine based therapy and one study examines therapeutic horseback riding. All five studies observe positive physical effects in the patients through the use of equine based therapy, especially in gait development and balance ability. Two of the chosen studies aimed to document positive mental effects too. In particular, improvements in the areas of motivation and social interaction were measured. The number of studies found on to the topic demonstrates, that investigation is still in the early stage. The size of the trials and the number of participants in the five studies point out that more research is desperately needed. Nevertheless, the analysed results note exclusively positive effects in the physical and psychological rehabilitation of brain injury patients who receive equine based therapy. Equine based therapy observed in relation to more researched diseases, such as Post Traumatic Stress Disorder or Multiple Sclerosis, demonstrates exclusively positive effects in rehabilitation too. Brain injuries, and their recovery are individualistic and need more specific investigations, for example on the optimal time frame for recovery and rehabilitation. Here, investigations into equine based therapy could tie in with ways to make improved and more successful rehabilitation possible in the future, in this as yet very unexplored field.

## Zusammenfassung

Pferdegestützte Therapieformen, beispielweise die Hipbothherapie oder das Therapeutische Reiten, finden Anwendung in der Rehabilitation und Therapie von Patienten mit körperlichen oder seelischen Einschränkungen. Dabei hat die Bewegungsübertragung vom Pferd in den Körper des Patienten physiotherapeutische Wirkung. Darüber hinaus wirkt die Kommunikation zwischen Pferd und Patient auf Ebene der Körpersprache und der Aufbau einer Mensch-Pferd Beziehung psychotherapeutisch. Die vorliegende Thesis untersucht die aktuelle Studienlage pferdegestützter Therapieformen und ihre positiven Auswirkungen auf Patienten mit Hirnverletzung. Dies wird mittels eines systematischen Literaturreviews untersucht. Dabei wird die Datenbank PubMed nach experimentellen Studien zum Thema systematisch, anhand Einschluss- und Ausschlusskriterien, durchsucht. Das finale Ergebnis umfasst fünf Studien zum Thema. Dabei befassen sich vier Studien mit der Therapieform der Hipbothherapie und eine Studie mit der Therapieform des Therapeutischen Reitens. Alle Studien halten positive, physische Entwicklungen der Patienten durch die pferdegestützte Therapie fest, insbesondere in der Gangentwicklung und der Gleichgewichtsfähigkeit. Zwei der gefundenen Studien hatten die Zielsetzung, auch positive psychische Effekte zu dokumentieren. Dabei wurden insbesondere Verbesserungen in den Feldern Motivation und soziale Interaktion gemessen. Die Anzahl der zur Thematik gefundenen Studien lässt darauf schließen, dass die Forschung hier noch am Anfang steht. Auch die Größe der Trials und Probandengruppen in den fünf Studien zeigt, dass noch ein großer Bedarf an weiteren Untersuchungen besteht. Dennoch zeigen die analysierten Ergebnisse ausschließlich positive Entwicklungen, sowohl in physischer als auch psychischer Rehabilitation der Patienten mit Hilfe pferdegestützter Therapie. Pferdegestützte Therapien zeigen in bereits umfangreich untersuchten Erkrankungen, wie zum Beispiel posttraumatischen Belastungsstörungen oder Multipler Sklerose, ausschließlich positive Entwicklungen in der Rehabilitation. Hirnverletzungen und deren Regeneration sind sehr individuell und benötigen weitere spezifische Untersuchungen, unter anderem zum optimalen Zeitraum der Genesung und Rehabilitation. Daran können dann auch Untersuchungen zur pferdegestützten Therapie anknüpfen, um eine zukünftig bessere und erfolgreichere Rehabilitation in diesem noch sehr unerforschten Gebiet zu ermöglichen.

# 1. Introduction

“These wonderful creatures are our partners – infinitely patient, attentive and always ready to give their all. They make us proud; they give us the gift of happiness, harmony, and inner peace. They make our souls smile. If only we allow them, they even help us to form our characters and make us rise above ourselves.” (Slawik, 2007) – so describes Christiane Slawik (2007) in her book. Her written description of horses captures not only the human fascination with these animals, it describes what horses can do in terms of therapy for ill or disabled people.

As early as the 16<sup>th</sup> Century, medical writings identified the horse as an instrument for improving human health. However, it still took centuries for the horse to become popular in the field of therapies; not until the year 1950. It is first mentioned as hippotherapy (Gäng, 2016, P.14).

Today, the horse finds a place in therapy in the fields of sport, medicine, psychology and curative education (Deutsches Kuratorium für Therapeutisches Reiten e.V., 2020). Here, the horse replaces the limited function of its rider, while the harmonious locomotion is transferred into the rider’s body. The horse also helps out with its senses, for example in cases of vision or hearing impairment (Deutsche Reiterliche Vereinigung, 1989, P.33).

Numerous studies have already been conducted and scientific research continues to show the effects of horses in therapy. Munoz-Lasa et al. (2019) are currently running a pilot study with patients who have Multiple Sclerosis, which shows significant improvements in spasticity, fatigue, and depression due to hippotherapy.

Further physical improvements have been demonstrated in studies using hippotherapy. Children suffering from Cerebral Palsy have shown increased functional performance and motor function as a result of hippotherapy. (Park, Rha, Shin, Kim, & Jung, 2014).

Studies currently highlight the successful use of equine assisted psychotherapy or therapeutic horseback riding as treatment for veterans with Post Traumatic Stress Disorder (PTSD). Symptoms, including flashbacks, anxiety, and depression, have shown lasting improvements due to equine therapy within studies (Burton, Qeadan, & Burge, 2019; Johnson et al., 2019).

Equine based therapy is not only used to treat PTSD. Gäng (2016, P.53ff.) describes in her book, how women with Anorexia benefit from therapeutic horseback riding. Through successful experiences with the horse, self-esteem returns to these patients. Additionally, people with Attention Deficit Hyperactivity Disorder (ADHD) benefit from the use of equine based therapy.

This was noted in a thesis-based study, where the patients showed improvements in aggression, self-control, and hyperactivity. This was measured forty weeks post treatment (Götzky, 2016, P. 31).

Despite the numerous studies conducted in relation to equine based therapy, centred around various health conditions, from physical ailments to mental illness, equine based therapy is still subject to scrutiny from the health system. The German health system describes hippotherapy as a treatment whose benefits have not been proven (Gemeinsamer Bundesausschuss, 2020, P.35).

The World Health Organisation's current stance around equine based therapies highlights the necessity for more extensive research on the topic. Not only focusing on the narrow spectrum of previously identified diseases and disorders but expanding the umbrella to encompass a greater number of trials, participants, health issues and outcomes. Therefore, this thesis is written to provide an overview of the studies on the subject of equine based therapy in the treatment of brain injury patients.

## **2. Current Status**

### **2.1 Brain Injury**

#### **2.1.1 Definition**

An Acquired Brain Injury (ABI) is an injury to the brain occurring during a person's lifetime.

There can be different causes for experiencing an ABI, such as a stroke, bleeding in the brain, an infection, a tumour, a lack of oxygen, or a fall (Headway, 2020).

Another brain injury under the umbrella of ABIs, is a Traumatic Brain Injury (TBI). This is any injury that disrupts normal brain function. The mechanisms for this type of injury can include objects penetrating the skull and entering the brain, sudden or violent movement, or a hit to the head (American Association of Neurological Surgeons, 2020). Violent movements of the head can currently be observed in the National Football League. Players have an increased probability of 0.5% per game, of suffering a concussion, which comes under the umbrella of mild Traumatic Brain Injury (Fortunato, 2015, P.7).

In 2018, 19,000 people in Ireland were suffering from a brain injury. ABI's are most often observed following a stroke. Traumatic incidents are the second largest contributors. Road traffic accidents, falls and assaults are determined as the leading causes for TBI in Ireland (Acquired Brain Injury Ireland, 2018).



Figure 1: Main causes of brain injuries in ABI Ireland Service in 2018 (Acquired Brain Injury Ireland, 2018)

### 2.1.2 Severity of Brain Injury

The severity of the brain injury is measured by the degree of brain tissue damage caused. Unlike other bodily trauma, the measurement of a brain injury is indirect and complex.

There is a correlation between the loss of consciousness (LOC), depth of coma and brain tissue damage. LOC is the main determining factor in the assessment of brain injury severity (Brainline, 2020).

Worldwide professional healthcare staff use the Glasgow Coma Scale (GCS) to assess brain tissue damage. It should be conducted immediately and continuously to correctly assess the severity of the injury (Maimaris, & Worthington, 2016, P.13).

The functions of eye opening, verbal response and motor response are assessed and scored (Royal College of Physicians and Surgeons of Glasgow, 2020).

**GCS** | eye opening  
verbal response  
motor response

Eye opening		Verbal response		Motor response	
Spontaneous	4	Orientated	5	Obeys commands	6
To sound	3	Confused	4	Localizing	5
To pressure	2	Words	3	Normal flexion	4
none	1	Sounds	2	Abnormal flexion	3
		None	1	Extension	2
				None	1

Figure 2: Scoring of responses in Glasgow Coma Scale (Royal College of Physicians and Surgeons of Glasgow, 2020)

The severity of the brain injury is classified using three levels: mild, moderate, and severe. A GCS score of three to eight describes an unresponsive person in the deepest level of coma, seen in severe brain injuries. A score of nine to thirteen describes a person neither in a coma nor fully alert and relates to a moderate brain injury. The highest score of fifteen describes a responsive and conscious person, this indicates a mild brain injury (Brainline, 2020).

Glasgow Coma Score	Severity of brain injury
14 – 15	Mild
9 – 13	Moderate
3 – 8	Severe

Figure 3: Relation of GCS and severity of brain injury (Maimaris & Worthington, 2016, P.13)

A one-year study in Hannover and Münster, in Germany, observed the relationship of the different severities of TBI measured using the GCS. The study suggests that, according to the GCS, 90.9% of TBI cases are defined as mild, 3.9% of cases as moderate and 5.2% of cases as severe (Rickels, Wild, & Wenzlaff, 2011).

The outcome of moderate brain injuries is mostly positive with 60% of patients making a full recovery. 25% of patients suffer a moderate degree of disability due to the injury. For 15%, the degree of disability will be severe. Approximately 10% of patients with a moderate injury die. The outcome of severe brain injuries is observed as the worst. Only 25-33% of patients will have a positive outcome followed by a full recovery. 30% of patients will be left with a disability, varying from moderate to severe. Approximately 5% of patients will be left in a permanent vegetative state due to brain tissue damage. 33% of severe brain injury patients die (American Association of Neurological Surgeons, 2020).

