# *Heart Rates in Familiar and Unfamiliar Pairs of Young Horses and Their Riders*

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# Abstract

Heart rate is commonly used variable to measure stress in horses when used together with other variables. Synchronisation of heart rates is commonly used as an indicator of communication and relationship between the horse and the rider. In this experiment were measured differences in heart rates and behaviour in familiar and unfamiliar horse-rider pairs. Also, connection between heart rates of the riders and the horses were measured, as well as, synchronization between heart rates in each horse-rider pair. Subjects in this study were 12 three- and four-year old horses that were in basic training in Hólar University and 12 students who were training them. The riders rode the horses through a simple track in a riding hall, where they had to ride different patterns at walk, they rode once a familiar horse that they had been training themselves and once an unfamiliar horse. A bicycle was placed in the center of arena to test fear responses in the horses. In this study no difference was found in heart rates of the horses with familiar and unfamiliar riders ($T = 0.82$, $p < .46$) neither in behavioural measurements ($Z = 37.50$, $p < .09$). The familiarity of the horse didn't impact either on the heart rates of the riders ($T = 0.37$, $p < .73$). There was significant correlation between heart rates of the horses and the riders ($r = 0.55$, $p < .021$). Synchronisations were found between heart rates in several horse-rider pairs ($p < .000$). These results suggest that it is important to look for other factors than familiarity of the rider if the horse is stressed with a new rider. These results support previous findings of syncronisation and underline the importance of the rider being conscious of the effect of his or her psychophysiological state on the horse.

Hjartsláttur er algengur mælikvarði til að mæla stress í hestum þegar aðrir mælikvarðar til að mæla stress eru einnig notaðir. Samstilling hjartslátts knapa og hests er oft talinn gefa til kynna samband og samskipti á milli knapa og hests. Í þessari rannsókn var mældur munur á hjartslætti og hegðun hjá knöpum og hestum sem þekktu hvort annað og svo pörum sem ekki þekktust. Einnig voru tengsl á milli hjartslátts knapa og hests mæld ásamt samstillingu á milli hjartslátts hvers hests og knapa. Þátttakendur í þessari rannsókn voru 12 þriggja og fjögurra vetra hestar sem voru í grunnþjálfun í Háskólanum á Hólum og tólf nemendur sem voru að þjálfa þá. Knaparnir riðu hestunum í gegnum einfalda braut í reiðhöll þar sem þeir þurftu að ríða mismunandi reiðleiðir á feti, þau riðu einu sinni á hesti sem þau þekktu og höfðu sjálf þjálfað og einu sinni hesti sem þau þekktu ekki. Reiðhjól var staðsett í miðju reiðhallarinnar til að kanna ótta viðbrögð í hestunum. Í þessari rannsókn fannst enginn munur á hjartslætti í hestunum eftir því hvort þeir voru með þekktan eða óþekktan knapa ($T = .82$ $p < .46$) né í hegðunar mælingum ($Z = 37.50$ $p < .09$). Kunnugleiki við hestana hafði ekki heldur áhrif á hjartslátt knapanna ($T = .37$ $p < .73$). Það var marktæk fylgni á milli hjartslátts hesta og knapa ($r = .55$ $p < .46$). Samstilling var á hjartslætti milli flestra knapi-hestur para ($p < .000$). Þessi niðustaða gefur til kynna að mikilvægt er að leita eftir fleiri þáttum en kunnugleika ef hestur er stressaður með nýjan knapa. Niðustöðurnar styðja við fyrri rannsóknir á samstillingu hjartslátts og undirstrika mikilvægi þess að knapinn sé meðvitaður um áhrif andlegs og líkamlegs ástands síns á hestinn.

# 1. Introduction

## 1.1The Horse, Social Prey Animal

Horses are sensitive animals and their behaviour is principally guided by their instinct to flee in the face of danger. They are adjusted to be constantly aware of their environment. Another important factor that impacts the behaviour of the horse is that they are highly social animals. In the nature they live in groups with other horses, each group has its own organisation and each individual adjust their behaviour and communication with other individuals to maintain cohesion in the group. Horses are attuned to learn social communication from a young age because throughout evolution social communication has been important for horses survival, as well as effective reacting to stressors and potential threats in environment. It is important that the horse senses when other horses are nervous to be better prepared to react and flee if one horse in a group senses a predator. Psychophysiological state of humans can also have an impact on the mental and psychophysiological state of the horse. It is not exactly known what ways the horse uses to recognize the differences in humans and their behaviour as well as in their mental states.

When humans start to train horse the first thing that the horse has to learn, is that the human do not pose a threat. They habituate to humans and instead of being afraid, the horse starts to see humans as a partner, on whom it can trust, at least to some extent. In addition, teaching the horse to trust humans, another basic principle in horse training is to get the horse to understand in the best possible way what is expected from him, minimising the stress and fear in horses (McGreevy & McLean 2018). To make this possible it is important that the trainer has enough knowledge of horses' ethology and learning theory.

Horses make differences between individuals, and they form different relationship with one another (Mills & Nankervis, 2009; Snorrason, Sigurjónsdóttir, Thórhallsdóttir, & van Dierendonck, 2003). It is also often said that horses form a special bond with their trainer or owner. Familiar trainer can possibly even lower the stress level on the young horse in new situation, which the horse may see as a danger (Marsbøll & Christensen, 2015). So, the view how the horse sees humans can change from humans being predators to being something that provides the horse security. It is possible that reactions towards familiar and unfamiliar human are not the same, and that communication in familiar and unfamiliar horse-human pairs is different.

Heart rate measurements are often used to asses psychological stress in horses (Visser et al., 2002). In stress reactions the autonomic nervous system prepares the body to react and an increase in heart rate is a sign of increased activation of autonomic nervous system (Encyclopedia Britannica, 2019c). The aim of this study was to investigate if young horses have higher heart rate with unfamiliar rider than with familiar rider, as well as if the riders has higher heart rate when riding an unfamiliar young horse rather than a young horse they know. Heart rate measurements were used as indicators of stress. Also, behavior of the horses was recorded to support the heart rate measurements as indicators of stress. It was also investigated if there was synchronization between heart rates of each rider and each horse, which could indicate whether psychophysiological state of the horse and of the rider affect one another.

## 1.2 Stress Reactions

In horses, stress and fear are two closely related emotions and a stressed horse is often also afraid and ready to flee. To be able to totally understand when the horse is stressed and why, it is important to define what stress means. Even though it is often talked about stress in everyday talk, defining stress is not necessarily that simple. According to Bradshaw (2017) Hans Selye was one of the firsts who defined stress. Hans Selye wrote in 1946 that stress is *"a state of non-specific tension in living matter"*. A bit later Brett (1958) defined that stress as *"Any factor that inhibits growth and reproduction in a population"* (Bradshaw, 2017). Today there exist many a bit different definition depending on the context, and whether stress is in animals or in humans. In animal welfare stress is considered to occur when an animal is required to make an abnormal or extreme adjustment in its behaviour or physiology to cope with adverse effect in its environment (Marlin, & Nankervis, 2015). Nevertheless, the definition fits also to humans. In horses, stress can be defined to be a physiological or behavioral response, that assists the horse to cope with environmental factors that are threatening its survival (Fazio & Ferlazzo, 2003; Stull, 1997). For psychological stress in humans the definition of Lazarus (1966) is often used: "stress arises when individuals perceive that they cannot adequately cope with the demands being made on them or with threats to their well-being." (Center for Stress Management, 2019).

Horses, as well as humans, respond to stressors in their environment by several physiological, behavioural, biomechanical, immunological and anatomical mechanisms that interact with each other's (Sjaastad, Hove & Sand, 2010; Stull, 1997). The hypothalamic – pituitary – adrenalin cortex, sympathetic nervous system and thyroid system are involved in these processes (Fazio & Ferlazzo, 2003). When the horse notices a predator, it is important that his body reacts effectively enabling the horse to flee as fast as possible to avoid being eaten. Fast reaction is possible because of increase in sympathetic nervous system activity and release of epinephrine in adrenal glands (Encyclopedia Britannica, 2019b). Increase in heart rate, increase in oxygen delivery to the brain, dilated blood vessels in skeletal muscles and increase in blood glucose level are physical reactions that are built up in the sympathetic nervous system in stress reaction, allowing the body to react instantly (Encyclopedia Britannica, 2019a). In humans there is also strong correlation between heart rate and implicit stress (Ricarte, Salvador, Costa, Torres, & Subirats, 2001). All the physiological and cognitive processes connected to stress reactions are effective at helping the horse to remove himself from dangerous situation and avoiding the same danger in future (Starling, Branson, Cody, & McGreevy, 2013).

