The impact of physiological symptoms of arousal in the rider on horse-rider interaction

Name	Elodie Kievith
Student number	890906001
Major	Equine, Leisure & Sports
Adress	Veldsalie 12 2631 TH Nootdorp Netherlands
Institution	Hogeschool Van Hall Larenstein, Wageningen, Netherlands
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Internal coach	Inga Wolframm, Van Hall Larenstein, Wageningen

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1 Abstract

What makes equestrian sports unique is the fact that it depends on a close interaction between rider and horse. Their sensitive body enables horses to pick up the slightest change in aids from the rider. Even signs subconsciously submitted by the rider are noticed. Nevertheless, little scientific research exists examining the effect of different psychophysiological symptoms from the rider on the behaviour of their horse, and subsequently performance and safety. The aim of the current study was to investigate the interactive effects between physiological arousal symptoms in the rider and performance of a horse when being presented with novel stimuli. More specifically, the study aimed to determine differences in symptoms of physiological arousal of the rider around moments of the horse misbehaving and average values. In addition, pre-competitive mood states were taken into consideration. Eighteen Dutch horse-rider combinations (mean age 25.67 ± 8.43) participated and performed an obstacle course of passing unfamiliar objects while following a set path. During this course, heart rate, muscle tension of the trapezius muscle, skin conductance and skin temperature of the riders were measured using a NeXus 4 biofeedback monitor. Furthermore, all tests were taped on camera to allow for subsequent analysis of equine behaviour during the tests. An ethogram was designed to evaluate equine and rider behaviour on a 4-point scale (1=“no adverse reaction” to 4 = “extreme adverse reaction”). This was scored from video on 15 pre-determined points in the course. Pearson’s Product Moment Correlations were conducted to investigate relationships between average psychophysiological parameters of the rider during the course and total ethogram scores. Furthermore, every time a horse scored a 3 or 4 on the ethogram, denoting adverse behaviour, psychophysiological data 5 seconds prior to and 5 seconds following the event were compared to each other and mean data using a one-way repeated measures ANOVAs with post-hoc paired samples t-tests including Bonferroni corrections.

Most important findings showed that during obedience tests SC levels tended to be lower prior to the horse showing adverse behaviour than afterwards ($t(13) = -2.58$, $P = 0.023$). ST levels tended to be higher prior to the horse misbehaving than afterwards ($t(14) = 2.32$, $P = 0.036$) and compared to average ST throughout the test ($t(14) = 1.85$, $P = 0.085$). These results suggest that increased skin temperature and lower skin conductance levels prior to a horse showing adverse behaviour indicate a decrease in alertness and focus of the rider to the current behaviour of the horse. This might be the result of aids being submitted less insistently which offers the horse an opportunity to act out on its own against the riders' intention. In addition, a negative relation was found between high average heart rate and debilitative interpretations of cognitive anxiety ($r = -.44$, $n = 18$, $p = .071$). So, higher levels of arousal are experienced by riders not to be useful to their performance. Current results, combined with existing research, indicate the importance for a rider to find a balance between being focussed and alert at all times and reaching an excessive level of arousal, both from a performance and safety point of view.

2 Nederlandse samenvatting

Paardensport is uniek door het feit dat prestatie afhankelijk is van een hechte communicatie tussen ruiter en paard. Door zijn gevoelige lichaam is een paard in staat om de kleinste verandering in de hulpen van de ruiter op te merken, zelfs als de ruiter deze verandering zelf niet doorheeft. Toch is er vrijwel geen wetenschappelijk onderzoek gedaan naar het effect van fysieke symptomen van psychologische factoren van de ruiter op het gedrag van het paard, en onderliggend de prestatie en veiligheid. Het doel van het huidige onderzoek was om de interactieve effecten tussen fysieke symptomen van spanning van de ruiter en de prestatie van het paard wanneer ze geconfronteerd worden met onbekende objecten te analyseren. Daarbij is meer gedetailleerd ook gekeken naar verschillen in fysieke symptomen van spanning van de ruiter rond een moment waarop het paard zich misdraagt en gemiddelde waarden. Hiernaast zijn ook de stemmingen van de ruiters voor aanvang van de proef in overweging genomen. Achttien Nederlandse paardruiter combinaties (gemiddelde leeftijd 25,67 ± 8.43) namen deel aan het onderzoek en legden een obstakel proef af. Hierbij moesten ze onbekende objecten passeren langs een vaste route. Tijdens deze proef werden bij de ruiter de hartslag, spierspanning van de trapezius spier, huidgeleiding en huidtemperatuur gemeten met een NeXus 4 biofeedback apparaat. Daarbij werden alle proeven vastgelegd op film zodat de prestatie en het gedrag van het paard later geanalyseerd kon worden. Er is een ethogram gemaakt om het gedrag van het paard en de ruiter te beoordelen op een schaal van 4 punten (1 = ‘geen verzet’ tot 4 = ‘extreem veel verzet’). Op vijftien vaste punten in de proef zijn de combinaties hierop beoordeeld. Een Pearson’s Product Moment correlatie test is uitgevoerd om de relatie tussen gemiddelde fysieke waardes van de ruiter tijdens de proef en de totale ethogram score te onderzoeken.

Verder zijn de vijf seconden voor en vijf seconden na een moment van spanning met elkaar en met gemiddelde fysieke waarden vergeleken met een one-way repeated measures ANOVAs met post-hoc paired samples t-tests met Bonferroni correcties.

De belangrijkste resultaten tonen aan dat tijdens de obstakel proef, huidgeleiding lager bleek te zijn voor een moment waarop het paard zich misdroeg dan daarna $t\ (13) = -2.58$, $P = 0.023$). De huidtemperatuur waarden bleken hoger te zijn in voor een moment waarop het paard zich misdroeg in vergelijking tot daarna ($t\ (14) = 2.32$, $P = 0.036$) en tot de gemiddelde waarden tijdens de proef ($t\ (14) = 1.85$, $P = 0.085$). Deze resultaten suggereren dat de hogere huidtemperatuur en lagere huidgeleiding voor het moment dat het paard zich misdroeg, een daling in de aandacht en alertheid van de ruiter voor het gedrag van het paard aantonen. De misdraging van het paard is mogelijk het resultaat van minder consequente en strenge hulpen van de ruiter, die het paard hiermee de mogelijkheid bied om, tegen de bedoeling van de ruiter in, zelfstandig te handelen. Hiernaast is er een negatieve relatie gevonden tussen een hoge gemiddelde hartslag en negatieve interpretaties van cognitieve angst ($r = -.44$, $n = 18$, $p = .071$). Dit betekend dat hogere symptomen van spanning door de ruiters als onbehulpzaam voor hun prestatie worden ervaren. De resultaten van dit onderzoek, gecombineerd met bestaand onderzoek, wijzen op het belang voor een ruiter om een balans te vinden tussen alert en oplettend zijn en te gespannen raken. Dit is belangrijk voor zowel veiligheid als een goede prestatie.

3 Introduction

The relation between a horse and its rider is of great importance. In equestrian sports, a good performance depends on effective cooperation and communication between rider and horse. A rider needs to be in control of its own body and mind, but next to that also needs to deal with the different facets of the character of its horse (Meyers *et al.*, 1999). These components make equestrian sports unique. Next to unique, equestrian sports are also dangerous. Injuries in horse-related incidents can be very serious and even fatal (Hawson *et al*, 2010).

In the Netherlands, about 400.000 people perform equestrian sports. The chance of getting injured is lower then the average injury risk of all sports. However, horse-related injuries are more serious, the number of emergency cases is higher then the average of all sports and the number of acute hospitalizations is high. Falling of is the main cause of horse-related injuries. Most traumas at the emergency department are found on arms (40%), often regarding fractures, and the torso and neck, with often serious damage to the spinal column and spinal cord (34% of acute hospitalizations) (Consument veiligheid, 2010).

Figures regarding equine related injuries in the Netherlands in one year show a total number of 49.000 injuries, of which 9.400 emergency treatments and 1.400 hospitalizations after emergency treatment. When comparing horseback riding to all other sports, it is found that the risk of injury per 1.000 hours of sport is lower in equestrian (0.8) then other sports (1.9). However, the emergency treatments per 1.000 hours of sport are higher in equestrian (16) then in other sports (8.6) (Consument veiligheid, 2010).

Nevertheless, equestrian activities continue to grow in popularity in many parts of the world (Hawson *et al*, 2010). Because despite all the elements of danger, the feeling of shared flow with another being takes the experience of horseback riding to a dimension beyond the level of mastering a risky sport (Keaveny, 2008).

According to Keeling *et al* (1999), approximately one quarter of horse-related accidents are caused by the horse being frightened and miscommunication between rider and horse.