### 2.1.3 Effects of Brain Injury

The symptoms and effects of a brain injury on a person's life are widespread and dependent on the injured part of the brain. Every brain injury is different and can cause different effects in varying degrees of severity (Headway, 2020).

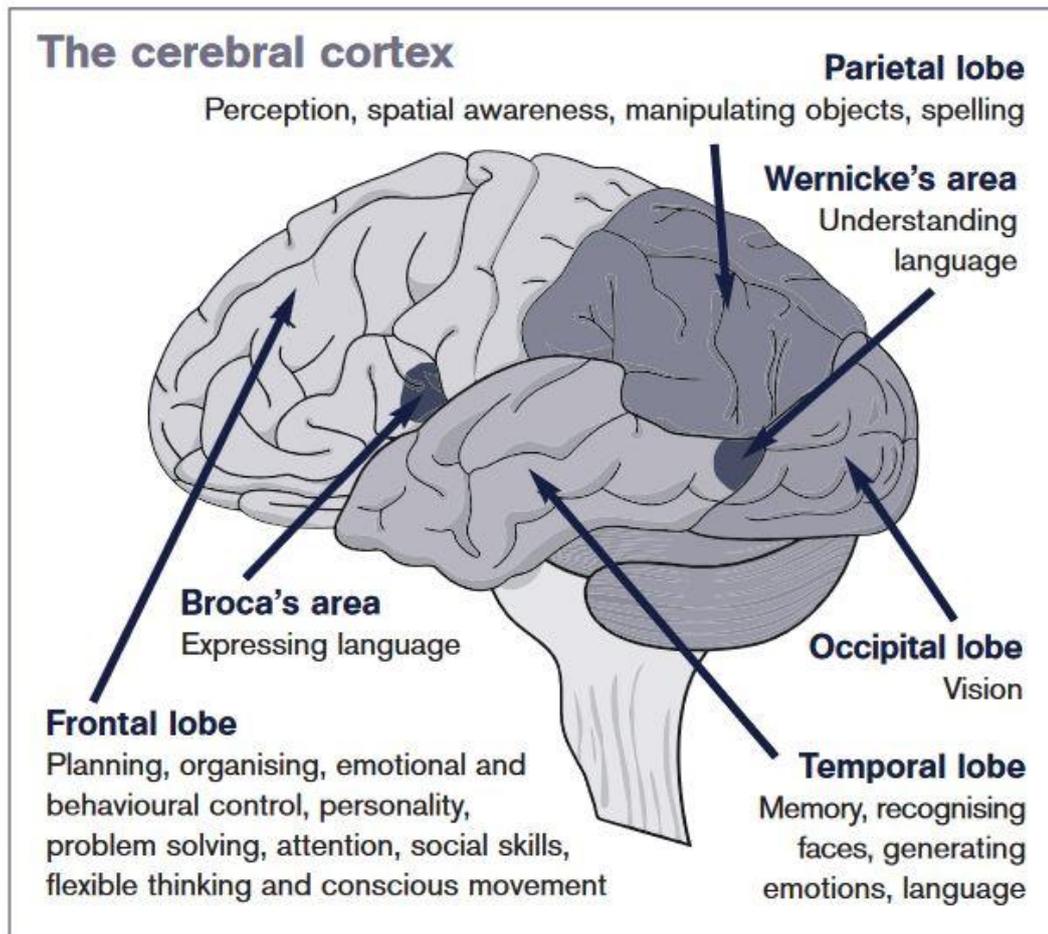


Figure 4: Brain lobes with their function (Maimaris & Worthington, 2016, P.31)

Injury to the frontal lobe, the foremost area of the brain, often incurs emotional and behavioural difficulties. Impulsive behaviour, negativity, intolerance, and inflexibility are some of the most noticeable changes. Furthermore, the damage can cause major implications such as depression, anger, social unease, or mood swings (Paradiso, Chemerinski, Yazici, Tartaro, & Robinson, 1998).

A current study suggests, frontal lobe dysfunction could be split into four main diseases, caused by brain injury. According to the lead scientist, the diseases observed in those who suffered a frontal lobe injury, or damage, are a drop in processing speed, Dysexecutive Syndrome, emotional reactivity, and impaired ability to empathise. The observed symptoms can be arranged into this classification (Stuss, 2011).

Brain injuries can cause difficulties in communication and thinking skills. The frontal lobe is responsible for planning, reasoning, and making decisions- damage here can cause the loss or reduction of these skills (Collins, & Koechlin, 2012).

Furthermore, damage to the Broca area, a region in the frontal lobe, or temporal lobe, can cause disorders in speech and language. Aphasia is a commonly acquired disorder attributed to damage to, or injury in, these regions. Aphasia is characterised as a difficulty understanding written or spoken language (Receptive Aphasia), or finding the right words to express something (Expressive Aphasia) (Headway, 2020). With a recovery outcome of only 2% in severe TBI, Aphasia can be a serious lifelong limitation for patients (Gil, Cohen, Korn, & Groswasser, 2009).

Sleep Disorder is one of the most common symptoms patients experience as a result of a brain injury. This includes: nightmares, sleep walking, excessive sleepiness, or problems with sleep efficiency (Headway, 2020). There are many contributing factors with sleep disorders in patients with an ABI. These may include, but are not limited to pain, side effects of medication, depression, or physical inactivity (Brainline, 2020). It is observed three times more in people with a brain injury than in the rest of the population. It is estimated that 50% of patients recovering from a TBI experience sleep disturbance and approximately 25% are diagnosed with Sleep Disorder like Insomnia, Hypersomnia or Apnea (Mathias, & Alvaro, 2012). Without sleep, the brain and body cannot recharge, the brain will not be able to forge memories and refresh connections. Finally, the sleep disturbances cause more trouble for the patient. Common examples are deepening depressions, lack of energy, increased fatigue, and anxiety (Ponsford et al., 2012).

Physical abilities are monitored in different lobes of the brain. Motor skills are not created through just one brain structure- imaging methods in studies showed how the brain learns by using, and storing, motor movements in different parts of the brain (Seitz, 2001, P.343).

This outcome explains the widespread physical symptoms caused by a brain injury. Balance and coordination are the most frequent somatic complaints with half of the patients who have a severe traumatic brain injury often impacted negatively after damage to the parietal lobe (Ruet et al., 2019).

Right or left-sided weakness can also be affected in an injury to the parietal lobe. If the right side of it is damaged, it will cause a weakness in the left side of the body and an injured left lobe similarly affects the right side of the body (Headway, 2020).

Sensory difficulties as a physical complaint can be the result of a brain injury. For example, vision problems such as any anomalies of accommodation, version or vergence (Kapoor, & Ciuffreda, 2002). Furthermore, there are sensory problems observed within the sense of hearing.

This is significantly common in veterans recovering from a traumatic brain injury (Gallun, Papesh, & Lewis, 2016; Oleksiak, Smith, Andre, Caughlan, & Steiner, 2012; Henry et al., 2011).

Seizures are a common symptom which can be experienced after brain injury, usually due to a scar in the brain resulting from the injury. Most seizures happen in the first several days or weeks after the injury. Depending on the injured part of the brain, the probability can amount to 10-50% (Englander, Cifu, & Diaz-Arrastia, 2014).

## 2.2 Types of Equine Based Therapy

### 2.2.1 Hippotherapy

Hippotherapy describes an equine movement-based therapy, which helps to engage the sensory, neuromotor and cognitive systems (American Hippotherapy Association, 2020). In Germany and Great Britain, Hippotherapy is used as a unique kind of physiotherapy. During a hippotherapy session, the patient's body creates natural responses, from increased movement and improved posture, to movement impulses which the horse initiates due to its gait (Debusse, 2015, P.22). The patient does not have an active influence on the horse (Svoboda, Dvoráková, & Janura, 2011). The rhythm and the vibrations caused by the horse's movement, creates stimuli on the patient's body. The movement is three-dimensional and similar to the human gait, which activates the interaction of the neural and locomotor systems (Soehnle & Lamprecht, 2019, P.2).

A well-schooled and well-behaved horse is essential for a successful hippotherapy session. The goal in training the therapy horse is to minimise the likelihood and strength of flight-responses, which involves avoiding frustration and confusion for the horse in training. An extensive, correct training of the therapy horse promotes the patient's safety as the most important factor (Starling, McLean, & McGreevy, 2016). A trained physiotherapist and a skilled horse person, to lead the horse, are required. More ground workers can be helpful to stabilise and secure patients, to increase the safety factor (Deutsches Kuratorium für Therapeutisches Reiten e.V., 2020).

In America, Hippotherapy is not only used in physiotherapy, it is used by professionals in occupational therapy and speech-language therapy too (American Hippotherapy Association, 2020).

### 2.2.2 Therapeutic Horseback Riding

Therapeutic Horseback Riding is often used for patients with physical disorders. Moreover, this kind of therapy is used for psychological trauma and developmental disorders, which are often a consequence of accidents or loss. The focus is based on the relationship between horse and patient (Gäng, 2016, P.15).

One of the most well-known traumas, PTSD, most often observed in military veterans, is highly topical in therapeutic horseback riding studies. PTSD symptoms in this patient group include anxiety, flashbacks, emotional numbing, stress related illness and civilian life difficulties, all of which are treated with this kind of equine based therapy (Johnson et al., 2018).

Horse riding helps to rouse the patient physically and mentally. It has even been shown to sustainably increase levels of concentration and attention in children with ADHD, even after the equine based therapy treatment has been completed (Götzky, 2016). Through the different stages of riding the horse- first with a leader on the ground, then with a lead horse, then all alone, the patient sees and realises their own progress (Gäng, 2016, P.15f.)

The major objective of therapeutic horseback riding is the patient gaining self-confidence and self-esteem, which opens up new possibilities for their life and promotes good coping mechanisms, communication skills, and interpersonal skills (Deutsche Reiterliche Vereinigung, 1989, P.36).

All of the other activities included in the horse riding, like brushing or feeding the horse, are part of the therapy session as well. This deepens the relationship between patient and horse (Gäng, 2016, P.15f).

Furthermore, the patient benefits from the positive physical effects of horse riding. Like every other sport, riding supports the conservation of health, physical fitness and performance and increases the well-being (Deutsche Reiterliche Vereinigung, 1989, P.37).

### 2.2.3 Equine-assisted psychotherapy

In equine-assisted psychotherapy, all kinds of horse activities (feeding, grooming, leading, lunging, caring) relate to the overall psychotherapeutic treatment of the patient (Wilson, & Turner, 1998, P.42).

The target group for this kind of therapy includes patients with psychosomatic disorders, eating disorders and Post Traumatic Stress Disorder. Furthermore, it can be used by patients with depressive or personality disorders, anxiety, and fear. It is particularly effective in the area of relationship-based issues (KROED, 2020).