## 1.3 Nervous System

Mammalian nervous system have three main functions: receive sensory information, integrate sensory information to other information like previous experiences and acting models and to build up motor responses (Encyclopedia Britannica, 2019d). Sensory neurons carry sensory information of the danger through peripheral nervous system to the central nervous system (brain and spinal cord) which then transmits the information through the body, preparing the body to react (Sjaastad et al., 2010). Thalamus is the brain area that is locates in diencephalon. It coordinates activities of the autonomic nervous system and the body's other autonomic functions and homeostasis (Sjaastad et al., 2010) In the thalamus happens the first procession of sensory information, and the main function of Thalamus is to transfer and modify sensory information and connect it to the cortex (Sjaastad et al.,2010). Integration of information, like previous experiences and acting models, to sensory information happens in cortex (Sjaastad et al., 2010). The cortex is in charge of cognitive information processing, and conscious procession of information happens there (Leblance, 2013; Sjaastad et al., 2010).

After receiving information and after processing it either unconsciously in autonomic nervous system or consciously in the cortex, humans and animals react in the most suitable way to the situation. So, the behaviour can be rapid autonomic reactions or conscious decisions, depending on what is best to do in certain situations. Because the horse is a prey animal his behaviour is largely determined by rapid flight response for unknown and potentially dangerous stimuli whereas human reactions are determined more by conscious information procession.

Nervous system can be divided into somatic and autonomic nervous system. Somatic nervous system produces, for example, voluntary body movements (Sjaastad et al., 2010). The autonomic nervous system is involuntary and works without conscious directions. The job of the autonomic nervous system is to maintain body's homeostasis and prepare the body to react fast without conscious consideration in case of danger (Sjaastad et al., 2010). Therefore, Autonomic nervous system is divided into sympathetic and parasympathetic nervous system (Leblanc, 2013). Parasympathetic nervous system is mainly activated during rest and it is responsible for example digestive secretions. Activation of parasympathetic nervous system decreases in instant danger and in acute stress reactions. In general, increase in sympathetic activity stimulates other organs and inhibits others, making the body more able to respond to threat (Sjaastad et al., 2010).

## 1.4 Heart Rate

Heart rate is primarily regulated by the balance between the slowing influence of parasympathetic nervous system and the accelerating influence of sympathetic nervous system (Sjaastad et al., 2010). When mammal is stressed the whole sympathetic nervous system is activated and widespread fight-or flight response is formed. Epinephrine, also called adrenaline is a hormone that is released in acute stress reactions (Encyclopedia Britannica, 2019b; Sjaastad et al., 2010). It boosts cardiac output and increases heart rate. When mammal is stressed breathing quickens which results in increased blood supply transporting extra oxygen and glucose to skeletal muscles and to the brain making the body more able to react fast (Encyclopedia Britannica, 2019b; Sjaastad et al., 2010). At the same time the activity of parasympathetic nervous system decreases; digestion slows down, because the blood flow is mainly to skeletal muscles instead of organic muscles. Also, the body's immune response is inhibited. This makes the mammals that are constantly under stressors more vulnerable for diseases (Sjaastad et al., 2010). A healthy heart is able to vary its output according to the needs of the body and in heavy physical activity or in instant danger cardiac output can be many times greater than in rest (Sjaastad et al., 2010).

In general, larger animals have lower resting heart rate than smaller animals (Sjaastad et al., 2010). In horses the resting heart rate is normally between 25 to 40 beats per minute (Marsland, 1968) and in humans approximately 70 beats per minute (Sjaastad et al., 2010). Though, resting heart rete varies considerably between individuals of same species (Sjaastad et al., 2010). Older individuals have lower resting heart rate than younger ones (Betros, McKeever, Kearns & Malinowski, 2002; Sjaastad et al., 2010). Physically fit animals have lower resting heart rate in general than less fit individuals (Sjaastad et al., 2010). In physically fit humans, the resting heart rate can go as low as 40 beats per minute (Sjaastad et al., 2010). There is no clear consensus if training has an effect on resting heart rate in horses (Marlin & Nankervis, 2015)

Fear is associated with raising heart rate of the horse rapidly to over 100 beats per minute (Evans, 1994). In addition to heart rate, also other physiological measures such as heart rate variability, cortisol release, eye temperature and different behavioural measurements have been used when measuring stress (Hall et al., 2013; Hockenhull, Young, Redgate and Birke, 2015; Keeling, Jonare,and Lanneborn, 2009; Marsbøll & Christensen, 2015). It is important to remember that all of these parameters are connected also to exercise level. When exercise level is controlled, heart rate is suggested to be suitable measure of stress and emotional reactivity (Von Borell et al., 2007; Hall et al., 2013). More reliable measurements can be done when more than one variable is used. For example, behavioural measurements are often used to asses stress in horses together with heart rate measurements (Yarnell, Hall and Billett, 2013).

## 1.5 Behavioural Measures Assessing stress

An evidence-based ethogram to measure reliably horse's behaviour doesn't yet exist, despite that, there is a demand for standardized behavioural tests (Visser, Karlas, Van Deurzen & van Reenen 2009a). Nevertheless, developing a comprehensive ethogram to evaluate the behaviour of the ridden horse is not straightforward (Hall & Heleski, 2017). McGreevy and McLean (2018) suggest, that in order to accurately interpret behaviour of the ridden horse it should be compared to horses' natural behaviour and natural ways of communicating. After all, this approach depends always on the accurate interpretations of observed behaviour. To validate observed behaviour there has been made comparisons between observed behaviour and physical measures, like heart rate and cortisol secretion (Hall & Heleski, 2017). Nevertheless, the relationship between behaviour, mental state and physiological response is a complex one, and physiological measures do not always correlate with behavioral observations and comparisons of these measures are lacking consistency (Yarnell et al., 2013). McCall, Hall, Mc Elhenney and Cummins (2006) suggest that combining physiological variable, like heart rate and more than one behavioural variable is the best existing indicator of the reactivity and fear in the horse.

When talking about the behaviour of the ridden horse it is crucial to take into account also the behaviour of the rider as well as the synchronisation between these two (Hall &

Heleski, 2017). When the rider is more skilled and the horse more trained signals in the communication become less visible and more difficult to observe. When the communication between the horse and the rider is harmonious horses are more compliant than if the horse-rider combination doesn't work well together (Munsters, Visser, van den Broek, & van Oldruitenborgh-Oosterbaan, 2012). If the training has been inappropriate, and the horse is experiencing discomfort or fear, or the rider signals are unclear, it is more likely that conflict behaviour occurs (Hall & Heleski, 2017). When measuring behaviour of the ridden horse it is crucial to define conflict behaviour. In animal behavioural literature conflict behavior refers to actions when two or more motivational systems are in contradiction (Hall & Heleski, 2017). For example, when the rider is asking the horse to move forward over a bridge, and the horse is motivated to respond the rider's signal to avoid the riders leg aid but at the same time he doesn't want to go over a bridge that he is afraid of and as a consequence the horse starts to rear. So, rearing is conflict behaviour resulting of conflict in two motivational systems.

The kind of behavioural measurement that are suitable depends on what kinds of situations the behaviour is assessed in, or which is the training level of the assessed horse. Hockenhull and Creighton (2013) were assessing the ridden horses' behaviour in British leisure horses. They were using measures, like shying, pulling/ leaning on the bit, jogging when asked to walk, moving before asked when rider is mounting, resisting slowing down when asked. When it was measured behaviour in horse – rider matching tests, was used measurements of nervousness/ excitement, neck carriage, stride length and ear and head position (Munsters et al., 2012). Visser, VanDierendonck, Ellis, Rijksen, and Van Reenen (2009b) were researching effect of training methods in horses behaviourr. They used measures of body tension, head position, lip movement, teeth grinding and tail swishing. Von Borstel et al., (2009) studied impacts of rollkur (forced hyperflexion of horse's neck) on welfare and fear in horses. They were using measures like: attempts to buck, head-tossing, tail swissing, changes in pace, bouts backing up, crabbing (the horse moves sideward–forward, the hind legs of the horse travel on a line beside the front legs, rather than in a straight line), abnormal oral behaviour like opening the mouth, ears fixed backward, visibility of eye white and snorting. It was also observed if the rider used whip or kicked the horse in an attempt to make the horse move forward.