Horses tend to react to unfamiliar or potential dangerous situations with avoidance or flight, which can be of considerable hindrance during riding and may cause dangerous situations (Falewee *et al*, 2006). The element of danger in equestrian sports might cause arousal within a rider. Furthermore, especially in a competitive setting, performing sport involves several aspects that form both opportunities but also potential sources of stress. These aspects are for example the opportunity to show athletic ability, to compare ability to that of others and evaluation by significant people like coaches or parents (Smoll and Smith, 1991). The arousal that might be caused by the possible sources of stress when performing equestrian sports can be split into cognitive and somatic components. Cognitive anxiety contains the mental aspects, for example caused by the fear of bodily harm, negative social evaluation or fear of failure. Somatic anxiety is the physical component, reflecting physiological responses like and increase of heart rate, respiratory and muscular tension (Endler, 1991).

The different components of anxiety are expected to be of influence when performing equestrian sports, since performance and safety depends on a good horse-rider interaction, which exists of subtle signs from both sides (KNHS, 2008; Saslow, 2002). Since the body of a horse is highly sensible as it functions to transmit and receive information (Brandt, 2004), it is expected that any minute changes of the riders aids due to an increase of somatic arousal will be picked up on by the horse (Wolframm *et al*, 2009).

Therefore emotional control is considered to be critical for equestrian sports, as performance greatly depends on the ability of the rider to control emotional responses to the extend that they do not affect their horse (Wolframm *et al*, 2010). However, regarding the physiological symptoms of arousal of the rider in relation to the behaviour of the horse, no research has been conducted yet.

The aim of the current study is to investigate the interactive effects between physiological arousal symptoms in the rider and performance of a horse when being presented with novel stimuli. More specifically, the study aims to determine differences in symptoms physiological arousal of the rider around moments of the horse misbehaving and average values. In addition, pre-competitive mood states will be taken into consideration.

Taking into account existing literature, it is hypothesized that a rider experiencing increased physiological symptoms of arousal will influence the performance of a horse in a negative way. Next to this, fear reactions or poor performance of a horse is expected to cause an increase in physiological symptoms of arousal in the rider.

4 Literature review

4.1 Nature of the horse

When working with horses, it is important to understand and accept their basic behavioural mechanism in the wild. Each species acquires genetically determined physical and behavioural characteristics which help them survive in their natural environment. The means of survival of the wild horse was instantaneous flight when being frightened by an unfamiliar stimulus. Stimulus that can result in a fear reaction can be visual, olfactory, tactile, auditory, or a combination of these stimuli. In addition, flight from another horse can also function as a stimulus. This means that for horses, speed is the main physical characteristic. Combined with the behavioural characteristic of flight; wanting to escape in a potential dangerous situation, it helped the horse survive (Miller, 2009). Flight was their main defence, since unlike other large grazing herbivores, horses don’t have horns or antlers (Goodwin, 1999). At the first sign of danger, every fibre of a horse’s being is tuned to flee (Keaveny, 2008). Thereby, in nature the behaviour of a horse is a direct interaction with its environment. Horses are herd animals, living in a group was essential in the survival strategy of the ancestral horse. It decreased the chance for an individual attack and increased the chance for an approaching predator to be detected. In addition, it had also had a big influence on the chance of reproduction. (Goodwin, 1999). For these reasons, horses prefer to associate with others of their own kind. However, also other species are accepted as companions (Goodwin, 2009).

Another component of the survival strategy horses is body language, which serves as a way to communicate. By body language, horses give each other warning signs and next to this, horses also pick up signs of other horses being relaxed (Christensen *et al*, 2008).

Research performed by Christensen *et al* (2008) showed that horses accompanied by a calm companion during a frightening situation showed less fear related behaviour then horses without a calm companion. This indicates a possibility to use social influence to reduce fear in horses. For example, by keeping horses in social groups and including older, experienced horses in groups of young horses, this could help to create habituation to fear-eliciting stimuli (Christensen *et al*, 2008). Another study on this subject executed by Visser *et al* (2008) showed that the reaction of mature school horses to a novel object test was more relaxed, containing less trotting and cantering, then that of young horses (at age of 9 months). In addition, the younger horses spent more time exploring the object. Since when breaking a horse, one of the main goals is to teach it not to run away, even if it is afraid, it is not surprising for the mature horses to be less prone to run than young horses (Visser *et al,* 2008).

4.2 Reaction of a domesticated horse to stress and fear

The genetically determined traits started as a way to survive in the wild, but have also been exploited during domestication (Goodwin, 1999). Although many horses don't live in conditions for which their evolutionary history has equipped them to survive anymore, the domesticated horse still forms associations with other species and responds to warning signs given by body language of other species, including humans (Goodwin, 1999). Hereby, the requirement for a horse to be able to detect and avoid potential predators continues to play a role in the human-horse relationship (Goodwin, 1999). Byers (1997) found that the threshold for experiencing fear has gotten lower during domestication. Nevertheless, once this threshold is reached, domesticated horses will show the same type of reaction as their wild ancestors, even in the absence of natural predators. Accordingly, also domestic horses will react to unfamiliar and potential dangerous situations with avoidance or flight (Christensen *et al*, 2008).

This flightiness of the horse is often the reason for injuring themselves or the people handling them. Therefore, the basic equine behavioural mechanisms should always be taken into consideration when working with horses (Miller, 2009).

The domesticated horse may be protected for their natural predators since they are in a controlled environment, but they might not realize this. Therefore, their natural psychological need to respond to their environment with flight still exists (Cooper, Albentosa, 2005). The characteristic behaviours of the horse is often cause for serious accidents (Thompson and von Hollen, 1996). Keeling *et al* (1999) state that out of horse related accidents, 27 percent are caused by fear reactions of the horse. The avoidance or flight reaction of horses to unfamiliar or potential dangerous situations (Christensen *et al*, 2006 and Christensen *et al*, 2008), can be of considerable hindrance during working situations such as riding and performing dressage (Falewee *et al*, 2006), as it may influence the horse's manageability and usefulness for specific tasks (McCall *et al*, 2006). In preventing serious accidents, the experience and skills of the rider are of major importance (Keeling *et al*, 1999).

Because of the element of danger that the nature of the horse forms, it is one of the main objectives when breaking a young horse, to teach it not to run away, even if it is afraid (Visser *et al*, 2003). When a horse is able to get accustomed to a number of stimuli that would normally be experienced as frightening, this will increase the safety in the horse-human relationship (Christensen *et al*, 2006). In a test executed by von Borstel *et al* (2010), horses were exposed to a frightening stimulus. One of the results was that the intensity of the fear reaction showed by trained horses (ridden more than a half year) reduced faster than those of untrained horses (ridden less than a half year).

4.3 Human-horse relation and communication

The nature of the horse plays a crucial role in the relation and communication between human and horse. The respond of most ingenuous horses to humans is comparable to how they would respond to any predator. They will want to avoid physical or psychological pressure by moving away bodily or postural. It is up to the human to successfully modify this behaviour to create a highly responsive equine performer, or when unsuccessfully produce a ‘problem horse’ (McGreevy, 2007).

When looking at the communication, the first thing to be noticed is the large size of the horse compared to the human. Meaning there always is an element of danger in the interaction (Brandt, 2004). This element of danger is caused by the fact that the horse possesses a muscle power that can override any of the human’s commands, if the human neglects to make its requests meaningful, consistent and polite (Saslow, 2002). This power can be released within a split second (Keaveny, 2008). Furthermore, the intensive body-to-body contact should be noticed, especially during riding (Brandt, 2004). This contact is an important part of the way horses form relationships. Physical stimulation at the right parts of the body will produce a pleasurable and relaxing response (Saslow, 2002).

Another essential part in the human-horse communication is finely developed body language, since by nature this is the main way of communication for horses. This makes it very important for the human to understand the body language of horses in order to respond in such a way that the horse understands the meaning. Since language is the starting point of human communication, the non-verbal communication that is so important when working with horses can be a challenge (Brandt, 2004).

Since not only the human tries to understand the body language of the horse, but the horse also learns to understand non-verbal communication of the human, a two way communication system will arise (Brandt, 2004).

With a history of being a food source and important mean of transport, the horse is now used for a broad variety of purposes (Hausberger *et al*, 2008). Horses have become especially very popular in sports and recreation (Visser *et al*, 2003). But also for reasons as food source, in therapeutic manner or for breeding horses are used. This diversity also means a diversity of people communicating with horses. The relationships build can vary from short occasional interactions (like the vet) or an intense, long term bond between a horse and its owner. Within these interactions, to improve the development and maintenance of a strong positive relationship is very important (Hausberger *et al*, 2008). Another important theme is the fact it is a working relationship. Next to being a companion, the horse needs to perform for its owner. This should lead to a partnership between human and horse (Keaveney, 2008). Mc Greevy and McLean (2005) state, that since the working situation will be associated by the horse with emotional and physical demands, this can have different influences on the human-horse relationship. Keeling *et al* (1999) concluded that a good relationship between horse and rider is essential in decreasing risk of injury during riding.