For example, positive outcomes were measured in a study conducted with teenagers dealing with depression and anxiety. There, the noted improvements described in confidence, self-esteem, and assertiveness (Wilson, Buultjens, Monfries, & Karimi, 2015).

Therefore, the main objectives of equine-assisted psychotherapy can be ego-strengthening and the building up of self-confidence and social competence (Wilson, & Turner, 1998, P.42).

These achievements are supposed to be lasting and should lead to transferable skills which can be used in social interactions within society (Burgon, 2015).

## 2.3 Positive Physical Effects of Equine Based Therapy

### 2.3.1 Motion-Transfer

Every movement process in horse riding is instigated by the horse's own movement and the forces created through this. The patient's movements are a reaction to the motion of the horse. This is true for every rider, regardless of age, experience, or discipline (Dietze, & Neumann-Cosel, 2009, P.76).

In hippotherapy and therapeutic horseback riding, the patient moves reactively to the horse's walk. The movement impulse created by the horse is like the human gait; the horse's pelvis shows the same three-dimensional movement in walk as the pelvis of a human walking (Goldmann, & Vilimek, 2012). Furthermore, motor and sensory inputs are shown as similar when riding a horse in walk, or walking. The stimuli initiate effective torso-balance training for the human body, especially beneficial for patients with ambulatory difficulties (Uchiyama, Ohtani, & Ohta, 2011).

The horse creates a three-dimensional and extraordinarily complex movement in all four gaits. The three dimensions of movement rotate about the X,Y,and Z axes (Willers, & Krapf, 1977, P.261f.), represented as dorsoventral flexion and extension, axial rotation and lateral bending in the equine spine (Townsend, Leach, & Fretz, 1983). The transfer into the patient's body occurs in three dimensions as well and causes complex effects there (Debusse, 2015, P.52).

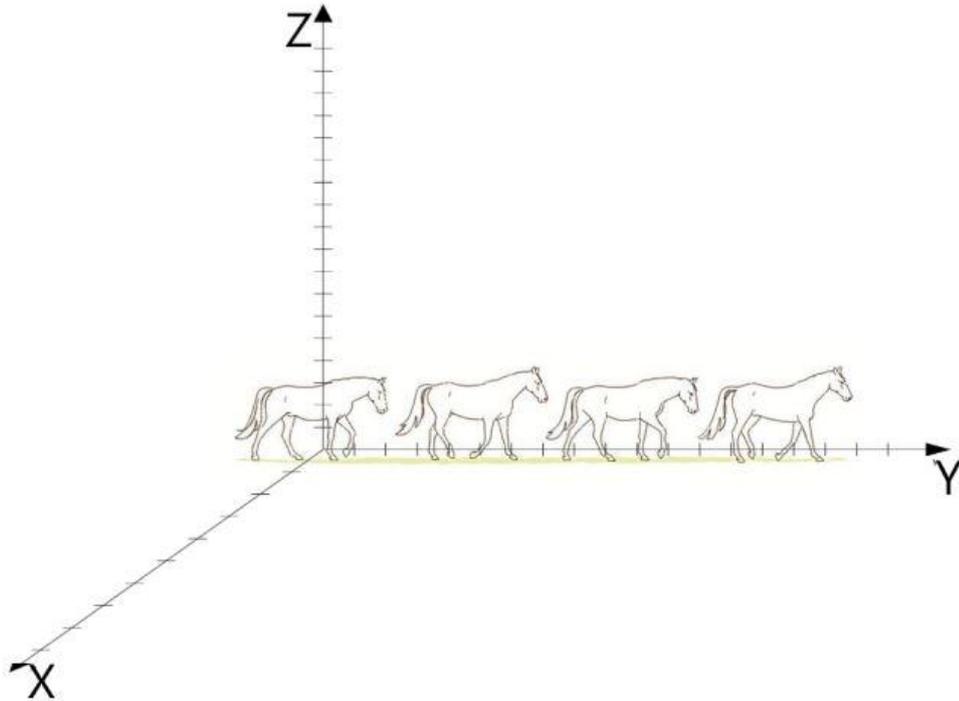


Figure 5: Position of the horse within X, Y and Z axes

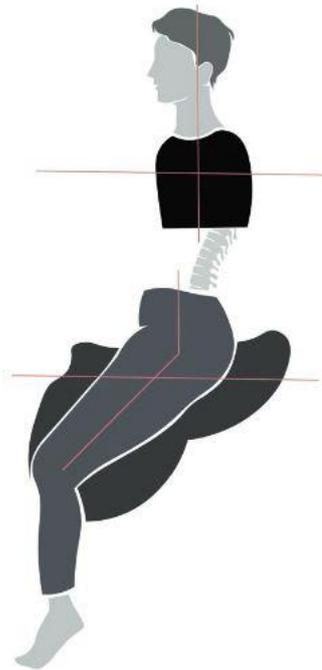
The most noticeable movement of the horse is going forward, working on the Y axis. (Soehnle, & Lamprecht, 2019, P.19).

The flexibility of the horse's neck is responsible for this movement and induces it. With every drop of the neck, the horse stabilises one hind leg under the balance point, while the other hind leg starts with the boost. The front legs get the space to stride forward with every lift of the neck (Zsoldos, & Licka, 2015). Within a study, scientists showed the negative impact of a fixed neck on the horse's spine. Negative consequences in the equine spine are pointed out in the flexion-extension movement, the lateral bending, and the axial rotation. Following on from this, the whole gait of the horse is negatively impacted in its stride length (Rhodin, Johnston, Roethlisberger Holm, Wennerstrand, & Drevemo, 2010). This makes the training of the therapy horse even more important when working with patients with movement difficulties.

Movement on the Y axis creates a rhythmical forward and backward movement into the patient's torso. The pelvis and hip, the largest point of contact the patient has with the horse, moves forward just as the horse does, while the upper body stays back (Soehnle, & Lamprecht, 2019, P.19f.).

This happens because the horses forward movement creates an impacting force. This force involuntarily moves the pelvis and hips minutely faster than the upper body.

Unconscious reactions of the patient's core muscles stabilise the spine and bring the upper body back over the hips into balance. With every step the patient regains balance and stabilisation with the aid of the core muscles (Debuse, 2015, P.53).



*Figure 6: Response of the patient's body to the horse's movement on the X axis (Soehnle & Lamprecht, 2019; P.21)*

The movement on the Z axis, visible as up and downward movement, the horse creates through the hind quarters. The boost is formed through impulsion from the hind end. Momentum carries this energy through the spine of the horse to the forelegs, and the head and neck (Deutsche Reiterliche Vereinigung, 2020).

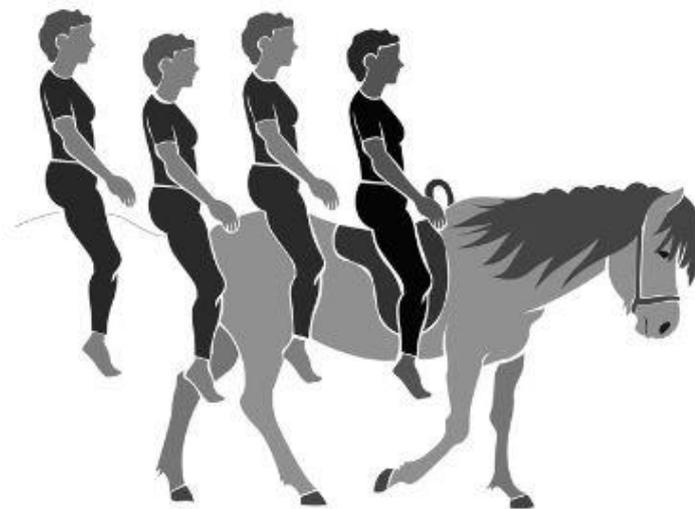
To do this, the spine flexes and extends twice during each complete walk stride (Townsend et al., 1983), which means the part of the horse on which the patient is sitting, bulges, and releases twice per stride too (Debuse, 2015, P.51).

The up and downward movement on the Z axis is dependent on the intensity of the horse's movement and on the swing it is creating. Length of legs and movement intensity have influence on every horse's swing (Soehnle, & Lamprecht, 2019, P.20). Over and above, studies show that the conformation of the horse influences the swing too. Therapy horses with a wide conformation showed a smaller swing than narrow therapy horses (Matsuura, Ohta, Ueda, Nakatsuji, & Kondo, 2008). With the level of schooling the horse gains during training, the swing can adapt.

Horses with a big swing can move flatter through schooling, as horses with less swing can learn to be more elastic and swing more (Dietze, & Neumann-Cosel, 2009, P.77f.). Therefore, correct training of therapy horses is paramount.

The human spine reacts to the swing with compression and traction, which stimulates correct postural development (Soehnle, & Lamprecht, 2019, P.20).

For creating this, the relaxed and loose pelvis of the patient is most important. The hip and the pelvis, as the direct connection between horse and patient, has the task of transferring the absorbed horse stimulus into the full length of the human spine (Debuse, 2015, P.52).



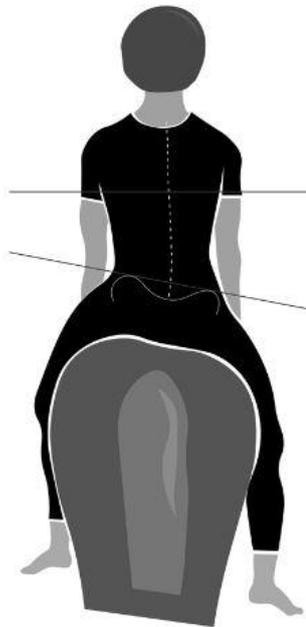
*Figure 7: Up and downward movement of the patient on the Z axis (Soehnle & Lamprecht, 2019, P.22)*

The side to side movement, on the X axis, is created by the sequence of footfalls in walk. In walk, the sequence is equilateral but not at once: left hind, left front, right hind, right front. This was first discovered, historically in the year 1882, due to the revelation of cameras. This sequence causes the horse to shift its weight from side to side while walking (Stillman, 1882, P.115ff.). As the horse walks, the spine rotates minimally (Townsend et al., 1983), which creates a sideways movement for the patient (Dietze, & Neumann-Cosel, 2009, P.78).

The range of motion on the X axis is dependent on the speed, height and shape of the horse. These qualities can be variable, affected by different influences on the patient's movement (Johnston, Holm, Faber, Erichsen, Eksell, & Drevemo, 2010).

If the horse is shifting weight from side to side, using left and right legs alternately, the human body must react with a stabilisation of the muscles of the pelvis and spine.

The pelvis moves to the side with the horse, where the weight is loaded, while the torso, especially the lower part of the spine, moves into a lateral flexion with the help of these muscles (Goldmann, & Vilimek, 2012).