## 1.6 Stress and Learning

For the welfare of the horse it is important to be able to asses when the horse is stressed and doesn't feel comfortable. Stress is determined by high arousal. High arousal makes the horse very responsive and ready to flight. It can also make the horse to be more responsive for rider's aids, but in the other hand if the aids are too big or unpredictable high arousal can lead to skittishness or unpredictable responses if the horse judges the aids unsafe (Starling et al., 2013). Behaviour of frightened horse can be unpredictable, and unpredictable behaviour can be dangerous for the horse and the rider or other people around the horse (McGreevy & McLean, 2018). When the horse is stressed (over optimal arousal level for learning), his problem-solving skills and concentration is weaker, and he doesn't learn as effectively (Starling et al., 2013). This is why it is so important to minimise the horse's tendency to flight.

It is recommended to use training and handling procedures that are suitable for each individual horse and assessing stress and welfare correctly in different horses is important. (Borstel, Visser, & Hall, 2017). If the amount of fear response in the horse is too big the horse is unresponsive to other stimuli like riders' aids because the focus of the horse is on the threat (McGreevy & McLean, 2018). Though the goal in horse training is to have stress level of the horse low, stress is not only maladaptive. It is also advantageous; Optimal learning requires a special, narrow range of stress. If stress level is very low, the horse can also be unfocused and not reactive and therefore also unresponsive for rider's aids (McGreevy & McLean, 2018). Reactivity is related to horses' keen observation of the body language of other species (Williams, 1999). Horse training is based on horses' reactiveness to human behavior and getting the horse to understand what the trainer wants by using body language. (McGreevy & McLean, 2018). Though, the trainer's physical appearance and behaviour can also create stress in the horse, if the horse gets confused, and activate horse's natural flight response to escape the situation (Williams, 1999).

## 1.7 Importance of Using Learning Theory and Ethology of the Horse in Training

It is important that riders and horse owners have enough knowledge about horses, their ethology, learning theory and their adaptive behavioural tendencies, to minimize stress in horses, horse related accidents as well as to increase horse's welfare. The training of a horse is predominantly influenced by the horse's learning processes and ability, the rider's biomechanics, balance, knowledge and skill and the horse's temperament and the history and training environment of the horse (McGreevy & McLean, 2018). The effectiveness of training depends on correctly and accurately manipulated training environment, aids, reinforcers and punishers (Creighton, 2007). A good trainer also recognises the motivational state of the horse and use that to capture and direct horses' behaviour (Creighton, 2007).

Right timing and consistency are important in training to avoid confusion in the horse and it is important that reinforces reliably follow the behavioural responses. For example, when the rider asks the horse to move to the side and the horse does what was asked the rider relief the pressure of his aids immediately. It is also important that the same aids always mean the same thing, and to train only one response to one signal and give one clue or aid at a time (Starling et al., 2013). Confusion in horse can lead to unexpected behaviourr and simultaneous aids can lead to inhibition of both signalled behaviours (Starling & et al., 2013). When the horse starts to inhibit the signals of the rider, it is likely that the rider start to use event stronger signals or punish the horse, which may in turn cause or even increase conflict behaviour and anxiety in the horse.

Consistency is important in training because it provides predictability and persistence and reduces frustration in the horse and makes the horse to be more relaxed (Starling et al., 2013). To build trust relationship with the horse it is necessary to achieve calmness in the horse. The way in which the trainer moves, speaks and how he interacts with his horse should produce consistency and makes the horse calmer (Starling et al., 2013). Consistency should produce sensitization and inconsistent training leads to insecurity in the horse and if the horse starts to habituate the stimulus it is possible that the horse starts to be unreactive (Starling et al., 2013). It is important that it is clear for the horse what is wanted and that aids for the same thing don't change between days or situations. Consistency and right timing come with experience and that's why it is important that when dealing with young horses the trainer has enough knowledge and experience.

## 1.8 Learning Theories

Learning theories are based on the horse's ethology. Habituation, sensitisation, classical conditioning, basic operant conditioning and chaining of operant responses are within the cognitive capacity of the horse (McGreevy& McLean, 2018). By habituating the horse learns to tolerate its surroundings instead of being afraid. Habituation is the simplest form of learning (McGreevy & McLean, 2018). In habituation the response decreases to the stimuli after exposure to it. To untrain fearful stimuli, the trainer needs to habituate the horse for all innocuous features in its local environment (McGreevy & McLean, 2018). The horse needs to habituate to people walking around him, having the pressure of the saddle on his back and the pressure of the girth, bridle, bit and so on. In foundation training the horse has to habituate to have human on his back. The horse should be exposed to low thresholds of fearful stimuli at once and gradually increase the stimuli in stages. Too large stimuli and fear response at once can have opposite effect and make the horse to be even more afraid.

Horses substantial tendency as a prey animal to avoid aversive stimulus is not only something that is tried to diminish or decrease in horse training, but it can also be used to get the horses do what the trainer or rider wants. By using operant conditioning and negative reinforcement, the horse is taught, for example, to go forward of the pressure of the riders' leg. In the first phase the horse learns through trial-error -learning (McGreevy & McLean, 2007). When the rider puts pressure on the horse, by using his leg on the side of the horse, the horse tries to do something and once the horse does the right thing the rider relieves the pressure and the horse gets reward. In the second phase the horse has learned what the leg aid means and he doesn't need to try different options to relief the pressure and he can answer correctly in the first place. The process when the horse starts to respond to a smaller cue is called sensitization (Starling, McLean & McGreevy, 2018).

Riding and the use of riders' aids are based on negative reinforcement (McGreevy, & McLean, 2018) Reinforcer is an action or event that increases the frequency of particular behaviour of which it follows. In negative reinforcement aversive stimulus is presented and when the horse reacts in a way the trainer wants the negative stimulus is removed. In positive reinforcement the trainer asks the horse to do something and the horse gets reward after doing the right thing (McGreevy, & McLean, 2018). Clicker-training is an example of a method that is based on positive reinforcement. Reinforcements, positive and negative, make response more likely in future. According to the learning theory, the stimuli that meets the behavioural needs of the horse are primary reinforcers. These needs are food, comfort and companionship (McGreevy, & McLean, 2018).

When using operant conditioning in horse training the timing of the cues and rewarding is the main thing. They are important to get the horse to understand what the trainer wants and to avoid confuses. Confusions can make the horse to be nervous or unsensitive for the aids. In severe cases confusion can lead to learned helplessness (McGreevy, & McLean, 2018). Learned helplessness means that the horse feels like he cannot effect on his environment, no matter if he responds the rider's aids or not, causing the horse to become dull.

In correct equitation, the pressures provided by the reins and rider's legs begin with the lightest pressures and smoothly but rapidly increase to a threshold that prompts a response (McGreevy & McLean, 2007). When the horse has learned leg and rein aids the seat aids can be connected to them. This is acquired through the process of classical conditioning. Because the seat aids in this case are diminutive versions of the original pressure (leg and rein), seat aids can be considered as discriminative stimuli (McGreevy & McLean, 2007). Seat works as discriminative stimuli because the behaviour or the reaction was first reinforced through operant conditioning and negative reinforcement. Classical conditioning is used also when training in hand when the horse learns for example voice command and to walk in the lead rein (McGreevy & McLean, 2007).

All riding and training are based on progressive improvements in responses and each step should differ only slightly from previous step allowing the horse to have many successes in learning process (Starling, McLean, & McGreevy, 2016). These improvements evolve trough process called shaping (McGreevy & McLean, 2007). This shaping of responses culminates in "free, rhythmically moving horse with long topline who follows the rider's aids without tension or resistance and is likely to improve positive emotional states associated with training." (Starling et al., 2016).