Horses are herd animals and equipped by nature to accept dominance. Dominance is not per se related to athletic ability, aggressiveness or intelligence, but is a personality characteristic of its own. Usually, except for the rare very dominant individual, most horses can easily be brought to be submissive to their handler (Miller, 2009).

When human individuals repeatedly reinforce their dominance over a horse, the natural response of the horse will be avoidance. Since a horse is more and more seen as a companion animal, this doesn't seem to be a good strategy. As the goal is to have a co-operative relationship between human and horse, this relationship should resemble the social relationships horses form in a herd. In a herd, horses form pair bonds, supporting each other and associating closely. Such a bond could be the basis for a human-horse relationship, taking it further then a 'leader-follower' bond (Goodwin, 1999).

4.4 Horse-rider interaction

Despite all the elements of danger, the feeling of shared flow with another being takes horse-related experiences to a dimension beyond the level of mastering a risky sport. By combining the purposeful direction of the human with the speed and power of the horse, an unique experience of physical unity is created that neither could experience alone. The sense of partnership and teamwork that develops between horse and rider is remarkable (Keaveney, 2008). Also during riding, the relationship between a horse and its rider is of great importance, both during competition and recreational riding. In competition, a good performance is dependent on effective cooperation between rider and horse. Next to the fact that the rider needs to be in control of its own body and mind, the rider also needs to deal with the different facets of the character of its horse. For any rider, staying calm and focussed, next to alert and positive while riding are important skills (Meyers *et al,* 1999). This is supported by Hausberger *et al* (2008), saying that the rider influences the horse and thereby its performance in many ways, for example by style of riding, seat, position, riding attitude and riding aids. By the influence of a rider and the given response by the horse, and interaction between both arises during riding.

4.4.1 Interaction during riding

During training, a rider influences the horse with several aids, using ‘negative reinforcement’. According to Skinner (1953), this term means subtracting something aversive (such as pressure) to reward the desired response, which lowers the motivational drive. McGreevy (2007), states that the word ‘negative’ in this term means the removal of pressure, which functions as a reward for the horse. To give an example, horses already learn in their early training that the pressure on their bit coming from tension in the rains will disappear when they slow down or stop. Or that the pressure given by the rider’s legs will disappear when they go forward. In order for the training to be effective and humane, the pressure executed should be subtle and immediately be removed when the horse complies. Once a horse is well educated, an association between negatively reinforced signals and certain responses is made, and the horse should response to light and subtle tactile signals. When the rider fails to release pressure immediately after the desired reaction given by the horse, and lacks to reward, this can cause conflicts and behavioural and physiological problems (McGreevy, 2007).

McGreevy (2007, p 495) states that ’’Effective riding involves the correct application of negative reinforcement and the subsequent transfer of stimulus control to various classically conditioned cues (such as those coming from the seat).’’ During riding, there are several aids serving as tools for the rider to interact with the horse. Different aids that can be given are physical aids given through seat, legs and rains, next to vocal instructions (KNHS, 2008). This is supported by Saslow (2002), who states that tactile stimulation is the main way for riders to communicate with their horse. In addition, several devices such as a whip or spurs are available. Eventually, these aids should be given as subtle as possible (KNHS, 2008).

Research performed by Saslow (2002), showed that the sensitivity of the horse on parts of the body which are in contact with the rider's legs during riding is greater then the already sensitive human fingertip. Meaning that horses are able to respond to pressures, which for humans are too light to feel. This indicates that human instability in the saddle will result in unconscious delivery of unnecessary tactile signals to the horse, consequently resulting in failure at teaching the horse which signals are meaningful.

When a horse does not get a chance to react to consistent, light and meaningful stimulus, it can become insensitive. Similarly, the seeming ability of a well-trained horse might be caused by responding to slight movements or tightening of muscles that the rider is not aware of, instead of the intended aids of the rider (Saslow, 2002).

4.4.2 Goals during riding

With use of a positive interaction with its horse, the rider can work towards certain goals during riding. It is important for a rider to maintain a good posture in harmony with the horse's movement, especially during competitions (Terada, 2000). When the rider is able to maintain a relaxed seat, a balance can be reached where the rider is able to adapt to all movements of the horse (KNHS, 2008).

In riding instruction, to 'relax' is a term which is often used as a basic requirement in order to make process. The term to 'relax' is not only abstract but also ambiguous (Terada, 2000). According to Terada (2007), what is probably intended to say is that the rider needs to be capable of maintaining a good posture by skilful coordination, following the movements of the horse 'without the use of unnecessary strength' or that the rider is able to use 'appropriate muscle activity'.

Next to specific performance goals of the rider, by executing certain exercises the horse is also trained towards a certain goal. Dressage forms the gymnastic basis of equestrian sports. The goal is to make the horse a ‘happy athlete’ through a harmonious and systematic education. The horse should be fully impressible for the rider’s aids and response accurate and without hesitation. Hereby, a harmonious interaction between rider and horse is reached (KNHS, 2008).

4.4.3 Effect anxious rider

Since the rider influences the horse in many ways, different studies have been executed regarding the influence of anxiety of the rider on the horse. Research performed by Keeling *et al* (2009) showed that the heart rate of the horse increased in a situation where the rider expected the horse to be frightened. In this test, a fear reaction of the horse was expected by the rider, since the rider was told in advance an umbrella would be opened while horse and rider passed. In fact the umbrella was not opened, which made this situation similar to the control situation (where no warning for an opening umbrella was given), apart from the expectation of the rider. The increase of the heart rate of the horses in this situation probably indicates that the horses were alert and more prepared to react to potential danger, since according to Boissy (1995), this would be a response of the horse to react to warning signals from another horse in the herd. Furthermore, Gautier and Cook (1997) state that the startle response is greater when an animal is aroused. This means that when the rider of a horse is nervous, they increase the chance of their horse to give the startle reaction they actually want to avoid. Therefore, an improved understanding of the influence of the nervousness of the rider might create awareness and thereby reduce risk of injury caused by fear reactions of the horse (Keeling *et al*, 2009). This is supported by Goodwin (1999), who claims that horses will react to tension of the human with the same alarm as if it were exhibited by another horse.

Also McCall *et al* (2006), state that equine behaviour is considerably influenced by the human handler.

4.5 Anxiety in the rider

Since anxiety in the rider appears to have an influence on the horse, it is useful to analyse this component. According to Taylor (1987), athletes with an insufficient level of arousal lack motivation, and are thereby not physiologically prepared for optimal performance. However, athletes suffering from an excessive level of arousal are also unable to perform optimally, since extreme arousal negatively effects motor coordination and efficient use of the cardiovascular system (Taylor, 1987). Martens (1977) refers to the condition of excessive arousal as anxiety. Anxiety can be split into cognitive and somatic components. Morris *et al* (1981) defined cognitive anxiety as the psychological part, containing for example negative expectations and cognitive concerns about oneself, the situation at hand, and potential consequences, and somatic anxiety as the physiological part of arousal and how this is experienced.

4.5.1 Intensity and interpretation

Research performed by Wolframm and Micklewright (2010) showed that the intensity and interpretation of pre-competitive cognitive and somatic anxiety has got an influence on equestrian performance. It has been found that a facilitative interpretation of cognitive and somatic anxiety has got a positive effect on the interaction between rider and horse. Riders experiencing the pre-competitive arousal as facilitative, might describe the feeling as 'excitement' or feeling 'psyched up', being useful to their performance.

However, the greater the intensity of cognitive and somatic anxiety, the less facilitative these symptoms were experienced by the riders. An increased level of cognitive anxiety will have an impact on memory resources, which might decrease the ability of the rider to give the correct aids and react to the behaviour of their horse in the most suitable way.

In addition, since horses are trained to respond to subtle aids from the rider, any change in muscle tension due to an increased somatic anxiety level might cause a distortion of the riders aids, causing the communication to be a less fluent and thereby a lack of cooperation from the horse. Hereby, riders might experience such an increase in anxiety symptoms as debilitative to their performance.