*Figure 8: Response of the patient's body to the spine rotation of the horse (Soehnle & Lamprecht, 2019, P.23)*

This motion transfer process also happens in therapeutic horseback riding. The added element of the patient controlling the horse, as well as retaining the passive motion transfer, places significantly increased demands on coordination, which is shown as perfection in complete synchrony of motion between rider and horse (Lagarde, Peham, Licka, & Kelso, 2005). The nervous system of the rider adapts in a positive feedback loop to improve posture and coordination on the horse. Intramuscular coordination is also developed through feedback from practice (Dietze & Neumann-Cosel, 2009, P.89). The previously mentioned study continuously measured phase-matched motions between the horse and an expert rider, ascribed to the adaption of the nervous system (Lagarde et al., 2005).

### 2.3.2 Strength and Endurance

The term endurance describes the ability to maintain physical performance over a long period. In other words: Endurance is the resistance against exhaustion. In horse riding, local endurance and general endurance are demanding. Luckily it is improvable through practice (Deutsche Reiterliche Vereinigung, 1989, P.31).

In equestrian sports, the horse is the primary athlete; but the rider must also be trained in his athletic performance (Stegemann, 2009). For example, in the equestrian discipline dressage, natural movements of the horse must be controlled with rider aids, like the thigh aid (Heisterkamp, 2008). To canter the horse, the thigh aid is to keep the inner leg close to the saddle girth, while the outside leg slips hand-wide behind the saddle girth. Both legs stay close to the horse's trunk in the described position, to keep a minimum of pressure for as long as the horse has to stay in the canter (Kaune, 1993). Thus, thigh aids focused on the lower body, represent local endurance. Depending on the duration of the physical strain, further differences in the type of endurance can be made.

Short-term endurance has a duration of thirty five seconds to two minutes, mid-term endurance is located in a time frame of between two minutes and ten minutes and, finally, long-term endurance describes physical strain which remains for more than ten minutes (Laube, 2009, P.168). So, thigh aids in the equestrian discipline dressage can be classified as short-term endurance.

Another discipline in equestrian sports is trail riding. There, long distances are covered by several hours of horse riding a day. Longer tours extend over several days. The tension in the whole body for a good seat on the horse, without disturbing the horse, must be maintained for many hours (Stamm, 2011, P.62). This physical strain can be defined as long-term and general endurance.

Keeping up the body tension required for sitting on the horse is a focus in equine based therapy, especially in hippotherapy. Current literature and study designs recommend hippotherapy sessions of twenty to thirty minutes duration, mounting and unmounting included (Soehnle, & Lamprecht, 2019, P.171). Therefore, the physical strain in equine based therapy can be classified as long-term and general endurance, while, especially in mounted work, strength as a physical quality is needed too.

Many muscles are involved in maintaining the performance of sitting on a horse. The most difficult aspect is the coordination between all of these muscles. The muscles in

the legs, back, core and pelvis are the main focus in horse riding (Deutsche Reiterliche Vereinigung, 1989).

Muscle weakness or tension can be created or exacerbated either from too little work, incorrect work, or malposition. Horse riding can compensate for these effects, in every person; but especially in patients with physical disorders. This has been observed in people with Arthritis, where decreased pain, improved range of motion and a better quality of life could be attributed to the accomplishment of equine based therapy (White-Lewis, Johnson, Ye, & Russell, 2019).

The gluteal muscles stabilise the pelvis and allow the patient to spread their legs and enable them to sit on the horse (Deutsche Reiterliche Vereinigung, 2020, P.29).

Due to the position used while on the horse, the muscles of the inner thigh usually tense up in sitting. As people get stretched and relaxed the adductor muscles symmetry improves (McGibbon, Benda, Duncan, & Silkwood-Sherer, 2009). A study indicates that horses with a wide conformation are particularly appropriate as therapy horses for patients to relieve muscular tension (Matsuura, Ohta, Ueda, Nakatsuji, & Kondo, 2008).

Furthermore, hippotherapy, carried out in the gait walk, shows an increase of strength in the lower limb due to regular sessions (Araújo, Oliveira, Martins, Moura Pereira, Copetti, & Safons, 2013).

The muscles of the back, especially the deep muscles, must work to maintain posture. Furthermore, they are involved in the described motion-transfer with tension and release, bringing the horses movement into the human body (Deutsche Reiterliche Vereinigung, 2020, P.29).

An electromyographic analysis showed the effect on the rider's muscles in the gait trot. In particular, the upper and middle part of the trapezius muscle showed peaks of work due to the stabilisation of the neck and scapula of the rider (Terada, Mullineaux, Lanovaz, Kato, & Clayton, 2004).

Finally, the abdominal muscles move and stabilise the pelvis. Abdominal muscles and back muscles operate symbiotically or antagonistically in typical horse-riding movements, such as, leaning sideways or twisting the torso (Deutsche Reiterliche Vereinigung, 2020, P.30).

In the previously described electromyographic analysis study the abdominal muscles, presented through the rectus abdominis, showed peaks of work for the purposes of following the horse's movement by swinging the pelvis forward (Terada et al., 2004).

### 2.3.3 Balance and Coordination

The sense of balance can improve with regular training. Equally, coordination is improvable with training (Dietze, & Neumann-Cosel, 2009, P.25).

Horse riding is an incredibly unique sport, and therapy can improve both elements simultaneously. The movement of a rider through, for example, the repetitive motions used to control the horse, and the movement the horse is creating due to its gait cannot be imitated in any other sport (Flood, 2018).

The sense of balance detects the posture and creates orientation. The sense of position the human body takes in is in three dimensions and, moreover, feeling forces like rhythm and speed are the complex tasks the sense performs. This sense is directly connected with the inner ear, the eyes, and the cerebellum. A loss of balance induces fear and causes an adverse reaction (Dietze, & Neumann-Cosel, 2009, P.31f.).

Every disease affecting the organ in the inner ear itself, every visual disorder, and every disease affecting the brain and neuromotor system can affect the sense of balance negatively (Scherer, 1997, P.315ff.). Parkinson's Disease (PD), for example, is one disease which affects the central nervous system and thus negatively affects the sense of balance. All symptoms such as shaking, postural instability and difficulties with gait follow on to motor impairments (Opara, Malecki, Malecka, & Socha, 2017).

In horse riding, the key essence of balance is to focus the sense on the pelvis. This is different to the daily routine of all people who are able to walk, as the control of balance is centred around the feet (Meyer, Oddsson, & De Luca, 2004).

For this reason, hippotherapy and therapeutic horseback riding often utilise "no stirrup work". The feel of balance in the pelvic area gets stimulated and improves due to regular training (Dietze, & Neumann-Cosel, 2009, P.32).

During a further therapy, where the rider may start to control the horse by himself through aids, the horse's performance gives feedback directly to the riders' level of balance. An unbalanced rider is not able to give clear and consistent aids, the horse will not move the way the rider asks (Williams, & Tabor, 2017, P.28).

Coordination is described as the coaction of skeletal muscles and the central nervous system during a motion sequence. Coordination is improvable through practice and repetition (Deutsche Reiterliche Vereinigung, 1989, P.29).

Horse riding is an ambitious coordinational challenge; however, with regular practice it will improve. Coordination in horse riding is created by harmonising all of the different movements of the body. Some are created by the horse, some are created by the rider.

A typical example is the former described motion-transfer: to keep the posture while the shoulder girdle stays mobile and the pelvis stays connected with the horse's movement (Dietze & Neumann-Cosel, 2009, P.25/86).

People with disorders and special needs can face coordinational challenges already in seemingly usual movements, such as children with autism displaying poor movement coordination in gait patterns (Eggleston, Landers, Bates, Nagelhout, & Dufek, 2018). In a current study with this patient group, therapeutic horseback riding has been shown to cause significant improvements in the stability of the gait and is therefore recommended as an appropriate rehabilitation therapy (Steiner, & Kertesz, 2015).

Hippotherapy also uses the remarkably high stimulus in horse riding for all neurological disorders. With the focus on the reactive movement of the patient sitting on the horse, the selective movement of torso and pelvis due to the horse gait stimulates the neuromotor system to notice these body parts separately (Soehnle & Lamprecht, 2019, P.87).

The medical professional society "Deutsche Gesellschaft für Neurologie" has worked since 1907 to reform neurological care in Germany. Inside the professional society, consisting of six thousand members, works a research group for neurology and sport. This research group recommends and suggests horse riding as an especially appropriate sport or therapy for neurological diseases with the symptoms of: disturbance of equilibrium and disturbed coordination (Tauber, 2009, P.32f.).

## 2.4 Positive Mental Effects of Equine Based Therapy

### 2.4.1 Horse-Human Relationship

Humans can build relationships with animals, just as animals can build relationships with humans. French scientists demonstrated in a highly topical study how horses identify their keeper, last seen six months ago, only from seeing a photograph. The results of the study conclude a high interspecies recognition of humans and a long-term memory of human faces- required qualities for an interspecies relationship (Lansade, Colson, Parias, Trösch, Reigner, & Calandreau, 2020).

Horses bring in other needed qualities to build an interspecies relationship to humans too. They show a complex social structure within the herd they live in. Herd dynamics, social interaction and the variability of these factors are extensively observed in horses (Goldschmidt-Rothschild, & Tschanz, 1977).

Usually horses are socialised very early around humans, often from the time of foaling, and moreover with the passage of time, they gain the ability to read human emotions and react to them (Gäng, 2016, P.99f.).

A study in Sweden demonstrates the sensitivity of horses to human nervousness, as one example of a horse's sense of human emotions. In this study, heart rate was used as a marker for anxiety in both horses and humans. Whenever the heart rate of the rider or ground worker increased because of nervousness or apprehension of a negative outcome, the horse responded rapidly with a rise of their own heartrate (Keeling, Jonare, & Lanneborn, P.70).

Respectively, humans react instinctively to perceived animal emotion. This is due to a care requirement as part of this relationship. If an owner of animals notices pain in them, they try to reduce the animal's level of stress with physical closeness and contact. Only when the stress level of the animal is reduced and the pain is gone will the human reduce their own stress level as well (Gäng, 2016, P.97f.).

From this it is shown to be paramount for the patient to build a positive relationship with the therapy horse within the work sessions.

Therefore, in the process of therapy, the patient should always be included in the relationship building activities: before work, the patient should say hello to the horse and establish connection through grooming as a treat for the horse (Buzel, 2016)

Scientists demonstrated in an experiment that to groom the preferred spot of the horse, as they do among themselves in the herd, lowers the heart rate of the horse and reduces stress. This tool can be used to build and strengthen a bond between horse and patient in a therapy session (Feh, & Mazières, 1993).