Understanding the learning theory and ability to read the horse is especially important when training and dealing with young horses, because young horses are often more vulnerable for misunderstanding and getting confused. Knowledge and experience are important factors to get the horse understand what the human wants and to get the horse to trust the human, and thereby also necessary to be able to build up successful communication and relationship with the horse.

## 1.9 Importance of experience

In general handling reduces stress experienced by the horse (Fuerix et al., 2009 b; Lansade, Bertrand, & Bouissou, 2005; Visser et al., 2002). When the horse habituates to training and training environment, the stress decreases. Even though, previous experiences of the horse as well as of the human have always an effect on how the relationship and communication form to be (Hausberger, Roche, Henry & Visser, 2008). How the trainer has been handling the horse has an effect on how the horse perseives humans, and how willing the horse is to be in human company (Fureix et al., 2009b). The relationship between horse and his daily caretaker has an effect on horse's reaction also to unfamiliar people (Hausberger & Muller, 2002). Relationship between horse and human is built upon success in the communication (Hausberger et al., 2008). To make the communication successful it is necessary that the trainer has sufficient knowledge about the ethology and learning of the horse. This is why sufficient knowledge and experience are necessary to build up good relationship with the horse. Anyway, there is always individual differences in horses, as well as in humans, and the right way of communicating with each individual horse is not exactly the same (Hausberger et al., 2008). This is why exact formula of how the horse should be trained cannot be created.

Cues and aids should be broadly consistent among riders so that the horse doesn‘t need to learn a new set of cues for each rider (McGreevy & McLean, 2018). Yet, there is always differences in human-horse communication between individuals and ecpecially between experienced and unexperienced trainers and riders (Meyers, Bourgeois, LeUnes, & Murray, 1999). Humans send lots of unintentional signals, and especially unexperienced riders and handlers are less capable controlling the signals they are sending for the horse. Good and experienced rider is in control of his body and movements as well as of the mind, and he is also prepared to deal with different reactions and mindsets of the horse (Kydd, Padalino, Henshall, & McGreevy, 2017).

## 1.10 Effect of temperament and attitudes, individual differences in communication

Interaction with horses and humans are result of interplay of two individuals. Temperament of the horse and temperament and skills of the human are important factors in this interplay. The communication between horse and human occurs through voice, body posture, hormones and pheromones, as well as through non-verbal communication (Baragli, Gazzano, Martelli, & Sighieri, 2009; Rochais et al., 2014; Sankey, Henry, André, Richard-Yris & Hausberger, 2011). In communication between individual human beings is differences just like in common ways of moving and using body language. Inevitably, how different people act with their horses are also at least slight differences, despite the experience of the rider. Horses are sensitive animals from their nature and they recognise these differences. Humans can behave in ways that confuse, frustrate and frighten horses, or a combination of all three. It is not clear whether the handlers' experience or is it the confidence and attitude of the handler that have the major effect on the human-horse relationship and cooperation between the horse and human. There is also recearsh of the impact of human gender on behaviourr of the horse, but differences have not been found (Henry, Hemery, Richard & Hausberger, 2005; Hausberg et al., 2008).

Horses can perceive a lack of relaxation in their handlers, and this may manifest as decreased compliance (Keeling et al., 2009). Because the horse is a highly social animal it is very sensitive to trainers' emotional states and therefore it is important to be aware of that, when being in contact with horses (Borstel et al., 2017). A calm, confident and focused rider gives consistent and clear direction to the horse through sensitive use of the aids, so, that the horse can sense safety and trust, which promotes the horse's positive attitude and calm consistent behavior. There is often differences how cooperation is between the horse and the rider despite the experience of the rider. Sometimes even with the best timing and consistency, which are important factors in horse training, some people fail to achieve calmness in some horses. This can be due to difference in attitudes (Hama, Yogo and Matsuyama 1996, in temperaments (Lloyd, Martin, Bornett-Gauci, & Wilkinson, 2007) or in the ways of communication with the horse (Hemsworth, Jongman, & Coleman, 2015). The best timing and the best amplitude of aids can also be slightly different with different horses. Temperament and reactivity of the horse can have an effect on behavior and also, on physiological factors, like heart rate of the horse (Lloyd et al., 2007).

Deficits in the management conditions (housing, feeding, possibilities for social contact, and training methods) may lead to relational problems between horses and humans (Hausberger et al., 2008). When the management conditions are suitable and correct it is more likely that the horse can form a good relationship with his trainer. Though, it is likely that the effect of management conditions goes through the human's attitude toward his horse. When the horse is considered as a friend, the human also takes better care of him (Hausberger et al., 2008). Yet, horses can also discriminate between people with different attitudes (Hama et al., 1996; Chamove, Crawley-Hartrick, & Stafford 2002). The attitudes towards the horse and how the rider perceives the horse has an effect on horse-raider cooperation (Hausberg et al., 2008; Visser et al., 2008). Recearch of Hama et al. (1996) showed that when people have negative feelings towards animals, while stroking a horse, they induce an increase of heart rate in the animal. In the study of Chamove et al. (2002) also positive attitudes towards the horse had a positive effect on horses behaviour. Presumably, attitudes of the rider have an effect on communication with the horse.

In a study of Munsters et al. (2012) heart rate of the horse was lower, when encountering challenging object that he could potentially be afraid of, when the rider- horse communication was harmonious, and the horse didn't show behavioural indicators of discomfort, than when the communication was not harmonious. It is generally considered, though, that horse- rider match influences on communication between the horse and the rider and performance in riding. The research, however, is inconsistent in the effect the horses and riders personalities on their cooperation and performance (Hausberger et al., 2008; Lloyd et al., 2007; Visser et al., 2008; Wolframm, & Meulenbroek, 2012). Lloyd et al., (2007) identified six horse personality traits that are likely to interact with rider's personality. It is possible that how the personality of the rider and the horse fit together has an effect on the relationship at least with more sensitive horses (Lloyd et al., 2007).

It is also possible that it is easier for horses to trust humans that he knows and with whom he spends time daily, because when they both know each other, the behaviourr is more predictable, and predictability creates trust (Sankey et al., 2011). When the horse and rider know each other, they can possibly work better together and there can be more harmonious communication between them. It has been reported that bonding with the horse has positive outcomes for training and welfare of the horses and of the human (Hemsworth et al., 2015; Walsh, 2009; Wipper, 2000). Researches shows that the horse is more relaxed with a familiar handler than with an unfamiliar handler (Hockenhull et al., 2015; Marsbøll & Christensen, 2015). Familiarity of the horse and the handler appear to have effect on heart rate of both horses and handler, so that the heart rate of the horse is lower with familiar handler than unfamiliar handler (Hockenhull et al., 2015). There is also a research showing that the familiarity of the handler has a positive effect on horses' behaviour during handling (Marsbøll & Christensen, 2015). The study of Marsbøll and Christensen (2015) was made on young, three years old Icelandic horses. Young horses can be more sensitive for new and different things and people, rather those he is used to, since young horses are often more reactive than older ones. It is likely that the familiarity of the rider could have an influence on horse's heart rate and behaviour when the horse is ridden but research has focused on handling situations and research has not been made before in young horses during riding.

### 1.11 Familiar Trainer as a Safe Base?

Domestic horses are capable in cross-modal recognition of their trainers from unfamiliar people (Proops & McComb, 2012; Sankey et al., 2011). Horses form social bonds with each other. The bond between a foal and a mare is special because the mare offers a secure base for the foal and the foal feels itself safe and secure close to his mother (Newberry & Swanson, 2008). Ijichi, Griffin, Squibb and Favier (2018) theorised that since domestic horses depend on human caregivers to a certain extent some level of attachment-type bond may exist between the horse and the care giver of the horse. Though, in the study the human-horse bond was not important for effective handling and familiarity of the handler did not affect behaviour or physiological indicators of stress. In the research by Ijichi et al., (2018) three twenty years old horses were used. It is possible that the results would be different with younger horses. Because of small sample size, it is also possible that the sample was not representative. Older horses have usually been in training several years, and they are often used to be handled by different people. It is possible that the horse-human bond is not be as decisive in older horses as in younger horses.

Research has not been made before in young horses who have only had one trainer. Young horses are potentially more sensitive to differences in communication than older horses, because they have not yet formed a stabile and generall concept of humans as safe, consistent and predictable. It is possible that the young horses trust better familiar handler or rider, who uses signs and aids exactly in the way the horse is used to, weights same amount the horse is used to carry and who have the same body language, and the same tempo in communication that the horse is used to, than unfamiliar handler or rider whos behaviourr is less predictable for the horse.