4.5.2 Self-confidence

Another factor of importance is a rider's level of self-confidence. Self-confidence was described by Morris *et al* (1981) as the being the believe of an individual to be able to meet the challenge of the task to be performed. A higher level of self-confidence showed to cause the riders to experience both cognitive and somatic anxiety in a more facilitative way, and resulted in better performance (Wolframm and Micklewright, 2010). This is supported by Hanton *et al* (2004), who found that self-confidence is an important variable influencing anxiety, perception of control and subsequently directional interpretations. A lack of self-confidence during the experience of pre-competitive symptoms resulted in loss of perceptions of control, creating problems with focus and concentration, and debilitating symptom interpretations regarding the forthcoming performance. Performers with high self-confidence also experience increases in pre-competitive symptoms, but for them this leads to an increase in motivation and effort. They were able to maintain confident towards the performance and felt in control.

Also results of research performed by Woodman and Hardy (2003) showed a significant relation between competitive sport performance and both cognitive anxiety and self-confidence. This is supported by a study from Jones *et al* (1994), who found a distinction between intensity and direction of competitive state anxiety symptoms, next to the importance of skill level. It shows that there is no difference in pre-competition anxiety symptoms, both cognitive and somatic, between elite and non-elite performers. However, it showed that elite performers interpretate these symptoms as more positive and facilitative regarding the consequences for their performance and are able to maintain a higher self-confidence level. Non-elite performers indicated more debilitative states and a lower self-confidence level. A higher level of self-confidence is likely to explain the more positive interpretation of anxiety of elite performers. In addition, when cognitive symptoms are interpretated as facilitative to performance, it is more likely to be called ‘excitement’ or ‘motivated’ rather then as ‘anxiety’ (Jones *et al*, 1994).

The nature of sport is an important situational variable. It is likely that a high intensity of anxiety will be experienced as facilitative for short, explosive duration sports but debilitative for longer duration, more finely-controlled skill sports (Jones *et al*, 1994).

4.5.3 Social evaluation

Research performed by Trotter *et al* (1999) regarded the interaction model of anxiety by Endler (1983) in a competitive equestrian setting, focussing on social evaluation. According to Spielberger (1966) part of Endler’s model is focussed on the differentiation between state anxiety (A-state) and trait anxiety (A-trait). A-State involves a short unpleasant condition that involves feelings of fear, nervousness and apprehension. The A-trait is a personality characteristic which is relatively stable and an indicator for the tendency to react with A-state anxiety during situations perceived as stressful.

This study done by Trotter *et al* (1999) looked into two hunter-jumping situations. The first situation was a non-stressful setting, during a familiar training at home. 30 minutes before mounting their horse, the participants completed the EMAS State, Trait and Perception questionnaires. The second situation being a competition, with a partly unfamiliar setting and social evaluation added. In this situation, 30 minutes prior to mounting their horse, the participants filled in the EMAS State and the EMAS Perception questionnaire. Results showed that individuals with high social evaluation A-trait experienced a greater A-state arousal in the pre-competition (stress) situation than individuals with low social evaluation A-trait. Furthermore, the greatest A-state response was found at the high social evaluation A-trait individuals during the stress situation (in comparison to the A-state during the non-stress situation of both low and high social evaluation A-trait and the A-state of the low social evaluation A-trait during the stressful situation).

These results show that individuals with a low or high social evaluation A-trait have a different state anxiety response to a stressful situation, but not to a non-stressful situation (Trotter *et al*, 1999).

4.5.4 Coping and focus

Since anxiety and self-confidence level have proved to influence equestrian performance, it is important for a rider to control their emotional responses to the extend that they do not affect their horse (Wolframm *et al*, 2010). This is supported by Hardy *et al* (1996), who found that the ability to cope with stressful events during sport and competition is an important part of a successful performance. Athletes can use different strategies to cope with performance stressors and to deal with success or failure. Coping contains any focussed attempt to manage situational demands. It does not stand for effectiveness or success (Compas, 1987).

Research performed by Poczwardowski and Conroy (2002) focussed on four different ways to cope with stressors during performance, containing appraisal-focused coping, emotion-focused coping, problem-focused coping and avoidance-focused coping. Results show that the way an athlete deals with stressors is an individual process, which will have an influence performance. Strategies like looking into the future, keeping things in perspective, learning and improving and focussing on the positive will be helpful for performance. Contradictory, being unable to leave a mistake behind, not being consistent and losing perspective of one's own role in performance, will lead to a decrease in performance.

Next to coping strategies, being able to usefully focus attention can also be a tool to deal with different facets of performing sport. There are different styles of focussing attention. During conditions of low exercise, intensity attention can voluntarily be shifted from dissociative to associative and from wide to narrow spans. However, during intense exercise the voluntary control decreases, which limits the effectiveness of external strategies on perceived and sustained effort. Meaning that the manipulation of the attention style shifts from 'easy' at low levels of intensity to 'hard' at high intensity levels (Tenenbaum, 2001). Research performed by Weiss *et al* (2008) regarded external and internal focus strategies during sport. External focus is directed at the effects of the body movement on the environment and in internal focus is directed at the execution of the motor task. Results implicated that in general, use of external focus was more beneficial for performance, as this way unconscious control processes can take over control of the movement. Thereby the performer can focus on the effect their movement has got on the environment (Weiss *et al*, 2008), especially when it regards well practiced skills (Wulf *et al*, 1998). This study is supported by Wulf *et al* (1998), who also found external focus to be beneficial for performance.

In addition it was found by Weiss *et al* (2008) that the preferred way to focus differed per athlete, and letting the athlete perform in his own preferred way will result in a higher self-esteem and better result. Thereby, internal focus may be beneficial for certain athletes.

4.6 Physiological symptoms anxiety of the rider

After analysing the psychological part of anxiety, it is of importance to look at the physiological processes this causes. Because although stress is of psychological source, it has got an effect on a number of physiological processes in the human body (Taelman *et al*, 2008).

4.6.1 Heart rate

Increased muscle tension in the neck, change in hormone concentration and change in heart rate and heart rate variability are physiological indicators of stress, which provide possibilities in order to be able to measure stress (Taelman *et al*, 2008). This is supported by McNaughton (1989), who states that autonomic responses are induced by mental activity and stress. The functioning of the emotional system has got an influence on for example heart rate, blood pressure, respiration rate and electro dermal activity. Accordingly, Taelman *et al* (2008) found that the mean HR of participants in their study increased significantly in 24 out of 28 cases from rest compared to a situation with the load of a mental task added. Finally, also Larsson *et al* (1995), state that exposure to conflicting tasks will result in an increase of heart rate.

Next to psychological factors, also physiological factors have got an influence on heart rate. The heart rate increases linearly with the relative work rate. With the onset of exercise, the oxygen requirements increase in proportion to the metabolic needs of exercising muscles.

The heart rate will rise in order to increase blood flow and oxygen delivery to exercising muscles and to maintain an adequate blood flow to essential organs like the brain and heart. In general, a specific physical task requires a certain amount of oxygen uptake when performed by different individuals. However, differences in individual mechanical efficiency (for example the ability of the exercising muscles to use oxygen) cause variation in these energy requirements (Navare, Thompson, 2003).

4.6.2 Skin conductance

Skin conductance response is an index of autonomic arousal (Critchley *et al*, 2000). This is supported by Vaezmousavi *et al* (2009), who state that skin conductance level (SCL) is an indicator for the state of arousal, which is expressed in the activity of sympathetic cholinergic neurons on eccrine dermal sweat glands level. The SCL provides information regarding features of brain state and the processing of information. Also Boucsein (1992), states that skin conductance responses are a solid way to measure phasic increases in sweat rate, indicating autonomic arousal. In a study performed by Williams *et al* (2001) it was found that fear stimuli caused increases in skin conductance responses (phases arousal). This is supported by Nagai *et al* (2004), who states that during a high arousal state, the skin conductance level will increase. In addition, they found that a decrease of skin conductance level is related to relaxation.

Buchel *et al* (1998) found that the brain mechanisms that generate the skin conductance response are also involved in the processing of emotions. Thereby, skin conductance response can be an index for both cognitive and somatic arousal (Critchley *et al*, 2000). This is in line with findings of Dawson *et al* (2007), who declared that skin conductance is a marker of sympathetic autonomic activity which is associated with arousal.

Giesen and Rollison (1980) found a relationship between self-reported anxiety and skin conductance response. The physiological response was interactively influenced by the individual self-reported anxiety and the psychological environment factor of context of stimulus exposure. Participants with a low-anxiety level showed almost no effects, but high-anxiety level subjects showed a strong reaction of increased skin conductance during a stressful situation, compared to a calm situation.

4.6.3 Muscle tension

According to Oishi and Maeshima (2004), the sympathetic nerve activity to the skeletal muscle is directly in proportion to the level of stress. Thereby, an increased level of stress results in more muscle activity.