Every successful partnership, from equine based therapy to competition riding, is built on a flow of interaction. This interaction is based on the qualities: respect, trust, confidence, and close communication. For this, humans must respect horses with their own emotions, intelligence, and personality (Wipper, 2011).

As a result of a symbiotic relationship to the horse, patients can learn about empathy and compassion. Horses do not show judgement as humans do. The human is taken as they are at that moment in time, not in relation to their role in society or any past achievements. Furthermore, to gain the full concentration of the horse in the form of respect, patients must work on their true confidence, which helps them to achieve a new level of self-belief (Hallberg, 2008, P.133ff.).

In addition to the described essential qualities of relationships, the horse can teach the patient about building and receiving a connection with another. With the horse as an authentic and not-judgemental partner, people feel safer developing this bond initially, providing them with transferable skills to develop positive human relationships (Burgon, 2015). Horses always give clear signals about how they feel, about danger and safety, which makes it easy for humans to develop appropriate reactions. For example, a grass chewing horse is always broadcasting ease (Gäng, 2016, P.99).

Research in Germany, Austria and Sweden suggests: closeness to animals increases the openness for relationships. The level of oxytocin increases, which lowers the level of stress. Furthermore, oxytocin can allay fears, brighten up the mood and improve empathy. In addition, the research showed that a stable relationship to a particular animal, like pet ownership or as patients experience in long-term animal assisted therapy, has more potent and long lasting effects in context to the level of oxytocin (Beetz, Uvnäs-Moberg, Julius, & Kotrschal, 2012).

In conclusion, research, with the aid of “The Equine Assisted Growth and Learning Association” (EAGALA) describes horses as naturally therapeutic by being themselves. Equine assisted psychotherapy clients are described as more relaxed and more motivated due to the horse’s presence. The different qualities the horse brings into the therapy session helps the clients immediately: their playfulness brings joy into therapy sessions, their size and strength keeps patients alert and concentrated, their calmness helps to calm down emotionally difficult situations (Lee, & Makela, 2015).

#### 2.4.2 Communication between Horse and Human

In the year 1904, in Berlin, a mathematician presented a horse which was supposed to understand verbal language. With head movements, hoof knocking and the help of a blackboard the horse solved arithmetic tasks and complex verbally phrased questions. It was not until 1907 that scientists were able to discover the actual reason: the horse was reacting especially sensitively to facial expressions and other body language signs shown by the questioner (Gross, 2014).

The study showed early on that an interspecies relationship between horse and humans is possible due to the fact that both species are able to build a common system of communication, allowing them to experience mutual interactions (Brandt, 2004, P.300).

The first experience of communication humans learn as babies, is within a nonverbal layer. Over the years, verbal communication gains more importance.

The horse uses the nonverbal communication layer, as this is their method of communication with other horses (Gäng, 2016, P.107f.).

In summary, the common system of communication between horse and human is body language, the nonverbal layer (Brandt, 2004, P.301).

The nonverbal layer works by way of facial expressions, gestures, sight, position, posture, and movement of the body. The difficulty for humans working with horses is to focus only on these elements of language, the earliest learned communication, whereas in their daily routine the focus is on the spoken word, the verbal layer (Gäng, 2016, P.108).

Humans work more effectively in the system of communication in horse-human relationships than in other animal-human relationships, such as with dogs and cats. This is based on the incredibly unique qualities the horse brings into the interspecies interaction. The large size of the horse, in contrast to the human communication partners, brings in a more dangerous element than in every interaction with dogs or cats. As a result, an effective communication system gains more importance due to the aspect of safety. Moreover, the high level of body-to-body contact between human and horses is unique. Humans have contact with dogs and cats for reasons such as grooming, playing, or training. The physical connection to the horse can exist beyond that in riding, where the communication takes place while the human partner is sitting on the back of the horse, a complicated physical and mental task for both (Brandt, 2004, P.300f.).

Besides the verbal and nonverbal layer humans use for communication, the transfer of information takes place on a conscious (transfer of content) and unconscious (transfer of emotion) level (Gäng, 2016, P.107).

The sensitive intuition of horses, and their reaction to human emotions, transferred on the unconscious level, has been shown in research. In one study, scientists demonstrated equine reactions with photographs of human facial expressions of anger and happiness next to each other. Whenever the horses focused on the right photo, showing the angry facial expression, there was a quick, measurable, increase of heart rate in the horse. This effect was not detectable when horses were looking to the left at the happy facial expression (Smith, Proops, Grounds, Wathan, & McComb, 2016).

This knowledge finds use in equine based therapy for veterans experiencing PTSD. In two different studies, one on equine assisted psychotherapy and one on therapeutic horseback riding, patients showed emotional improvements after six weeks of therapy.

Complaints like emotion regulation, emotional numbing and emotional loneliness showed improvements with the use of measurable factors (Johnson et al., 2018; Burton, Qeadan, & Burge, 2019).

In Summary, the horse reacts directly, naturally, and authentically to nonverbal signals and on every signal transferred unconsciously on an emotional level.

In other words, the horse behaves like a mirror. For every nonverbal signal and every unconscious emotion transferred in the interspecies communication, the horse reacts similarly through its body language (Gäng, 2016, P.109).

Therefore, in several studies, the mirror effect was measured through the heart rate of horses and humans in interaction with each other. As a result of the studies, the heart rate variability of the horses was shown to be similar in frequency dynamics to the human, even if scientists want to distance from the term mirror effect in that context (Gehrke, 2010).

Used in equine based therapy, the common system of communication between horse and human helps patients in many ways, according to the research of EAGALA. Therapists observe the horse and the signals it gives in conjunction with the patient's current emotional state. This creates more opportunity for the therapist to safely access emotional layers or difficult issues. In doing so, therapists know when they have to give space for the horse and patient or when they have to intervene (Lee, & Makela, 2015). Also, the horse behaves authentically, showing the patient forthright answers on the sent signals. This is not always easy to process for patients but remarkably effective, because patients experience their issues reflected. This observation was made in a study with suicidal girls in an equine assisted psychotherapy programme, which showed improvements in their attitude due to the reflection in the horse's response to them (Bauducco, 2012).

Moreover, patients often achieve a deep connection to their therapy horse during the therapy. In doing so, they start to feel safe with their presence and open up on their feelings, emotions, and issues to the horse in a direct and forthright way. The horse represents the needed emotional support (Kern-Godal, Brenna, Kogstad, Arnevik, & Ravndal, 2016).

### **3. Conceptual Formulation**

The core of this systematic literature review is based on providing an overview of the volume and content of current studies surrounding the treatment and rehabilitation of brain injury patients with equine based therapy.

Based on the title of the thesis the following questions will be answered within the methods:

1. Is there an equine based therapy that is preferential in the treatment or rehabilitation of brain injury?
2. Are there any positive physical effects indicated by the use of equine based therapy in patients with brain injury?
3. Are there any positive mental effects indicated by the use of equine based therapy in patients with brain injury?

### **4. Methods**

#### **4.1 Retrieval Strategy**

This systematic literature review has drawn from the database PubMed, containing life sciences and biomedical topics from the MEDLINE database.

All data was obtained in June 2020.

To find the appropriate literature to this topic, a well-directed choice of words and word combinations were selected. Within the search, words related to equine based therapy (“hippotherapy”, “therapeutic horseback riding”, “equine assisted therapy”) and Acquired Brain Injury (“brain injury”, “stroke”), each connected with the word “and” were carefully chosen.

Within the advanced search tool in the database PubMed, all word combinations were connected as terms with the word “or” to prevent duplicate studies.

#### **4.2 Inclusion and Exclusion Criteria**

This thesis reviewed the selection of papers for set inclusion and exclusion criteria in two phases.

In phase one, the papers underwent superficial examination for three previously set criteria:

First, the papers were examined by the year of publication. To ensure the topicality, exclusion criteria eliminated studies preceding the year 2009.

Secondly, the studies were examined based on access.

Full access to the paper had to be granted. Papers without access through the college portal were excluded.

Finally, the remaining papers were reviewed by the authored language. Inclusion criteria within this thesis states that papers must be written in German or English.

In phase two of the review process, the title, and the abstract of the remaining papers were examined for the literature selection. Here, the nature of the equine based therapy has been identified. Papers using simulated equine based therapy were excluded. The object of this thesis not only focuses on the physical movement of a horse, which could be simulated, it places equal importance on the effects of bonding and communication, which can only be derived from a living, reactive horse.

The next stage of examination identified the type of injury. The phrases “Acquired Brain Injury”, “Traumatic Brain Injury” and “Stroke” must be clearly identified in the title or abstract to meet the required inclusion criteria. Ambiguity surrounding the type of injury within the title or the abstract excluded these studies.

The final stage of screening examined the format of the study. Literature reviews are excluded, to avoid duplication of results in the upcoming analysis.

*Table 1: Inclusion and exclusion criteria*

	<b>Inclusion Criteria</b>	<b>Exclusion Criteria</b>
<b>Year of Publication</b>	2010 or later	2009 or earlier
<b>Access</b>	Free Access	Paid Access
<b>Language</b>	English or German	Other Languages
<b>Type of Equine Based Therapy</b>	Equine Based Therapy working with a living horse	Equine Based Therapy working with a simulator
<b>Type of Injury</b>	Acquired Brain Injury, Traumatic Brain Injury, Stroke	Lack of clarity or any other injury or illness
<b>Type of Paper</b>	Studies	Literature Reviews

## 5. Results

### 5.1 Flow of Studies

The initial search resulted in thirty five papers, which are screened for set inclusion and exclusion criteria.

Within the first phase of screening, nineteen papers were excluded due to their year of publication, their access, or their language.

In phase two of the screening process, another ten papers were excluded. Four papers were excluded as literature reviews, three papers did not show the required type of therapy with a living horse. Three papers did not clearly define the required type of injury.

Six studies remained after inclusion and exclusion criteria.

For the purposes of this literature review, the interview evaluation of Pohl et al. (2018) has been combined with the follow up study from Bunketorp-Käll et al. (2017).

The participants can therefore not be counted twice in the following analysis. The interview evaluation demonstrates the lasting effects and impressions of the Bunketorp-Käll et al. (2017) study.