It can be presumed that riders show more signs of physical stress with an unfamiliar horse, especially with a young one of whom they don't know anything about, and the rider can be in a danger of accident if the horse behaves in an unpredictable way like bucking. The stress is likely to be more when dealing with young horses, who often behave more according to their natural instincts; being afraid of people and trying to get rid of that danger by bucking or fleeing and running (McGreevy & McLean, 2018). Though, in humans also a contrary effect has been observed; The handlers had higher heart rate during in-hand task with familiar than with an unfamiliar horse in the studies by Hockenhull et al. (2015) and von Lewinski et al. (2013). Nevertheless, this is likely to be due to higher performance anxiety with familiar horse. In current experiment there were no audience and the tasks they needed to perform were simple, so it is not likely that the riders were experiencing performance anxiety.

## 1.12 Synchronisation

Humans and horses are living creatures that interact with each other's through complex communication. Horses are very adept at sensing what is going on around them. There is evidence showing that horses are able to perceive psychological and physiological state of human, and that heart rate of the human can have an effect on heart rate of the horse (Fureix, Jego, Sankey, & Hausberger, 2009a; Hama et al., 1996; Keeling et al., 2009). In a study by Keeling et al., (2009) the riders and handlers were told that an umbrella would be opened as they rode or led the horses pass the assistant with an umbrella. The umbrella was not opened but the heart rate increased in both, handlers and consequently also their horses.

Heart rate synchronization gives a physiological perspective to investigate horse-rider relationship. In the study of Hockenhull et al., (2015) synchronization of heart rates was investigated in handling tests in familiar and unfamiliar horse-rider pairs. Seventeen horses, who were aged between two years to twenty-five years were investigated. There were found synchronisations in heart rates in three familiar and two unfamiliar horse-rider pairs. In the study of Bridgeman, Pretty and Terry (2011) relationship between dressage horses and their riders was investigated. Heart rate synchronisation was found in training situations but not in competition situation. Significant synchronisations were found in 13 of 17 horse-rider pairs.

Yet, the relationship between horse and human heart rate is not straightforward (Hockenhull et al., 2015; Merkies et al., 2014; von Lewinski et al., 2014). The study of Hama et al. (1996) suggests an association between the psychological orientation of the human and the heart rate of both horse and human. Negative attitude and higher heart rate of the human when stroking the horse had an impact on the heart rate of the horse but positive attitudes did not have an effect. In addition to attitudes, also environmental conditions impact on the degree of heart rate synchronization. In a study conducted by Lewinski et al., (2014) increase in stress level and in heart rate in the rider in a competition situation did not lead to increase in heart rate of the horse. Similar results were found in a study by Bridgeman (2009). Synchronisations between the heart rates of the horse and of the rider were stronger in training than competition environment (Bridgeman et al., 2011). The riders stress was higher in competition situation and it has been suggested that stress inhibits the rider’s ability to communicate with his horse and thereby the relationship and synchronization were lower (Williams, 1999). Also, the temperament of the horse, as well as of the rider, can have effect on the stress level and heart rate of the rider and of the horse as well as on the synchronisation. When the horse was evaluated to be nervous as his temper, the horse had higher heart rate and the heart rate and somatic anxiety of the rider were also higher (Bridgeman et al., 2011). Earlier studies have mainly been conducted using mature horses. The way how young and mature horses react and communicate with humans can be different. It is possible that the effect would be different in young horses and in unfamiliar horse-rider pairs. The age of the horse and how much experience he has of different human contacts and of humans in general can have effect on heart rate synchronization.

Riders often consider the relationship with their horses as emotional (Hausberger et al., 2008). So, it can be considered that when the rider and the horse are familiar with each others the relationship between them and attitudes are different than when they don‘t know each other. It is also possible that familiar rider provides security for the young horse. Familiarity is also known to have positive effects on behaviourr during handling in horses (Marsbøll & Christensen, 2015) and the heart rate and stress level is potentially lower when the horse knows the rider (Hockenhull et al., 2015). The synchronisation has not been investigated before among young horses who are in basic training. The aim of this study is to measure if the horse and the rider have higher heart rates when they are unfamiliar to each other compared to when they are familiar to each other, while they perform a short ridden track in walk. The first hypothesis is that the situation is more stressing for the horse with an unfamiliar rider, and that heart rate of a horse is higher with an unfamiliar rider than with familiar rider. The second hypothesis is that rider has higher heart rate with an unfamiliar than with familiar horse. It will also be investigated if there is connection between the heart rates of the young horse and the rider. Hypothesis number three is that there is a correlation between the heart rates. Correlation between the heart rates will be investigated in whole sample and separately in familiar and unfamiliar pairs by using average heart rates of each horse and rider. Heart rates of each horse rider pair will be investigated also separately to find if there exists synchronisation in heart rates. To support the measurements of heart rates, also behavioral measurements of the horse will be used, presuming that when the heart rate is higher the horse shows also more problem behaviour.

# 2. Material and Methods

## 2.1 Subjects

The subjects in this research were 12 Icelandic horses and 12 voluntary riders who had gone through a seven weeks foundation training course. The horses were trained, in Hólar University in Iceland during the autumn semester, 2019. Hólar University is an institution offering graduate education in equine science. Equine science department offers three years long B.Sc. education in riding and riding instructions (Hólar University, 2019). The second-year students were participating in a course of young horse training. All the students had experience of horses and they will be professional horse trainers at the end of the present year. Ten of the riders were females and two males. The riders were between 20- and 24- years old. The teachers in the basic training course were qualified horse trainers and riding instructors.

Each horse had had one second year student as a trainer in the foundation training course. All 12 horses continued onwards to a basic training course with the same rider. Two to three weeks had passed of the basic training course, and the horses were nine to ten weeks trained in total when the experiment took place. Seven of the horses were mares and five geldings. All the horses were born in 2015 or 2016, being three to four years old in this experiment. The treatments were performed after one and two weeks had passed since the basic training course began. The horses had been sent in training to Hólar University from different horse farms in Iceland.

All the horses who participated in the experiment had gone through the same training program and were trained by using the same methods in Hólar University. In the regulations, horses who are sent in training in Hólar University should be halter trained. Otherwise, horses in Iceland are often not much handled before they start foundation training at the age of three or four. This makes it likely that the horses in this experiment didn't have much previous experience of people when arriving in training in Hólar.

The experiment was introduced for the students in a class. Enrollment paper for the experiment was set to go around in the class. All the volunteers could sign during the class by writing their names on paper. Of 24 students twenty signed themselves in the study. It was possible to pick up 13 volunteers so that time schedules fitted together with riding classes and other studies. One horse became lame and was not able to take part in the experiment. Eventually 12 riders and 12 horses took part in the experiment.

All the riders performed the experiment once with the horse that they had foundation trained from the beginning and once on a horse that they had never been on before, and some other student from the class had been training. Consequently, all the horses as well as riders performed the experiment twice; once as a familiar pair and once as an unfamiliar pair. Before taking part in this experiment, the horses had been ridden a few times by a teacher of the course, and once by a judge, who had been judging the exam at the end of foundation training course. Otherwise they were used to have only one trainer riding them.

The horses were housed in individual boxes (1,9m x 3,4m). Bedding in the stables was sawdust pellets. The horses were set out daily with other horses. Horses were fed three times a day with grass forage, amount varying after individual needs. Vitamins and minerals were given for the horses daily and the horses had unlimited access to water and salt.

## 2.2 Experimental design

The experiment was performed in four days between 9:45 and 14:00 which is typical time for these horses to be trained. All the horses took participated in the experiment in two days. Half of the horses participated first with a familiar rider and half of the horses with an unfamiliar rider, as well as half of the riders participated first with an unfamiliar horse and half with the horse they were training, to ensure that it would not skew the results if the horses or riders were more nervous in the first experiment day. There was one or two days between the dates that horses performed the experiment. None of the horses had been trained earlier during the experimental day. The horses went through the experiment two at once, if there was only one horse and rider at once then another horse, who was of similar age and training level as the horses in the experiment, was taken into the riding hall and lead around the arena whilst the other horse was performing the test.