While participating in a sport event, many central neural networks are activated. Parts of these networks are involved in motor execution and planning, emotion and behaviour and sensory, perceptual and cognitive systems. The physical goals that are set to achieve with the musculoskeletal system are reached with use of the emotion-behaviour system. In order to be able to execute fine movements, or to use specific skills, it is important to be able to inhibit the central nervous system. This will cause an inhibitory response of the motor system, and thereby improve physical performance under mental stress (Oishi and Maeshima, 2004).

A study performed by Lundberg *et al* (1994) showed a significant increase of tension in the trapezius muscle, induced by mental stress. In addition, this research indicated that the increase of muscle tension due to stress is accentuated on top of a physical load.

This is supported by Larsson *et al* (1995), who found an increase of shoulder-muscle tension during induced mental stress.

4.6.4 Skin temperature

Boudewijns (1976) conducted research regarding finger temperature as a psychophysiological indicator of arousal. During this study, participants went from a situation assumed to be relaxing (participants received relaxation instructions) to a situation assumed to be stressful (participants received electric shock and threat of electric shock). In addition, a control group was included that did not receive shock, to make sure that any changes in finger temperature were not caused by stimulus chances of the shock administration. The self report of arousal was measured by having participants rate the internal arousal they felt on a scale from zero to ten. Zero being described as ‘completely relaxed’ to ‘terror’ at ten. Participants indicated this level during the experiments with their dominant hand, while simultaneously their finger temperature was measured on their other hand.

Overall, the results of this research show that the finger temperature decreased during assumed stressful situations and increased during assumed relaxation conditions. In addition no significant correlation was found between the finger temperature and the other psychophysiological measures. However, the finger temperature did relate to self-report of arousal (Boudewijns, 1976).

Furthermore, another important finding was the fact that the response of finger temperature, compared to skin conductance, is relatively slow in reaction to changes in the stimulating conditions. This means a longer rest period between the changes of conditions is needed in order to accommodate the temperature response. Therefore, finger temperature will not be a valid way to measure second-to-second changes in conditions or internal states. Finally, Boudewijns (1976) concluded that finger temperature has got potential for biofeedback therapy. Since it seems to be a reliable indicator of psychological arousal and is easy to understand, the concept is a suitable way to explain level of arousal to patients.

The clinical potential of finger temperature will increase due to the fact that the reaction of the finger temperature to changes in condition is quite slow. For that reason, this parameter will be affected by environmental changes less quickly than other psychophysiological responses.

An investigation by Mittelmann and Wolff (1942) showed a consistent relationship between finger temperature and emotional reactions, whether conscious or unconscious. Fall in finger temperature was related with emotional stress (for example anxiety or embarrassment) and conditions regarding conflict or danger. In addition, a rise in finger temperature had a relation with emotional security and reassurance.

According to Rang and Dale (1991), an increased circulation of adrenaline effectively diverts blood flow from the skin towards skeletal muscle. The influence of an increased adrenaline secretion is of longer duration in the skin than in the exercising muscle (Larsson, 1995).

4.7 Interaction between anxiety of rider and horse

Since horses think differently from humans, riders are required to adapt and react adequately to the behaviour of their horse in order to improve safety. By detecting and interpreting novel stimuli, a rider can estimate the expected reaction of the horse (Keaveny, 2008). Since the reaction of horses to unfamiliar or potential dangerous situations tends to be avoidance or flight (Christensen *et al*, 2006 and Christensen *et al*, 2008), these reactions might decrease the rider's ability to control the horse. Taking existing literature into account, it is expected that the level of arousal of the rider will influence the horse-rider interaction and subsequently the performance. However, no research evaluating physiological symptoms of arousal in the rider and the behaviour of the horse has been conducted yet, creating possibilities for further research.

Therefore, the aim of the current study is to investigate the interactive effects between components of physiological arousal in the rider and performance of a horse when being presented with novel stimuli. More specifically, the study aims to determine differences in somatic symptoms of the rider around moments of the horse misbehaving and average values. In addition, pre-competitive mood states will be taken into consideration.

5 Method

5.1 Participants

The data collection of this research was carried out at the stables Stal Smit in Delfgauw and stal ten Bosch in Driel, the Netherlands. The target group consisted of 18 Dutch horse-rider combinations (mean age 25.67 ± 8.43, female = 17 and male = 1). This group consisted of both competitive (competing at the Dutch B to Z level) and non-competitive riders (competitive n = 9 and non-competitive n = 9). All participants performed horseback-riding regularly. The horses ridden during the test were familiar to the riders, it was either their own or their lease horse (n = 18, own horse = 16, lease horse = 2).

5.2 Procedure

The permission of both the stables and the riders was gained prior to the data collection. All participants were notified about the procedure and signed up voluntarily. Further information was provided beforehand by a poster at the stables regarding the purpose of the research and learning possibilities for participants. Furthermore, participants were advised that all gathered information would be handled confidentially. All participants filled in the CSAI-2R questionnaire shortly prior to warming up their horse and performing the obstacle course.

All participants performed the same obstacle course, in which they were asked to follow a set path in trot. Within this set path, passing obstacles was included. Obstacles consisted of two umbrellas, balloons and a plastic sail hung up at the wall (see annex 10.12 and 10.13).
Beforehand, participants had minimal knowledge regarding the obstacle course. The only information provided was that they were supposed to pass novel stimuli and that no jumping was involved. No further instructions were given and they were not allowed to view the obstacle course beforehand.

Riders were free to warm up their horse as they pleased in another arena. Prior to entering the obstacle course, participants were fitted with a NeXus 4 biofeedback monitor. This was used to record the rider’s muscle tension (trapezius muscle), skin temperature (finger), heart rate and skin conductance. Fitting of the biofeedback gear took place outside of the arena in order to prevent riders from familiarising themselves with the obstacle course. When entering the arena, both rider and horse saw the course for the first time. The riders were filmed from the moment they entered the arena till the end of their test (the end being halt either at A or C)

All riders performed the same exercise during the obstacle course, following a set path (see annex 10.14 and 10.15). During the entire test, the horse-rider combination was followed at a distance of maximal 10 meters by a person carrying a laptop in order to collect data. On the laptop, markers in the biofeedback program were placed in order to indicate fixed points of the exercise:

- Marker 1: horse-rider combination entering the arena
- Marker 2: after entering the arena, the combination is positioned at either E or B
- Marker 3: at the end of the test, the combination is positioned at either A or C

These markers were used in the data processing in order to equalize the biofeedback data and film material.

5.3 Materials

A NeXus-4 of Mind Media B.V. was used for data collection. The NeXus-4 is a 4 channel physiological monitoring and biofeedback platform that utilizes Bluetooth 1.1 class 2 wireless communication and flash memory techniques. It offers data collection with up to 1024 samples per second. For the current study, 32 samples per second were collected. Channels operating at a sample frequency of 1024 Hz were used to measure heart rate (EKG) and muscle tension (EMG). Channels operating at a sample frequency of 128 Hz were used to measure skin conductance and skin temperature.

In addition, the obstacle courses where filmed with a digital camera from Sony.

5.4 Scoring performance

After data collection, the performance of rider and horse was scored with the conducted video material, using an ethogram. This ethogram consisted of 3 categories; resistance to riders aids, flight behaviour and rider behaviour. These categories were measured at a 4-point scale:

- Resistance to riders aids, ranging from 1 (Willing to work, reacts immediately to riders aids, tail swings loosely, ears relaxed) to 4 (Extreme resistance to riders aids through bucking, rearing, continues swishing of tail)
- Flight behaviour, ranging from 1 (passes obstacle without hesitation and follows correct path) to 4 (Refuses to pass, turns around, moves away in opposite direction)
- Rider behaviour, ranging from 1 (Rider sits quietly, quietly insisting that the horse obeys) to 4 (Rider uses hands, legs, seat and whip together, appears hectic and forceful)

5.5 Questionnaires

Participants (n = 18) were asked to complete the Competitive State Anxiety Inventory 2 (CSAI-2R) questionnaire shortly prior to warming up their horse and performing the obstacle course. The CSAI-2R questionnaire was developed by Cox *et al* (2003) and is a 17-item questionnaire that measures subscales of intensity of somatic anxiety (arousal), cognitive anxiety (arousal) and self-confidence. Each CSAI-2R item was rated on a scale from 1= 'not at all' to 4='very much so'. In addition, riders indicated the direction of the CSAI-2R items on a 'direction scale' developed by Jones and Swain (1992). Riders rated each item from on a scale from -3='very unhelpful' to +3='very helpful', which depended on how helpful riders felt each item to be for their performance. For example, a score of 3 (moderately so) on 'I am feeling confident' might be experienced as 'somewhat helpful' to their performance and thereby scored as a 2 on the direction scale. Final scoring was carried out manually in accordance with the instructions by Cox *et al* (2003).