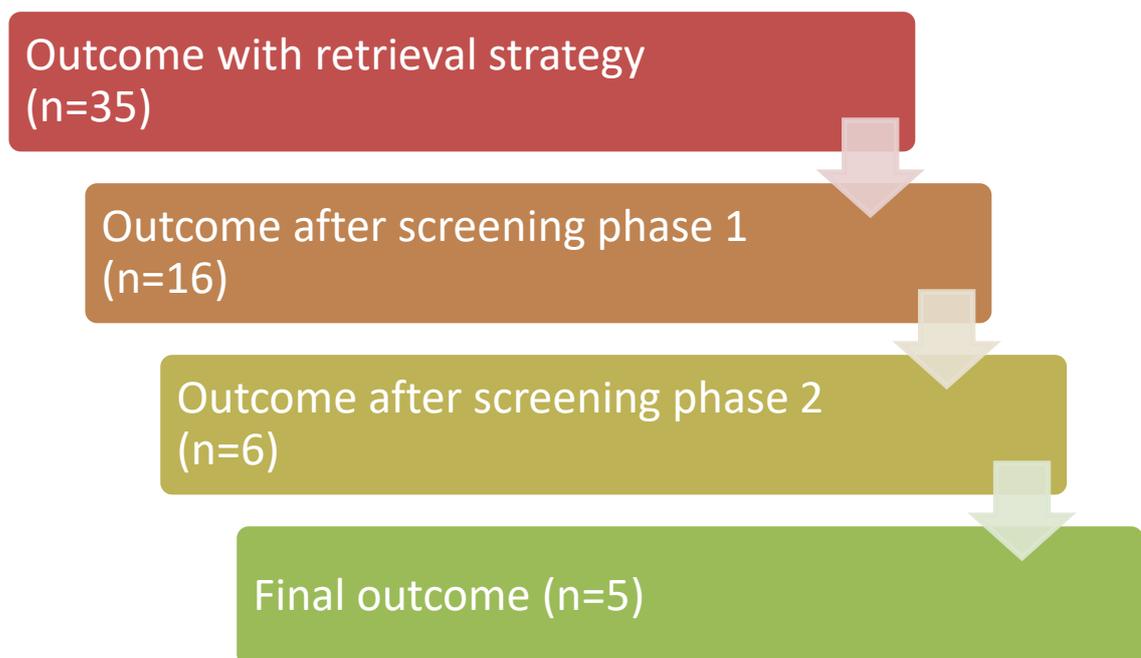


Figure 9: Flow of studies

## 5.2 Characteristics of Studies

Of the five studies included in this review, the sample size ranged from one to one hundred and twenty three participants with an age range from thirteen to eighty five. One study, a case study with one participant, worked with a child, while the other studies worked exclusively with adults.

Upon collation of the data it was found that three of the one hundred and eighty two participants suffered a TBI, the other one hundred and seventy nine participants suffered a stroke.

It is notable that the commencement of the studies in relation to the onset of injury was varied, it ranged from six months to fifteen years after the date of injury.

All the participants were required to walk independently before starting the study. Most studies allowed gait aids, for example a walking stick or a posterior wheeled walker.

Another similarity of the participants in all five studies, was the absence of serious health issues, including seizures, heart diseases or serious orthopaedic problems. All participants had the ability to understand simple verbal and visual instructions.

The duration of the studies ranged from eight to sixteen weeks. The majority of studies (n=3) examined control groups, using conventional therapies, in comparison to the experimental groups using equine based therapy. The frequency of therapy sessions ranged from one to three sessions per week. The duration of individual therapy sessions was consistently thirty minutes, with the exception of the study from Bunketorp-Käll et al. (2017), which had no information about the session length.

The five studies used different instruments to measure the outcome of the studies. Physical outcomes were measured using different tests and scales, a 10-meter walk test, measuring gait speed, step length and time was most frequently used. Mental outcomes were measured subjectively.

The characteristics are summarized below:

Table 2: Characteristics of studies

<b>1st Author (Year) Country</b>	<b>Study Aims</b>	<b>Type of Injury</b>	<b>Number of partici- pants (Age)</b>	<b>Type of Equine Based Therapy</b>	<b>Type of Paper</b>
Beinotti (2010) Brasil	To evaluate the hippotherapy influence on gait training in post-stroke hemiparetic patients	Stroke	20 (30-85)	Hippotherapy	Case- Control- Study
Sunwoo (2012) Korea	To investigate the effects of hippotherapy for adult patients with brain disorders, caused by TBI or stroke	Stroke, TBI	8 (25-70)	Hippotherapy	Pilot Study
Lee (2014) Korea	To examine the effects of hippotherapy on gait and balance ability in patients with stroke	Stroke	30 (DS 64)	Hippotherapy	Case- Control- Study
Erdman (2016) USA	To describe and examine the use of hippotherapy, with regard of the positive effects, with a boy who suffered a TBI	TBI	1 (13)	Hippotherapy	Case Study
Bunketorp- Käll (2017) Sweden & Pohl (2018) Sweden	To investigate whether horse-riding therapy and rhythm and music-based therapy affect functional mobility in late phase after stroke  &  To explore stroke survivors' experiences of participation in a multimodal group-based intervention that included horseback riding	Stroke	123 (50-75) & 18 (51-74)	Therapeutic Horseback Riding	Case- Control- Study & Interview Study

### 5.3 Aim 1

*Is there an equine based therapy that is preferential in the treatment or rehabilitation of brain injury?*

The majority of studies (n=4) examined hippotherapy as a treatment in the rehabilitation progress of brain injury patients. In one of these studies, other activities with the horse, such as grooming and feeding were actively encouraged, while other studies (n=3) focused exclusively on the mounted activities.

The remaining study examined therapeutic horseback riding as treatment. There was no study found using the treatment of equine assisted psychotherapy in brain injury patients.

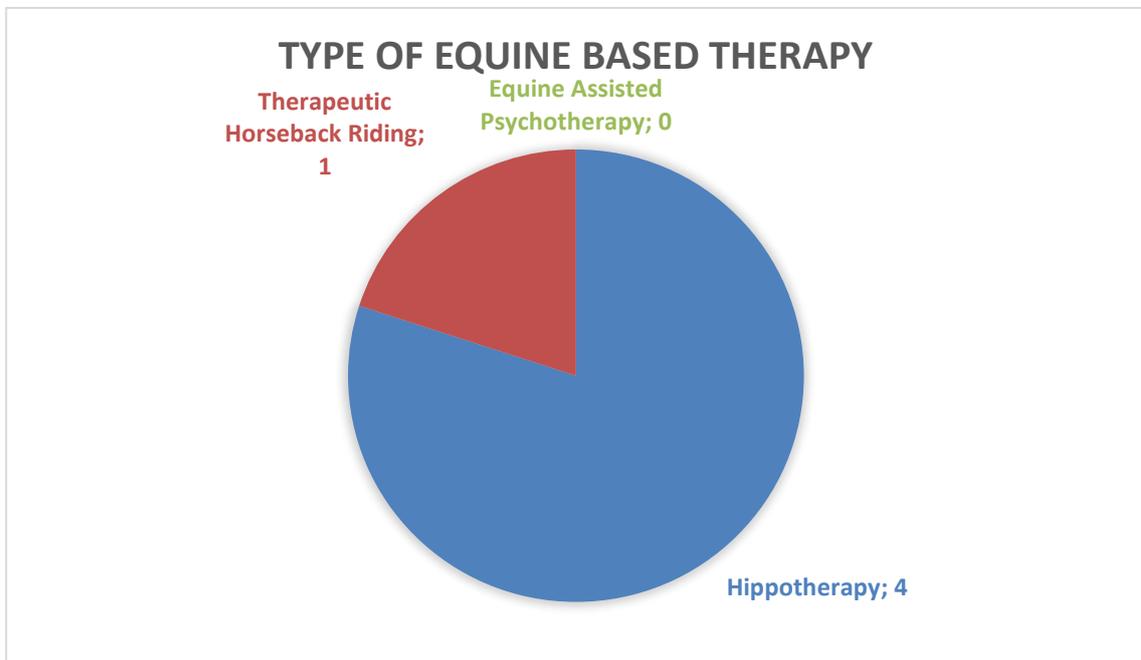


Figure 10: Spread of types of equine based therapies in included studies

### 5.4 Aim 2

*Are there any positive physical effects indicated by the use of equine based therapy in patients with brain injury?*

Two of the five studies were working without any control groups. They only examined the equine based therapy and its effects on the participants. Both studies, with the use of different measurable scales and tests, found improvements in balance ability and gait, even lasting for weeks post therapy.

Additionally, one of these studies showed improvements in functional strength, functional mobility, and gross motor skills.

The remaining three studies showed similar improvements after equine based therapy, measured by different scales and tests. The improvements are shown in the fields gait (n=3), balance (n=2) and motor skills (n=1). Furthermore, the three studies show improvements in comparison to control groups, which used non equine based therapy. It is shown that gait (n=3) and balance (n=2) are significantly improved in comparison to these control groups.

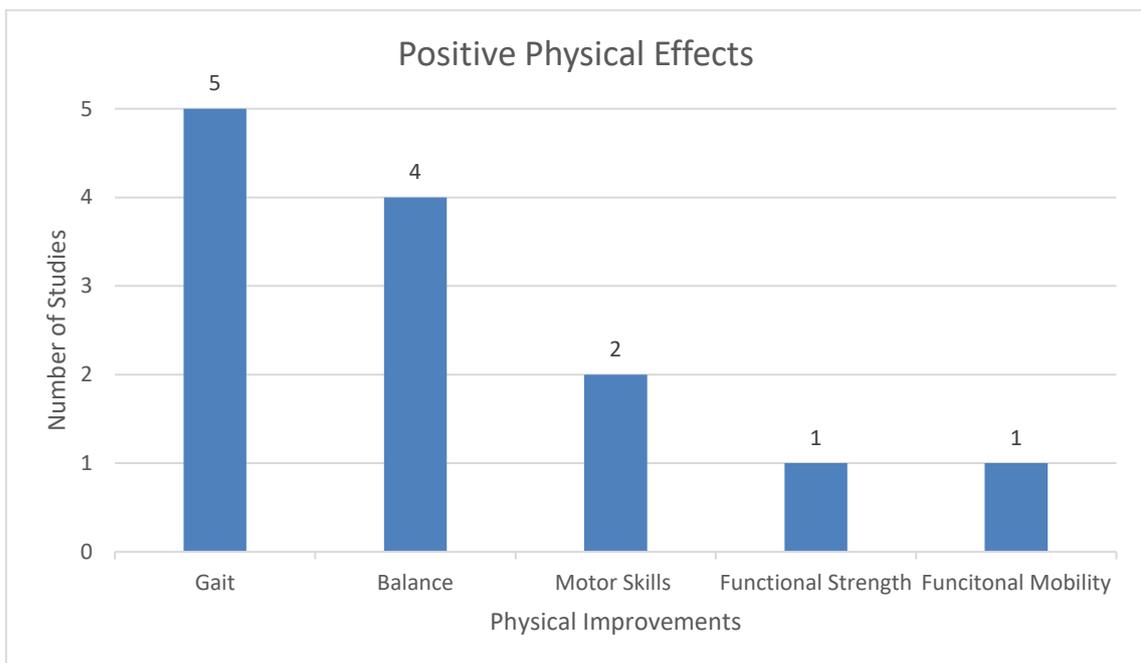


Figure 11: Positive physical effects documented by the included studies

In addition, one study subjectively measured sustained physical effects with the aid of interviews. The participants described physical improvements which can be attributed to the fields of balance and strength.