The track was filmed to facilitate observation of the horse's behaviour in different tasks. Observations were also made if horses were obviously nervous at some point of the experiment before the filming was started. A camcorder was placed at the end of the riding hall, so, that it was filming both of the riders and horses who were performing the experiment at the same time. The timers of heart rate monitors were matched with video recorder to enable matching the time points when the horses and riders were in certain task and the heart rate in that moment. It took about three minutes to perform the experiment. All the tasks were done in the same place for each horse-rider combination.

Each rider went to get the horse they were doing riding in the experiment from the stable and bridled it and led the horse to be tacked up in the area where they are used to being tacked up. After that the riders led the horses to the riding hall. In the riding hall the riders rode a small track which is introduced more accurately in appendix1. First the riders led their horses one circuit of the outside track of the arena in the riding hall. Then the riders mounted the horses, asked horses to move forward when they were ready, rode circle, rode serpentine, rode pass a bicycle which was placed in the center of the riding arena (in X), stopped the horses, waved a hand three times and dismounted the horses. The experiment was considered finished, and filming ceased when the riders dismounted the horses. Measurement of the heart rates were stopped before the riders and horses left from the riding hall.

## 2.3 The Heart rate monitor

Heart rates of the horses and the riders were recorded by Polar Vantage M Heart rate monitor (Polar Electro Oy, Kempele, Finland) in every second. In the first experiment day heart rate monitors were set on the horses in their stables by using a surcingle. The electrodes were placed on the left side of the horse behind the withers under the saddle and under the girth of the saddle. Areas where the sensors were placed were moistened with saltwater to aid conductivity. Heart rates were recorded in every second.

Due to lack of connectivity in the heart rate monitors some adjustments had to be done for rest of the experiment days. A possible explanation for the dysconnectivity was that the electrodes were not attached well enough on horses' skin and that they were moving under the surcingle and under the saddle during the experiment. In next three days the electrodes were placed on the horses while the riders were saddling up the horses. The electrodes were placed on the same place as was done in the first experiment day and the hair was moistened with salt water, like was done in the first day. A surcingle was not used, and the electrodes were placed directly under the saddle, behind the withers and under the barrel between horse skin and saddle girth, trying to attach the electrodes well between the skin of the horse and the saddle, to minimize the movement of the electrodes during the experiment. After the electrodes were placed on the horses 5 minutes pause was allowed to let the horse reach resting heart rate again, in case attaching the electrodes had had effect on the heart rate.

The riders placed an electrode by an elasticated belt on their chests by themselves. The riders had one monitor on their left hand and one on the right hand, one recording their own heart rate and one heart rate of the horse. Heart rate was measured every second.

## 2.4 Behaviourral measurements

A rudimentary ridden horse ethogram was developed for this study (appendix2) based on ethograms in the studies of von Borstel (2009) and Hockenhull and Creighton (2013). Horses in this training level show resistance behaviour often by not going where the rider asks, or by trying to escape aversive stimuli in one way or the other. So, this kind of behavioural measures were used to go were chosen to this experiment. Scores were assessed visually from video recordings by qualified horse trainer and riding instructor, who didn't know which pairs were familiar and which unfamiliar. If the horse showed specific resistance behavior, that behavior was marked in the ethogram with X.

## 2.5 Statistical Analysis

The data from the heart rate monitors was transferred to an online program (flow.polar.com) where it was possible to see the heart rate curve and follow heart rate changes in every second. In these investigations it turned out that the measurements of the horses in the first experiment day were not reliable. First all data was transformed to excel and from excel all the data used in statistical analyses was transferred to Minitab version 19.2 for Mac, in order to perform the statistical analysis.

The sample size of the horses decreased considerably due to unsuccessful heart rate measurements and dysconnectivity. Of 24 heart rate measurements of the horses, seven were unusable leaving 17 heart rate measurements for further investigation. All the seven unreliable measurements were of horses which performed the experiment in the first day. For that reason, two measures, one with familiar rider and one with unfamiliar rider were available from five horses (instead of 12 horses) and the sample forced to become quite small. Because of the modification of experimental design, the first part of the heart rate measurements of the first day were disposed, so that they were comparable with the measurements of rest of the experiment days.

Prerequisites for the variables to be normally distributed in order to be able to use parametrical statistical analyses were tested. Normality assumption was tested by using Kolmogorov-Smirnov. P-value in Kolmogorov-Smirnow test was $> 0.150$ in both familiar and unfamiliar groups. Also, the sample of the horses was following normal curve among Kolmogorov-Smirnov test, $p > 0.06$ in the sample of horses with unfamiliar rider and $p > 0.08$ in the sample of horses with familiar rider. In addition to Kolmogorov- Smirnov test, visual investigation of graphics; scatterplot, histogram and box-plot diagram were done to confirm that the variables were close to be normally distributed.

Because the prerequisites to use parametric analyses were fulfilled, paired T-test was used to measure differences in the heart rates of the horses with familiar and unfamiliar riders as well as to investigate differences in heart rates of the riders with familiar and unfamiliar horse. Even though some of the horses started the experiment with unfamiliar rider and some horse with familiar rider to avoid order effect, it was investigated if there was difference in heart rates depending on if the horse and rider performed the experiment for the first or for the second time. Paired T-test was used to compare the heart rates between the days. No effort was made to assert bias towards female riders.

Behavioural variables were investigated by using Wilcoxon Signed Rank test, so that sum was calculated for conflict behaviour for each horse separately with familiar and unfamiliar rider and the values were compared together. Differences in behavior between the days were also tested by using Wilcoxon Signed Rank Test.

Average heart rate was calculated for each horse with familiar and unfamiliar rider and for each rider with familiar and unfamiliar horse. Pearson correlations were calculated for the average heart rates in the whole sample, and separately for the average heart rates in the sample of unfamiliar pairs and in familiar pairs. Pearson correlations were also calculated for heart rates of each horse-rider pair by using heart rate measures in each second.

## 3. Results

Average heart rates of the horses varied from 56 to 127 beats per minute and average heart rates of the riders varied between 65 to 157 beats per minute. Hypothesis 1: Young horses have higher heart rate with unfamiliar rider than with familiar rider, was not supported by the data T = .82, p < .458. Hypothesis 2: Riders have higher heart rate with young unfamiliar horse than with young familiar horse, was neither supported T = .37, p < .734. There was no difference either in behavioural measurements in horses with familiar and unfamiliar riders Z = 24.00, p < .906.

There was significant correlation between the average heart rates of the horses and the average heart rates of the riders when all the horse rider pairs were investigated in one group r = .55 (p < .021). When familiar and unfamiliar groups were investigated separately significant correlation was found between average heart rates of familiar riders and familiar horses r = .684 (p < .042). There was no significant correlation between heart rates of unfamiliar riders and unfamiliar horses r = .525 (p < .181). Of all individual horse-rider pairs there were significant correlations in heart rates in all unfamiliar pairs (n = 8), and in five of nine familiar horse rider pairs. Correlations are shown in table 1.

**Table 1** Correlations for each horse rider pair

| Horses | Familiar rider | | Unfamiliar rider | |
|---|---|---|---|---|
| | r | *p* | r | *p* |
| 1 | – .043 | .523 | .320 | .000 |
| 2 | –.075 | .232 | .371 | .000 |
| 3 | | | .487 | .000 |
| 4 | | | .363 | .000 |
| 5 | .195 | .002 | | |
| 6 | | | .340 | .000 |
| 7 | .672 | .000 | | |
| 8 | .248 | .000 | .476 | .000 |
| 9 | –.081 | .158 | .735 | .000 |
| 10 | .084 | .159 | .529 | .000 |
| 11 | .362 | .000 | | |
| 12 | .714 | .000 | | |

There was no effect of order of track completing. Heart rates didn’t differ between the first and second time the horses performed the experiment T = .8, p < .44. There was no difference either in behavioural scores between the days Z = 37.50, p < .086.

# 4. Discussion

## 4.1 Effect of Familiarity of the Rider on the Horse

In this study familiarity of the rider didn’t effect on heart rate in young horses. There is not much previous research of familiarity of the rider on the horse, and the few existing studies have observed horses in handling not in riding. The results of previously made studies are contradictory (Hockenhull et al., 2015; Marsbøll & Christensen, 2015). In the study of Hockenhull et al., (2015) the familiarity of the handler had an effect on heart rate of the horse. In the study of Marsbøll & Christensen, 2015 heart rate was not affected by familiarity of the riders, but horses showed less fear response with familiar than unfamiliar rider.