5.6 Data processing and analysis

The data was processed with the help of the programme SPSS (Statistical Package for Social Scientists). In order to investigate relationships between average psychophysiological parameters of the rider for the duration of the test and total ethogram scores, Pearson's Product Moment Correlations were conducted. Furthermore, every time a high ethogram score of 3 or 4 on the 4-point scale was reached, denoting adverse behaviour, psychophysiological data 5 seconds prior to and 5 seconds following the event were compared to mean data from both tests using a one-way repeated measures ANOVAs with post-hoc paired samples t-tests including Bonferroni corrections. Finally, the relationship between the CSAI-2R questionnaire and the average psychophysiological values was investigated using Pearson product-moment correlation coefficient.

6 Results

6.1 Heart rate

A one-way repeated measures ANOVA was conducted to compare scores on the average heart rate of the rider (M = 149.41, SD = 10.17) and values prior to (M = 153.43, SD = 17.17) and after (M = 150.05, SD = 19.98) the horse misbehaving. No significant differences were found with Wilks' Lambda= .817, *F* (2, 13) = 1.46 , p > 0.05

6.2 Skin conductance

A one-way repeated measures ANOVA was conducted to compare scores on the average skin conductance and values prior to and after the horse misbehaving. An effect nearing significance was found with Wilks' Lambda = .648, *F* (2, 11) = 2.98, p = .092.

Considering this was an exploratory study, it was decided to further investigate using post-hoc procedures. Paired samples t-tests were conducted to determine specific differences in skin conductance values.

Skin conductance was significantly lower prior to the horse misbehaving (*M* = 5.08, *SD* = 4.06) than afterwards [*M* = 5.29, *SD* = 4.17, *t* (13) = -2.58, p = .023, p < 0.05; 5.08 ± 4.06 vs. 5.29 ± 4.17]. The values of skin conductance before an event (M= 5.37, SD=4.07) did not differ significantly from the average values [M = 7.07, SD = 6.42, t (12) = -1.67, p > 0.05; 5.37 ± 4.08 vs. 7.07 ± 6.42]. The values of skin conductance after an event (M = 5.59, SD = 4.18) were also not significantly different from the average values [M = 7.07, SD = 6.42, t (12) = -1.53, p > 0.05; 5.59 ± 4.18 vs. 7.07 ± 6.42]. A clear overview of the measured values is presented in figure 1.

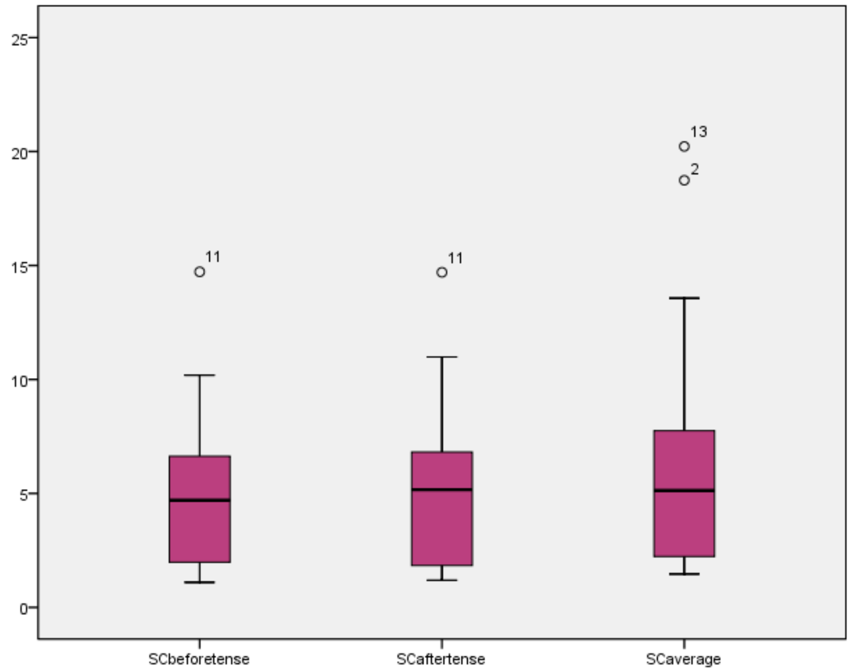


Fig. 1 Skin conductance; prior to an event, after an event and average values

6.3 Skin temperature

A one repeated measures ANOVA was conducted to compare scores on the average skin temperature and values prior to and after the horse misbehaving. An effect nearing significance has been found with Wilks' Lambda = .68, F (2, 13) = 3.13, p = .078.

Considering this was an exploratory study, it was decided to further investigate using post-hoc procedures. Paired samples t-tests were conducted to determine specific differences in skin temperature values. Skin temperature was significantly higher before the horse misbehaving (*M* = 24.33, *SD* = 5.02) than afterwards [*M* = 24.16, *SD* = 5.11, *t* (14) = 2.32, p = .036 p < 0.05; 24.33 ± 5.01 vs. 24.16 ± 5.11]. Similarly, a difference nearing significance was found between the skin temperature before the horse misbehaving and the average value.

The skin temperature before an event was higher than the average value [M = 23.89, SD = 5.39, t (14) = 1.85, p = .085, 24.33 ± 5.01 vs. 23.89 ± 5.39]. A clear overview of the measured values is presented in figure 2.

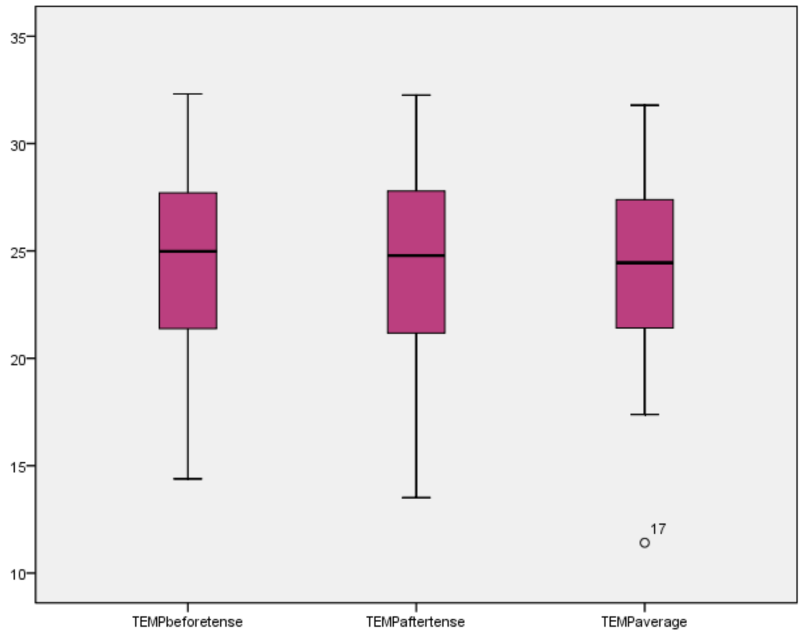


Fig. 2 Skin temperature; prior to and event, after an event and average values

6.4 Muscle tension

A one repeated measures ANOVA was conducted to compare scores on the average muscle tension of the rider (M = 17.20, SD = 360.74) and values prior to (M = 32.56, SD = 132.74) and after (M = -3.57, SD = 21.31) the horse misbehaving. No significant difference could be found with Wilks' Lambda = .935, *F* (2, 13) = 451, p > 0.05.

6.5 CSAI-2R questionnaire

The relationship between the CSAI-2R questionnaire and the average psychophysiological values was investigated using Pearson product-moment correlation coefficient. A negative correlation which is nearing significance was found between the average heart rate and the direction of cognitive anxiety ($r = -.435$, $n = 18$, $p = .071$), with high levels of heart rate associated with debilitative interpretations of cognitive anxiety.

6.6 Ethogram

The relationship between the total percentage of the ethogram score and the average psychophysiological values was investigated using Pearson product-moment correlation coefficient. No correlation was found between ethogram score and average heart rate values ($r = -.13$, $n = 18$, $p < 0.05$), ethogram and average muscle tension ($r = -.21$, $n = 17$, $p > 0.05$), ethogram and skin conductance average ($r = .098$, $n = 15$, $p > 0.05$) neither for ethogram and average temperature ($r = -.17$, $n = 18$, $p > 0.05$).

7 Discussion

The aim of the current study was to investigate the interactive effects between components of physiological arousal in the rider and performance of a horse when being presented with novel stimuli. More specifically, the study aims to determine differences in symptoms of physiological arousal of the rider around moments of the horse misbehaving and average values. In addition, pre-competitive mood states were taken into consideration.