### 5.5 Aim 3

*Are there any positive mental effects indicated by the use of equine based therapy in patients with brain injury?*

Three of the five included studies examined the mental effects of equine based therapy on the participants.

The results of one study were objectively measured with two scales. The result showed no significant improvements after equine based therapy. The average of both scales showed mild depressive tendencies before and after the therapy program.

The other two studies measured the mental outcomes subjectively, through interviews with the participants and, in case of the child, the parents. In both studies the outcome showed improvements in motivation and social interaction. Furthermore, one of the studies described improvements in emotional well-being, future hope, self-confidence, and self-esteem.

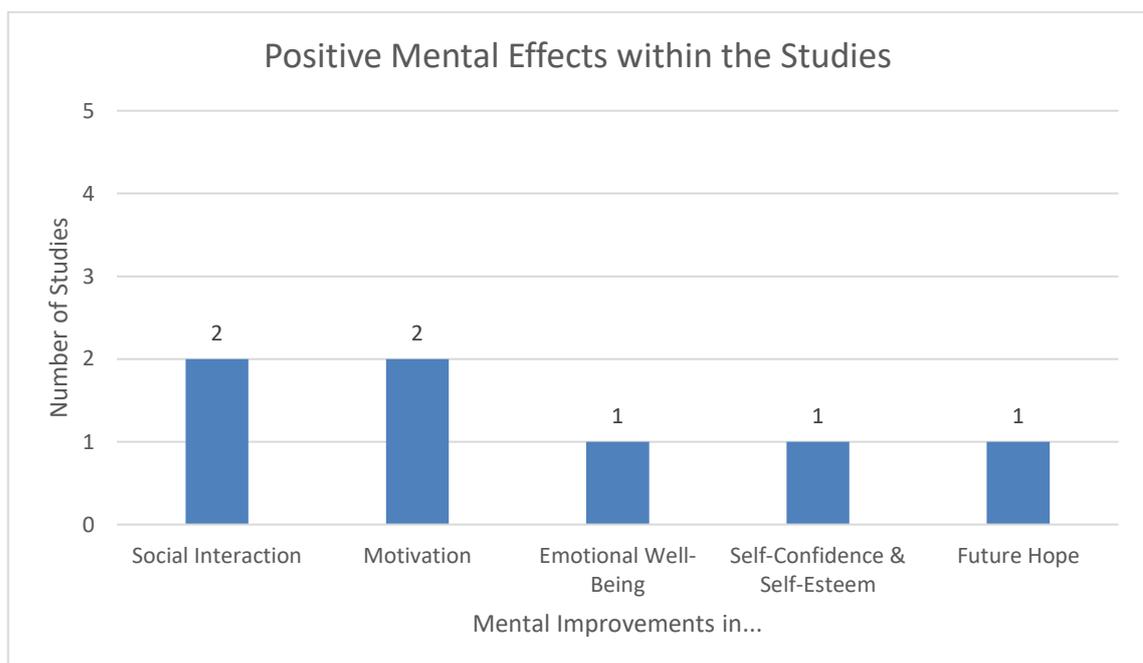


Figure 12: Positive mental effects documented in included studies

## 5.6 Summary of Results

Table 3: Summary of results of the included studies

1 <sup>st</sup> Author (Year) Country	Type of Equine Based Therapy	Physical Effects		Mental Effects	
		Measured yes/no	Outcome positive/neutral/ negative	Measured yes/no	Outcome positive/neutral/ negative
Beinotti (2010) Brasil	Hippotherapy	yes	positive	no	
Sunwoo (2012) Korea	Hippotherapy	yes	positive	yes	neutral
Lee (2014) Korea	Hippotherapy	yes	positive	no	
Erdman (2016) USA	Hippotherapy	yes	positive	yes	positive
Bunketorp- Käll (2017) Sweden & Pohl (2018) Sweden	Therapeutic Horseback Riding	yes	positive	yes	positive

## 6. Discussion

### 6.1 Impact of the Type of Equine Based Therapy

The results of the literature review show that more studies were found within the criteria to hippotherapy than to therapeutic horseback riding, or equine assisted psychotherapy in patients recovering from a brain injury. Consequently, there were more studies found observing positive physical effects than positive mental effects.

Hippotherapy, as a special kind of physiotherapy, has the objective to improve different physical functions, such as an increase in body movement or an improvement of postural function (Debusse, 2015, P.22).

Within the literature review, this objective has been observed. All five of the studies showed improvements in different gait parameters, like increased gait speed or improved step length asymmetry ratio. The majority of studies (n=4) showed improved balance too. Besides, the studies show other improvements such as the gaining of functional strength or motor skills. So, the physical improvements of hippotherapy are observed within the literature review. But with four of the five found studies using hippotherapy, there is a lack of information on the measuring of positive mental effects.

Equine assisted psychotherapy and therapeutic horseback riding both aim to treat psychological trauma (Wilson, & Turner, 1998, P.42; Gäng, 2016, P.15). That means that only these therapies could show measurable mental health effects in patients, as it is not possible in hippotherapy. This is shown by the literature review too. The only study using therapeutic horseback riding which notes positive mental effects in brain injury patients, covers an increased social interaction attached to a raised level of self-confidence and self-esteem, increased motivation attached to future hope, and an improvement in general emotional well-being (Pohl, Carlsson, Bunketorp-Käll, Nilsson, & Blomstrand, 2018).

In the study of Erdman, & Pierce (2016) the use of hippotherapy was adjusted based on the patient's daily condition, with therapy instruments from equine assisted psychotherapy. In every session the patient from the case study was meant to brush and feed the horse. On two days the patient came to therapy with aggravated behavioural difficulties, so the therapists allowed more choice for the patient to configure the therapy session. On these days, the patient chose more of the unmounted activities like brushing and feeding instead of mounted work. This was the only study using hippotherapy, showing subjectively measured positive mental effects, which may be attributed to these activities.

The presumption of the positive mental effects attributed to therapeutic horseback riding and equine assisted psychotherapy needs to get more attention in terms of the recovery of brain injury patients. Currently, the literature review shows a lack of information on the positive mental effects within the context of equine based therapy.

The benefits of equine based therapy in overcoming trauma are demonstrated with veterans experiencing PTSD, with help of therapeutic horseback riding (Johnston et al., 2018) and equine assisted psychotherapy (Burton et al., 2019). Even world-renowned American horseman Monty Roberts created a three day program in 2010 to help veterans in overcoming PTSD:

“We have been working with persons suffering from Post-Traumatic Stress Injury (PTSI), over the course of five separate clinics each year. The results are coming in, and the outcome is fantastic. We have people laughing and getting back to a normal life who have been afflicted with PTSI for upwards of 35 years, [...] All the way from Vietnam to Afghanistan, your local Police Station to the Ambulance Driver these injured heroes come home in a terrible state and need our help to reconnect with their communities. The horses are doing their work with incredible efficiency.” (Join-Up International Inc., 2020).

A brain injury can cause Post Traumatic Mental Illness as well as veterans experiencing PTSD after intense operations. Still worse in brain injury is the fact that medical staff cannot always diagnose the mental illness shown, beyond any doubt, due to a mental or physical trauma. Examples of such mental illnesses are depression and anxiety (Schönberger, Ponsford, Gould, & Johnston, 2011). As these symptoms are accompanied with further physical limitations caused by brain injury such as cognitive, behavioural, or emotional sequelae, it is shown to be still more challenging for psychotherapists to treat this group of patients successfully (Judd, & Wilson, 2002).

In this thesis, one of the inspected studies demonstrated a successful psychological treatment through the use of a horse with a brain injury patient. With the anticipation for grooming and feeding the horse, and interacting with it, the patient arrived early and joyful to the therapy sessions. This was denoted by a reduction of unwanted behavioural difficulties and connected to the nontherapy atmosphere of the barn environment (Erdman, & Pierce, 2016).

Besides this described escape from a usual, formal therapy situation, the horse represents additional emotional and mental support within a psychological treatment (Kern-Godal et al., 2016). Within one study, therapists described the feeling of security patients showed around the horse, which led them to show their authentic emotions, making psychotherapy more successful (Lee, & Makela, 2015).

In summary, it can be said that further studies are needed to investigate the mental effects of different types of equine based therapy on the mental status of brain injury survivors. The studies with patients dealing with PTSD could lead the way here, as similar studies must take place with brain injury patients. Especially, investigations into therapeutic horseback riding and equine assisted psychotherapy as instrumental here are needed. A study design with comparable groups receiving conservative psychotherapy would be recommendable, to show the comparative effectiveness within this very individual group of patients.

The observations in studies with PTSD patients and the results of the studies of Erdman, & Pierce (2016) and Bunketorp-Käll et al. (2017) give optimism for improved recovery in brain injury patients through the help of the horse, while scientific evidence is still pending.

## 6.2 Adverse Effects, Dropouts and Risk of Equine Based Therapy

The five included studies examined one hundred and eighty two participants recovering from a brain injury with help of equine based therapy. None of the participants recorded adverse effects, there were no dropouts in any of these studies. This represents a high level of acceptance amongst the patients and an aspect of safety through the type of therapy.

Within a comparison review, with a larger number of included studies, the results on adverse effects and dropouts are similar. There were no adverse effects described in any of the studies, furthermore there were four dropouts described in an amount of two hundred and fifty six participants, which makes a minimal dropout quote of 1.6% (Marquez, Weerasekara, & Chambers, 2018). At the same time, the comparison review exclusively included studies using hippotherapy, with no limitation to a real horse, so even the use of a horse simulator was included. This must be considered in the comparison between the two reviews.

In conventional psychotherapeutic treatment, the dropouts show a significantly higher rate in diseases showing the same symptoms as in ABIs. Individual psychotherapy in patients with anxiety shows a dropout rate of 17% (Gersh et al., 2017), in patients with depression there is even a dropout rate of 20% observed (Cooper, & Conklin, 2015). Moreover, a large-scale systematic review of the dropout rate of patients with PTSD using conservative psychotherapy was pooled at 36% (Goetter, Bui, Ojserkis, Zakarian, Weintraub Brendel, & Simon, 2015). The current observed studies show less success in relation to completion of a psychotherapeutic treatment than the observed equine based therapy studies. As previously described in chapter 6.1, the barn environment and the horse could help to relax inflexible therapy situations.