It is possible that as a consequence of small sample size the effect didn’t appear in this research. It has also been shown in research that the experience and knowledge of the rider effects on how the horse understand the rider and consequently how secure the horse feels with the rider and how the relationship between them is formed (Hausberger et al., 2008). All the riders in this study had been studying to be professional horse trainers and their experience could be considered to be roughly at the same level. In the study of Hockenhull et al., (2015) human subjects were different kind of horse people and the experience was not taken in consideration. It is possible that because of similar experience level of the raiders and trainers in this study difference in unfamiliar and familiar pairs didn´t appear.

Horses’ previous experiences affects their behaviour and his expectations of people (Hausberger & Muller, 2002; Hausberger et al., 2008). In this study all the horses were trained by using same methods and they had similar experiences of people, experiences of people limited mainly to their trainers at Hólar University. Training methods can have impact on how the horse perceives humans (b.Fureix et al., 2009; Visser et al., 2009). It is possible that if the horse has been trained by using training methods that emphasize the importance of natural behaviour of the horse, use of body language in communication and respecting the horse’s natural needs, like the training is aimed to do in Hólar University, the horse learns that human is not a predator and there is no need to be afraid of human. If the horse gets bad experiences of people at some point of training period or later in life, it is possible that the horse would be more likely to react differently with familiar and unfamiliar people.

In the study of Marsbøll and Christensen (2015) the familiarity of the handler did not impact on the heart rate of the young horse. The results of the current study support these findings. Different results in this study and the study of Marsbøll and Christensen (2015) compared to the study of Hockenhull et al., (2015) could be explained by the previous experiences of the horse. In the current study and in the study of Marsbøll and Christensen (2015) young horses were investigated, and in the study of Hockenhull et al., (2015) horses were of all ages. It is also possible that previous experience of the horse has an effect on how the horse reacts to unfamiliar people. When investigating young horses, it is more likely that they haven't had bad experiences of people, because they have had less human contacts in total due to young age. It is possible that since they have learned to trust people, they trust people in general and don't behave more cautiously towards unfamiliar people if no one has ever mistreated them. Previous research has been made with older horses or horses in various ages. It is likely that older horses have had different experiences of people. When collecting random sample of horses it is likely that they have been trained by using different methods. In current study all the horses were trained by using the same training methods.

People's attitudes towards horses has been shown to have an effect on the relationship between the horse and the human (Hama et al.,1996; Chamove et al., 2002). How well temperament of the horse and of the rider fit together can possibly also have an impact on that relationship (Lloyd et al., 2007; Wolframm, & Meulenbroek, 2012). It is possible that familiarity of the horse has an effect only on sensitive horses, like in the study by Lloyd et al., (2007), in which the temperament of the rider affected on the cooperation only on reactive horses. More reactive horses have lower stress threshold and it could be that the familiarity of the rider would emerge only when the horse is stressed or afraid. In this research a bicycle was placed in the riding hall to provoke possible fear reactions in horses, but this experiment assessed not only direct fear reactions but also overall communication between the horse and the rider in familiar and unfamiliar pairs.

In this study the familiarity of the rider didn't have effect on horse's behaviour. These results are contradictory to the results of the study of Marsbøll and Christensen (2015). In their study the familiarity of the handler had an effect on the behavior of the horse in fear response test. In this study it was not inestigated solely the fear responses of the horse, which could explain the difference in these results. In the study of Yarnell et al., (2013), which used behavioural and physiological measures to investigate stress, the heart rate and behavioural measurements didn't correlate. That was in accordance with the results in the current study where heart rate and behavioural measurements did not correlate. It is also possible that the familiarity of the rider is not a stressor for the horse if other factors like previous experience of the horse and of the rider is controlled.

In this study there was no difference in heart rates nor in behavioural scores depending on if the horse performed the experiment for the first or for the second time. This result is in contrary to the study of Marsbøll and Christensen (2015), in which behavioural scores were higher in the first experiment day.

## 4.2. Effect of the Familiarity of the Young Horse on the Rider

In this research the riders knew that all the horses were adequately trained and also had likely seen the horses before in training classes at school with their trainers. It is possible that the riders would have been more nervous to get on a new young horse that they don't know anything about. All the students are also used to performing with their horses in exams, and the experiment situation didn't cause stress for the riders. It is also possible that the riders experienced performance anxiety with their familiar horses that they have been training, like has been suggested in previous research (Hockenhull et al., 2015; von Lewinski et al., 2014), and were also stressed to get on unfamiliar young horse and that performance anxiety was masking the effect of nervousness to get on unfamiliar young horse.

## 4.3. Synchronisation Between Heart Rates

The results of connections between the heart rates of the rider and the horse support previous findings of the synchronisation of heart rates (Bridgeman, Pretty, & Terry, 2011; Hockenhull et al., 2015; Keeling, Jonare & Lanneborn, 2009). In previous studies the syncronisation of heart rates has been investigated in individual pairs. In this study the group level effect was also investigated. Synchronisation in individual pairs can be considered to be more valid and reliable measurement, since all the data of heart rates in each second is used, when in group level investigations, only average heart rates were used. Anyhow, these two ways to investigate communication between the horse and the rider gives slightly different results describing horse-rider interaction in slightly different point of view. Nevertheless, despite the way of investigation, it can be suggested that the heart rates of the horse and the rider are connected with each other.

When connections were investigated in each individual pair, there were more and stronger correlations in unfamiliar pairs than in familiar pairs. Though, it was not investigated if the difference was statistically significant. It is possible that the young horse is more alert to react for the smallest signs of potential danger with an unfamiliar rider who is behaving and communicating differently than the horse is used to, than with a familiar rider. It is possible that when heart rate of the unfamiliar rider increases the horse pays more attention to this psychophysiological sign of stress or alertness, because the horse doesn't know why the physiology of rider changed and what is going to happen next, and arousal level of the horse increases consequently. It is possible that the horse trusts more on familiar rider and is not as likely to interpret small physiological changes in familiar rider as a sign of danger as he might do with an unfamiliar rider.

Correlations were found between average heart rates in the whole sample so, that when the rider had higher average heart rate during the experiment also the heart rate of the horse was higher. When the familiar and unfamiliar pairs were investigated separately there was connection between heart rates of familiar riders and familiar horses, but not in unfamiliar pairs. It can be that when the horse and rider know each other, the average heart rates tend to be connected even tough linear connection between heart rates of individual couple would not necessary exist. It is possible that when the rider and horse know each other, the rider can have an effect on horse's heart rate and more interactive communication exists. For example, if the horse starts to be stressed and the heart rate increases, the rider can calm the familiar horse down by keeping her- or himself calm and the heart rate of the rider is not affected by the heart rate of the horse. The effect is also possible on the other way around; Stress in familiar rider doesn't always make the horse stressed, like has been shown in the studies of Bridgeman et al., (2009) and Lewinski et al., (2014). For example, if the horse and the rider are performing in front of audience, can the audience be stressor for the rider but is not stressor for the horse. The horse may senses the psychophysiological difference in the rider but evaluate anyway the overall situation not to be dangerous, even though the physiology of the rider indicates stress.

These results propose, that it is possible that the communication in familiar and unfamiliar horse-rider pairs is different, and that heart rates of riders and horses interact with each other differently in familiar and unfamiliar pairs. Even though, there was no significant difference in heart rates between the groups indicating that there is no difference in overall stress level depending if the rider and horse know each other. It is possible that there is more coherent communication, which is often called harmony, in familiar horse-rider pairs and that in familiar pairs arousal level is better controlled, and the communication in unfamiliar pairs is describer more by autonomic stress responses and that the connection in heart rates is more linear and direct in unfamiliar pairs.