7.1 Skin conductance and skin temperature

Results of the current study show significant differences in physiological symptoms of the rider with regards to a moment of the horse misbehaving. Prior to a moment of the horse misbehaving, the skin conductance was significantly lower and the skin temperature was significantly higher then after this moment. In addition, the skin temperature prior to a moment of the horse misbehaving was significantly higher then the average value. According to existing literature, these results indicate relaxation of the rider prior to the horse misbehaving, and an increase in arousal again after this moment.

Previous research has indicated both skin conductance and skin temperature to be reliable indicators of psychological arousal and suitable parameters for biofeedback therapy (Chritchley *et al*, 2008; Vaezmousavi *et al*, 2009; Boudewijns, 1976). Existing literature states that finger temperature will increase during assumed relaxation situations and decrease during assumed stressful situations (Boudewijns, 1976; Mittelmann and Wolff, 1942). Regarding skin conductance, a decrease during assumed relaxation and increase during assumed stressful situations occurs (Williams *et al*, 2001; Nagai *et al*, 2004).

The current findings may suggest a decrease in cognitive processes of the rider, such as alertness and directional focus on the current behaviour of the horse prior to the horse misbehaving. Accordingly, Taylor (1987) found that athletes with an insufficient level of arousal are not prepared for optimal performance. As a consequence of relaxation of the rider, the aids submitted to direct the horse through the obstacle course may not be applied insistently enough due to a lack of focus, and may result in the horse acting out of its own accord and contrary to riders' intention.

These findings are in line with previous studies, saying that due to the high sensitivity of a horse's body (Saslow, 2002), any minute changes of the rider's aids will be picked up on by the horse (Wolframm *et al*, 2009). Furthermore, horses have got a will and motivation of their own (Sorli, 2005). This supports the suggestion that when the aids of the rider are less insistent and consequent, the horse might use this opportunity to act out of its own. In an obstacle course containing novel stimuli, it may be expected the horse will want to follow its natural instinct to avoid or run from the stimuli. Thereby, if the rider does not respond adequately upon the horse due to a lack of focus, this could create a dangerous situation.

There are different ways to focus attention. For a rider, it appears crucial to continuously pay attention to the behaviour of their horse, the aids they are giving and most importantly, how their behaviour affects the behaviour and performance of their horse. This is consistent with research executed by Weiss *et al* (2008), who found that an external focus, which is directed at the effect of the movement on the environment, is beneficial for performance. For a rider, this is of great importance as performance in equestrian sports depends on an effective cooperation and communication between rider and horse (Meyers *et al,* 1999). By focussing on the response the horse gives to the submitted aids, and how the horse is affected by environmental factors, a rider should maintain an adequate communication with the horse.

This way, the rider will be better able to keep the horse obedient and prevent the situation from escalating. This is in line with findings of Keeling *et* al (1999), saying that the experience and skills of the rider are of great importance in order to improve safety. In order to keep control over their horse, riders make use of several aids, such as through seat, legs, rains, and vocal instructions, using negative reinforcement (McGreevy, 2007; KNHS, 2008). It is a rider's job to use these aids in a subtle and efficient manner in order to react adequately to their horse. When a rider fails to do so, this can cause conflicts and adverse reactions from the horse, resulting in a decrease in performance and potential dangerous situations (McGreevy, 2007).

The physiological symptoms after the horse misbehaving, being a decrease in finger temperature and increase in skin conductance in comparison to the moment prior to the horse misbehaving, indicates an increase of arousal. This might mean the rider will be better focussed and prepared for optimal performance again, in order to regain control over their horse. This appears to be beneficial for the performance. However, it should be considered that the rider should avoid reaching excessive arousal, as existing literature shows this is debilitative for performance and is most likely to trigger or intensify the adverse behaviour of their horse the rider actually wants to prevent or avoid. For example, extreme arousal will have a negative effect on coordination (Taylor, 1987). Suggesting that for a rider experiencing excessive arousal, their ability to give suitable aids will decrease. This will be picked up on by the horse, since equines are highly alert to signs of others being tensed which functioned as a warning sign within their survival strategy (Christensen *et al*, 2008). Thereby, it is likely that tension of a rider will intensify the horse's adverse reaction, which the rider actually wants to avoid.

Furthermore, it has been stated by Wolframm and Micklewright (2010) that the intensity and interpretation of pre-competitive cognitive and somatic anxiety has got an influence on equestrian performance. They found that a facilitative interpretation of cognitive and somatic anxiety has got a positive effect on the interaction between rider and horse. But the greater the intensity of cognitive and somatic anxiety, the less facilitative these symptoms were experienced by the riders (Wolframm and Micklewright, 2010). This means during an obstacle course, that if the rider's level of anxiety would increase too much, this will have a negative effect on the interaction between rider and horse. Thereby the rider will be less capable to keep their horse obedient. Consequently, safety of both rider and horse might be in danger.

In order to avoid an excessive level of arousal, it is important for a rider to cope with the situation at hand, in this case the horse misbehaving, in a suitable way. According to existing literature, there are different coping strategies to deal with situational demands. Strategies like looking into the future, keeping things in perspective, learning and improving and focussing on the positive will be helpful for performance. Contradictory, being unable to leave a mistake behind, not being consistent and losing perspective of one's own role in performance, will lead to a decrease in performance (Poczwardowski and Conroy, 2002). These strategies can be helpful for a rider during an obstacle course. For example, not being able to leave a mistake behind might cause a rider to stay tensed, which will be picked up on by the horse. Thereby, a circle of tension is able to continue. However, looking forward and focussing on the positive will help the rider to prepare appropriately for the task ahead, using the correct aids, which will affect the horse and performance in a positive way. This also indicates that to some extend that next to external focus, internal focus is important during riding as well.

When the rider is conscious of its own emotions and how their horse is affected by this, the interaction and thereby performance and safety will improve. This is supported by Weiss *et al* (2008), saying that an athlete will perform best when using its own preferred focus style. Thereby, internal focus may be beneficial for certain athletes as well.

Taking into account results of the current study and existing literature, it can be said it is crucial for a rider to find a balance between efficient focus and appropriate arousal and an excessive level of arousal. As too much relaxation offers the horse the opportunity to act out on its own, creating possible dangerous situations and a decrease in performance, this indicates the importance of the rider's focus and alertness. However, an excessive level of arousal will be debilitative for performance and subsequently safety as well. This is due to the facts the rider is less able to give adequate aids and responses to the horse, and the horse is likely to pick up on the tension of the rider as being a warning sign.

7.2 CSAI-2R questionnaire

Results of the current study showed a relationship between average heart rate and the direction of cognitive anxiety. A high average heart rate, indicating a higher level of arousal, was associated with debilitative interpretations of cognitive anxiety. These findings are in line with existing research. Wolframm and Micklewright (2010), found that the greater the intensity of cognitive and somatic anxiety, the less facilitative these symptoms were experienced by the riders. According to Jones *et al* (1994), the nature of sport is an important situational variable. They stated that it is likely that a high intensity of anxiety will be experienced as facilitative for short, explosive duration sports but debilitative for longer duration, more finely-controlled skill sports.

Performing an obstacle course is of longer duration, where finely-controlled skills are of importance due to the fact that a rider needs to admit subtle aids (McGreevy, 2007; KNHS, 2008). Therefore, the findings of Jones *et al* (1994) are consistent with the current research results. An excessive level of arousal and debilitative feelings proved to be of negative influence on performance (Taylor, 1987; Wolframm and Micklewright, 2010; Jones *et al*, 1994). This indicates possibilities in training cognitive processes in order to improve performance.

6.3 Heart rate

Results of the current research showed no significant relationship between the heart rate of the rider and behaviour of the horse. This might be explained by the fact that the heart rate is influenced by many factors, both internal and external. Internal factors of influence might be psychological stress or mental activity (Taelman *et al*, 2008; McNaughton, 1989). External factors of influence might be the fact that the rider is exercising; adding the factor of the rider's stamina (Navare, Thompson, 2003).

Larsson *et al* (1995), state that exposure to conflicting tasks will result in an increase of heart rate. This is supported by Taelman *et al* (2008) and McNaughton (1989), saying that stress, being of psychological source, will have an effect on different physiological processes, including heart rate. This means that heart rate offers the possibilities to function as an indicator of stress. These previous findings suggest that when the heart rate of a rider increases during an obstacle test, this would indicate an increase in arousal. However, in contrast with previous research, current measurements were conducted during exercise and not during rest. Meaning that during an obstacle course, external factors such as exercise and stamina are involved as well.