In this context, the increase of future hope with the help of equine based therapy, found in this thesis, is an interesting aspect to investigate. Without future hope and plans for the coming life after the event of injury, a dropout from conventional therapy might be made quickly; but a kind of therapy that raises hope for the future may prevent dropouts from patients, to its own advantage.

Brain injury survivors with serious mental challenges which they have to face, when their lives turn suddenly and abruptly, with no return, from one moment to another, are dependent on psychological help. In a state of emergency like this, usual treatments might not lead to success any more, so there is a need to broaden the horizon in psychotherapy for them. Equine based therapy could be recommended, with increased risks due to physical limitations being considered beforehand.

As described in chapter 2.1.3, the effects and symptoms of brain injuries are very individual, usually depending on the injured part of the brain (Headway, 2020). The therapy should be adjusted with respect to this uniqueness of the injury and their effects. For example, hippotherapy is recommended as a treatment for brain injury patients in general (Debusse, 2015, P.64); however, depending on the severity of the brain injury, and the treatment the neurosurgeon suggests for the patient, opportunities for treatment may include an induced coma or neurosurgery such as a craniectomy, where a flap of bone is cut out of the skull and may be replaced at a later stage of recovery (Maimaris & Worthington, 2016, P.7ff.). Patients who have had to experience this treatment, may show a more serious outcome.

The craniectomy is often accompanied by newly developed cognitive, neurological, or psychological deficits, or remaining in a permanent vegetative state (Stiver, 2009), able to breathe on their own, showing spontaneous eye-opening but only responding reflexively (Maimaris & Worthington, 2016, P.16).

These patients must be viewed with caution and may have too many deficits for hippotherapy. As a rule of thumb, it should be considered that if a safe mounting from the patient is not possible without great effort, therapy on the horse should be avoided (Soehnle & Lamprecht, 2019, P.6). In addition to assessing risks, the prejudices of patients or their relatives, must also be taken into account. A survey of parents with children getting treatment in hippotherapy revealed that their biggest worry in this kind of therapy was the risk of physical injuries ascribed to the horse (Léveillé, Rochette & Mainville, 2017).

Besides the inspection of patient deficits and the exact clarification for the patient and relatives, the extensive and all-round training of the therapy horse forms the core of safety in equine based therapy. Horses are not only used as partners in therapy, the use extends over the fields of: free time, sport, farming, forestry work, the police force and armed forces. Each field of use has its own focus in the training of the horse.

In sport, the main focuses in horse training, in general, are: cardiovascular conditioning, strength training, and suppling exercises (Clayton, 1991). According to the Hannover Police Department, in Germany (2020), police horses must be trained, in addition to the classic fields of dressage, show jumping and open country, in the field of confrontation with special acoustic and visual stimuli, and exercise in road traffic. Despite the extensive training and overwhelming stimuli in training and missions, police horses show less stress and workload compared to horses in sports (Munsters, Broek, Weeren, & Sloet van Oldruitenborgh-Oosterbaan, 2013).

Simultaneously, the therapy horse needs more stimuli in training to promote the patient's safety. As indicated in chapter 2.2.1, the goal in training here is to minimise the likelihood and strength of flight-responses, with the help of avoiding frustration and confusion for the horse in training (Starling et al., 2016). Besides the basic training of the horse, desensitisation is utilised to promote calmness and trust in the leader, or rider. Objects like umbrellas, wheelchairs, spray bottles, tarps, and balloons can be instruments in the desensitisation process (Soehnle, & Lamprecht, 2016, P.48f.).

In conclusion, the weighing of risks versus benefits and a minimisation of all dangers should be the main focus in considering equine based therapy for brain injury patients, just as with patients with any other disease; however, the small quote of dropouts, the all-round horse training, and the exact clarification around patients and relatives should refute mental reservations and increase acceptance. By opening the innovative and safe kind of therapy equine based therapy represents the life of many people with disabilities and their limitations could take a positive turn.

### 6.3 Cause of Brain Injury and Time Slot for Optimal Recovery

In the review, one hundred and eighty two participants were considered. Three of these subjects suffered their brain injuries through a traumatic event. The remaining one hundred and seventy nine brain injuries were caused by strokes. This makes clear that examinations of patients with TBI are currently missing. Chapter 2.1.1 provided an overview of the main causes of brain injuries in Ireland. There, it became clear that stroke is the leading cause of brain injuries in Ireland at 39%, closely followed by traumatic events at 33% (Acquired Brain Injury Ireland, 2018). Therefore, there is no proportionality in the number of investigated participants and the amount of people who experienced a brain injury through a traumatic event.

Within the discussion in chapter 6.1, the challenge for psychotherapists in the treatment of brain injury survivors was already established as being due to physical, cognitive, behavioural, or emotional limitations (Judd, & Wilson, 2002).

Further investigations have indicated the importance of positivity in the rehabilitation and recovery of TBI. There hope, optimism, adaptive coping styles and resilience are seen in connection with a positive influence on the recovery in TBI patients (Rabinowitz, & Arnett, 2018).

This shows the enormous importance and need for investigations in TBIs. The disproportionality in studies of stroke patients and TBI patients must be adjusted. The focus of future studies in the recovery of brain injury patients, with help of equine based therapy, has to turn to the injuries caused by traumatic events and to mental rehabilitation with more investigations in the field of equine assisted psychotherapy.

Another aspect which urgently needs further studies in the field of equine based therapy in brain injury patients, is the perfect timing for the best possible recovery. Within a study over thirty two months, the rehabilitation progress of independent ambulation after TBI was investigated. The result showed that the majority of patients reaching independent ambulation did that in the first three months post injury (Katz, White, Alexander, & Klein, 2004). Another study, performed with children with TBI, showed the best improvements within the first year post injury in ten neurobehavioral aspects. The same study shows further minor improvements during the following two years (Jaffe, Lincoln Polissar, Fay, & Liao, 1995). These studies suggest an optimal time frame of immediately after the onset of injury until a few months to a year afterward. In terms of neuroplasticity, neurons and areas of the brain can change in anatomy and function. These adaptive processes are shown at an early post injury stage too. The neuroplastic changes in that time frame can lead to some restoration of function in the brain (Cramer, 2000). So, equine based therapy starting in the optimal time frame after the onset of injury, insofar as the patient is in the condition to do so, can be assumed to have the best possible and reachable recovery outcome.

Furthermore, aspects such as the severity of injury and age of the patient, must be investigated as well. A study, observing the process of gaining consciousness after TBI treatments, suggests better outcomes in the rehabilitation process in mild or moderate injuries, than in severe injuries. This fact can be seen in relation to the time at which the patient was unconscious. The longer spent unconscious the more severe the injury, the worse the outcome and the harder and less successful the rehabilitation (Katz, Polyak, Coughlan, Nichols, & Roche, 2009).

Stuss, Winocur, and Robertson (1999, P.9) finally pick up the aspect of neuroplasticity in the context of the age of the patient. According to them, significant reorganisation is less complicated for a young brain than an adult brain.

They describe the process of growth making it easier for the brain to replace lost connections caused by the injury.

Both mentioned aspects, the severity of the injury and the age of the patient, find place in a study assessing the recovery of children with TBI. There, the conclusion shows that many children will significantly improve after suffering a TBI in a long-term assessment. Age was associated with the outcome as well as factors like seizures, length of hospital stay, or days on a ventilator, which can all be connected to the severity of the brain injury (Slovis, Gupta, Li, Kernie, & Miles, 2018).

In summary, all of the described aspects such as the cause of injury and optimal recovery time in relation to the severity of the injury and age of the patient show a lack of information in connection to equine based therapy. More studies are needed to, for example, investigate the ideal time slot to start equine based therapy in the context of the best possible outcome, or to investigate children and adults with TBI to compare their success with the help of equine based therapy in the rehabilitation process.

#### 6.4 Study Design, Execution, Criticism and Future Prospect

The study design in this thesis is a systematic literature review. The studies on the set topic were searched systematically with detailed inclusion and exclusion criteria and structured phases. Nevertheless, the review could have been done on a larger scale- more databases and other word combinations could have been used, still leading to the main topic.

Very few studies were found due to the research. On that basis the result of the review shows a lack of trials on the set topic. Furthermore, the few trials found point out that the studies on this topic are still in the early stages. One of the studies found was a case study, which means the gained results cannot be transferred to a larger population beyond any doubt. Also, the case study was the only one working with a child, so the results may not be transferable to adults. Another of the studies found was a pilot study, a small trial with only eight participants, working without any control group. This does not ensure comparability or transferability either. The remaining three studies worked with control groups, and all the participating patients were recovering from a stroke. This means that the results cannot be transferred beyond doubt to patients with TBI. In summary, it is difficult to generalise the found results, so further studies are urgently needed here.

Reasons for the current low degree of studies on this topic can only be suggested. Health systems in the world, for example the German health system, do not cover the costs of equine based therapy, as previously described in chapter 1 (Gemeinsamer Bundesausschuss, 2020, P.35). Trials in this field are therefore more difficult to finance as there is no financial support from the health systems. Due to this, studies are needed to increase the acceptance of equine based therapy in worldwide health systems in the future. Another suspected reason might be the acquisition of participants for the trials. As previously described in chapter 6.2, patients and their relatives do not know about the safety in equine based therapy, they might fear falls and injuries (Léveillé et al., 2017). Here too, bias could allay and acceptance amongst patients and their families could increase with larger-scale studies. Also, more detailed information should be made public to allow for equine based therapy being available to all patients as an alternative or addition to other therapies.

Despite the criticism of the small-scale thesis, and the non transferrable, beyond any doubt, studies, the literature compiled in this thesis and the found results show that every type of equine based therapy deserves more attention in the treatment of brain injury patients.

The studies found on the positive mental effects of equine based therapy in patients suffering PTSD, could lead the direction and give a reason for further research in brain injury patients, often suffering similar symptoms. The low dropout rate in equine based therapy, in comparison to conventional treatments in depression, anxiety and PTSD, creates evidence of positive outcomes and great acceptance in brain injury patients. The current stage of advanced horse training secures safety and offers opportunities for patients with more severe limitations to access equine based therapy.

Further researching the evidence found in this thesis that the horse may have a positive influence on the recovery process of brain injury patients, and taking it seriously, could lead into new approaches for the rehabilitation process. With all this knowledge, every chance to give a positive turn to the lives of those people who lose so much independence from one day to another, often unexpectedly, should be used.

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### 8.3 List of Abbreviations

ABI	Acquired Brain Injury
ADHD	Attention Deficit Hyperactivity Disorder
EAGALA	The Equine Assisted Growth and Learning Association
GCS	Glasgow Coma Scale
LOC	Loss of Consciousness
PD	Parkinson's Disease
PTSD	Post Traumatic Stress Disorder
PTSI	Post Traumatic Stress Injury
TBI	Traumatic Brain Injury