It was not possible to investigate fully if increase in riders heart rate increased horses heart rate or the other way around. By visual observation of charts, it is possible to say that the increase started in heart rates of the riders. Nevertheless, exact conclusions cannot be led according visual observations. It is likely that the horse is more tuned to sense smallest communicative cues from his nature than human, because the horse is a prey animal. Though, it is also possible that the communication goes through some other variables. It is not possible to say that the horse senses the heart rate of the rider or that the rider senses the heart rate of the horse. It can be that the rider notices change in behaviour of the horse and that, in turn, rises his heart rate, or that human starts to be tenser in his body and the horse senses the tension. Heart rate can be consequence of some other variable through which the communication between the horse and the rider goes.

## 4.4 Limitations of the study and suggestions for future research

A big disadvantage in this study was the big loss of data due to dysconnectivity in heart rate measurements. In the future, more attention should be paid to get reliable heart rate measurements. It would be beneficial to use also other psychophysiological measures of stress like heart rate variability, cortisol levels and eye temperature.

A topic for further research could be the effect of the familiarity of the rider on different types of horses. It is possible that familiarity has more impact on sensitive horses or if the horse has had different experiences of different people in his past. It would be interesting to perform research also with differently trained horses. Similar study is needed in more threatening situation to study if the horse is more relaxed with a familiar rider than unfamiliar rider. Though, it is important to have in mind ethical considerations. This research was mainly focusing on investigating if an unfamiliar rider is a stressor for a young horse, not if the familiarity of the rider can work as a buffer against fear and stress reaction. It would be interesting to perform similar experiment in a more stressed environment also for the rider and see if the stress in rider would affect the horse and thus modify the results.

It needs to be taken in consideration that in this study no comparisons between the synchronisation in familiar and unfamiliar pairs were conducted, so no conclusions can be drawn of differences in heart rate synchronisation in unfamiliar and familiar young horse-rider pairs. Anyhow, these results adduce the need to investigate which factors have an impact on heart rate synchronisation. In this study it was not investigated if the heart rate of the rider had an impact on the heart rate of the horse, or the other way around. To get an answer to this it is necessary to have different experimental design. Also, a bigger sample size would give more reliable results. There still exists a need for standardized behavioural ethogram to investigate behaviour in ridden horses. In this study the behavioural measurements are only directional and exact conclusions cannot be drawn.

## 15. Conclusion

There was no difference in heart rates or in frequency of conflict behaviour in the horses performing this experiment with familiar or unfamiliar rider. Neither heart rates of riders were affected by the familiarity of the horse. These results suggest that other factors than familiarity of the rider are important when taking into consideration how the rider impacts on stress level of a young horse. Connections were found between the heart rates of riders and young horses. This result is important to have in mind when riding and dealing with young horses. It is important to have in mind that the connections can be different in familiar and unfamiliar horse-rider pairs. How the communication can differ in familiar and unfamiliar pairs need more investigation.

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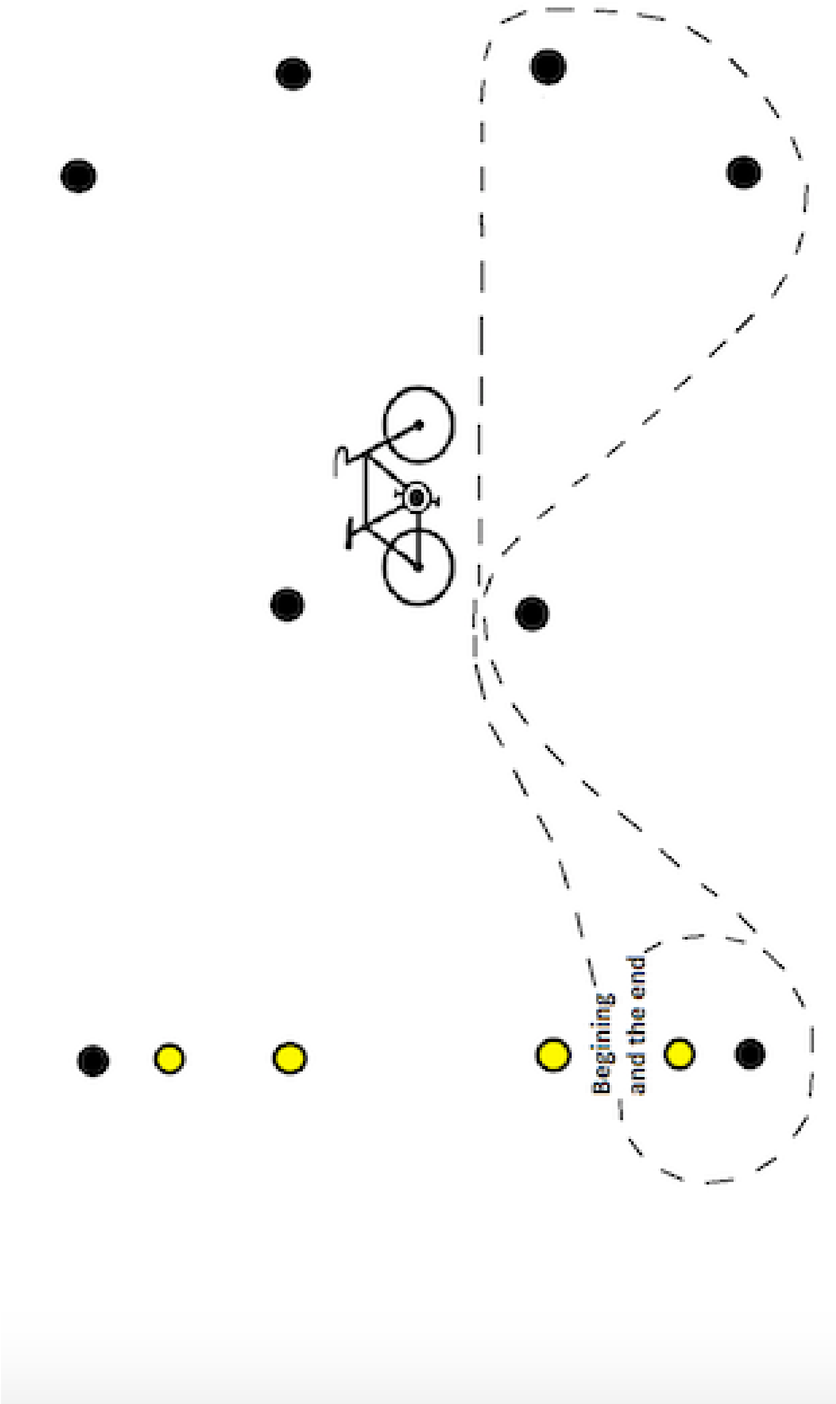
# Appendix:

## 1.The experiment Track



## 2. Ethogram

Write X always when horse shows the behavior described.
Make observations of one horse at a time.

| **Horse** | Attempts to stop, rider kicking in attempt to make the horse move forward | Jogging when asked to walk | Clear Body tension | Resisting to stop when asked | Move off before asked when rider mounts | Resisting to go, or not going where the rider asks the horse to go | Attemps to Buck/ Bucking | Other, What? |
|---|---|---|---|---|---|---|---|---|
| Video 1 Bay horse on the left | | | | | | | | |
| Video 1 Braun horse on the right | | | | | | | | |
| Video 2 | | | | | | | | |
| Video 3 Chesnut horse on the left | | | | | | | | |
| Video 3 Bay horse on the right | | | | | | | | |
| Video 4 bay horse on the left | | | | | | | | |
| Video 4 bay horse on the right | | | | | | | | |
| Video 5 Chesnut horse on the left | | | | | | | | |
| Video 5 Braun | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| horse on the right | | | | | | | | |
| Video 6 | | | | | | | | |
| Video 7 Red horse on the left | | | | | | | | |
| Video 7 Bay horse on the right | | | | | | | | |
| Video 8 Bay horse on the left | | | | | | | | |
| Video 8 braun horse on the right | | | | | | | | |
| Video 9 chesnut horse on the left | | | | | | | | |
| Video 9 Bay horse on the right | | | | | | | | |
| Video 10 chesnut horse on the left | | | | | | | | |
| Video 10 brown horse on the right | | | | | | | | |
| Video 11 Bay horse on the left | | | | | | | | |
| Video 11 Chesnut horse on the right | | | | | | | | |
| Video 12 | | | | | | | | |
| Video 13 | | | | | | | | |
| Video 14 | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Bay horse on the left | | | | | | | | | |
| Video 14 red horse on the right | | | | | | | | | |