As research conducted by Navare and Thompson (2003) shows, heart rate increases linearly with the relative work rate. In addition, they found that individual differences in mechanical efficiency will cause a variation in energy requirements and thereby heart rate among different individuals. These findings support the assumption that in the current study, exercise influenced the heart rate of participant on an individual basis. The different facets of the character of its horse are another external factor the rider needs to deal with (Meyers *et al.*, 1999). So next to the individual differences within riders, the differences within horses should be taken into consideration as well. For example, performing an obstacle course with a young inexperienced horse might take a bigger physical and psychological effort then with an older, better trained horse. Research performed by von Borstel *et al* (2010) indicated that the fear of trained horses (ridden more than a half year) reduced faster than those of untrained horses (ridden less than a half year), influencing the manageability of the horse. Another example of the individual differences between horses is the fact that according to Saslow (2002), when a horse does not get a chance to react to consistent, light and meaningful stimulus, it can become insensitive. Thereby, some horses might be used to react to stronger aids, while others react to a gentle touch. Meaning that riding a more sensitive horse will create a lower physical demand of the rider then a horse used to stronger aids, taking more strength from the rider. These factors are expected be of influence on the rider's heart rate, as it affects the physical workload.

Despite all the external factors, it may be suggested that the influence of anxiety on the heart rate might cause different values at certain points during the obstacle test. The character of the horse and stamina of the rider can be expected to be rather constant factors throughout the course. However, due to the many factors of influence on heart rate involved, the possibility to determine a significant relationship between heart rate and arousal during exercise is limited.

7.4 Muscle tension

It was hypothesized that an increase of arousal within the rider in relation to misbehaviour of the horse would show in increase of muscle tension. However, no significant difference in muscle tension between the moment prior to the horse misbehaving and the moment afterwards.

During the current study, muscle tension of the rider was measured at the trapezius muscle during an obstacle course. Looking at a study by Oishi and Maeshima (2004), it can be said that an increased level of stress results in more muscle activity. This is due to the fact that the sympathetic nerve activity to the skeletal muscle is directly in proportion to the level of stress. This is supported by findings indicating a significant increase of tension in the trapezius muscle, induced by mental stress (Lundberg *et al*, 1994; Larsson *et al*, 1995). What should be taken into account for the current study is the fact that data collection was executed during exercise, as participants were performing an obstacle course. However, results of a study by Lundberg *et al* (1994) showed that the increase of muscle tension due to stress is accentuated on top of a physical load. Meaning that in the current study, the fact that data was collected during exercise does not eliminate the possibility to indicate arousal by the level of tension in the trapezius muscle.

Nevertheless, no significant relation between muscle tension and behaviour of the horse has been found during the current study. Equally to the heart rate measurements, the different facets of the characters of the horse are of influence on muscle tension. Since according to Saslow (2002), a horse can become insensitive, causing some horses to need stronger admitted aids then others. Logically, admitting stronger aids requires more muscle tension of the rider.

This causes an individual difference in physical demands regarding muscle tension when performing an obstacle course. However, the increase of arousal should be measurable on top of these physical demands.

During riding, it is important for a rider to use appropriate muscle tension in order to maintain a good posture by skilful coordination, following the movements of the horse ‘without the use of unnecessary strength’ (Terada, 2007).

In addition, muscle tension is used in order to give suitable physical aids through seat, legs and rains, eventually as subtle as possible (KNHS, 2008). It may be expected, that an increase of muscle tension will be decrease the rider’s ability of giving subtle aids. And as the horse is likely to react to this change of aids due to its highly sensitive body (Saslow, 2002 ; Wolframm *et al*, 2009), this might be expected to have a negative influence on the horse’s behaviour and subsequently the performance. However, the measurements were conducted at the trapezius muscle of the rider, which are not directly involved in the horse-rider interaction. Aids submitted to the horse through the rains come from the rider’s hands and arms. An increase of tension within the trapezius muscle might have an affect on the movement of arms and hands and thereby only indirectly influence the behaviour of the horse. This might explain the fact that no significant relationship between tension in the trapezius muscle and behaviour of the horse has been found.

Nevertheless, as existing literature indicates, appropriate use of muscle tension is an important factor during equestrian sports. This indicates that although increased tension of the trapezius muscle has not been found to be significantly related to behaviour of the horse, the physiological subject of muscle tension in relation to performance in equestrian sports leaves opportunities for further research. Taking measurements at muscles more directly involved in submitting aids to the horse, such as muscles of arms and hands, might reveal new insights.

7.5 Ethogram

Results of the current study showed no significant relationship between the total percentage of the ethogram sore and the average psychophysiological values of the rider.

For the current study, horse-rider combinations were asked to perform an obstacle course were they were presented with novel stimuli. Taking the nature of the horse being a flight animal into consideration (Miller, 2009; Goodwin 1999; Keaveny 2008), it is expected the horse will react to unfamiliar stimuli or potential dangerous situations with avoidance or flight (Christensen *et al*, 2006 and Christensen *et al*, 2008). This can be of considerable hindrance during working situations such as riding (Falewee *et al*, 2006), as it may influence the horse's manageability and usefulness for specific tasks (McCall *et al*, 2006). As a consequence, the nature of the horse often forms the cause of serious accidents (Thompson and von Hollen, 1996). Since horses tend to be very attentive and reactive to changes in their environment, especially when presented with novel stimuli, this forms and additional challenge for the rider to psychologically and physically maintain the performance standard (Bridgeman, 2009).

These findings of previous studies suggest that presenting a horse-rider combination with novel stimuli will cause a potential dangerous situation, putting the skills of the rider and obedience and character of the horse to the test.

In their natural environment, their instinct tells a horse to avoid or even flight from novel objects or potential sources of danger (Christensen *et al*, 2006 and Christensen *et al*, 2008). However, the horses participating in the current research are domesticated and do not live in their natural environment anymore. Nevertheless, existing research has shown that the genetically determined traits, which started as a way to survive in the wild, have also been exploited during domestication. Thereby, it continues to play a role in the human-horse relationship (Goodwin, 1999).

Byers (1997) found that the threshold for experiencing fear has gotten lower during domestication. But, once this threshold is reached, domesticated horses will show the same type of reaction as their wild ancestors. These previous findings indicate that when a domesticated horse is confronted with novel stimuli during an obstacle course, its natural reaction would be flight or avoidance. It would go against a horses' natural instinct to take the initiative by itself to approach the novel objects without hesitation. In addition, each horse has got a will and motivation of its own (Sorli, 2005). So if a horse has got an easy going personality, it might be less difficult for a rider to get the horse to pass an obstacle. However, a more stubborn or distrustful horse might be more of a challenge to convince. Therefore, this is where the skills of the rider come in.

The goal of the rider during an obstacle course is to be able to follow the set path in the aimed gait and pass the obstacles. In order to achieve this, the rider needs to maintain obedience from their horse. In addition, the rider will want to stay in control of their horse, since flight reactions might cause dangerous situations. Keeling *et al* (1999), state that the experience and skills of the rider are of major importance in preventing serious accidents. Accordingly, when a rider submits suitable and consistent aids, a flight reaction of the horse might be prevented.
This would improve the safety of both rider and horse and is of great importance during an obstacle course. In addition, the training of the horse is a crucial factor in improving safety (von Borstel *et al*, 2010). Christensen *et al* (2006), state that when a horse is able to get accustomed to a number of stimuli that would normally be experienced as frightening, this will increase the safety in the horse-human relationship (Christensen *et al*, 2006). Von Borstel *et al* (2010), found that the intensity of the fear reaction showed by trained horses (ridden more than a half year) reduced faster than those of untrained horses (ridden less than a half year).

Accordingly, the level of training of the horse will be of influence on the safety of the horse-rider combination during an obstacle course. It might be expected that a horse which has been trained for a longer period of time will be more accustomed to novel stimuli and more obedient to the riders' aids. Thereby, the horse is less likely to show a less intense fear reaction. Meaning that training the horse offers opportunities to improve safety during an obstacle course and other working situations.

Looking at the average physiological values of the rider and the behaviour of the horse measured during the current study, a number of other factors next to arousal of the rider appear to be of influence as well. Due to all the factors involved, it is rather difficult to find a significant relationship solely between the physiological values of the rider and the behaviour of the horse.

Limitations of this research were formed by the limited number of riders participating, which might have influenced the outcomes. Furthermore, since it was an exploratory study, differences nearing significance found where looked into as well as significant differences, and functioned as indicators where the results pointed at. Next to this, the software used had never been used for this purpose before, creating a challenge to record all the physiological symptoms effectively. Finally, finding significant results regarding solely symptoms like heart rate and muscle tension and the behaviour of the horse, as it was influenced by the fact that data was collected during exercise.

Recommendations

Findings of this study should be valued by all riders, both competitive and leisure. Horseback riding continues to be a dangerous sport, which creates a great importance regarding improvement of safety. Results of the current study indicate the importance for a rider to be alert and focussed on their horse at all times. However, excessive levels of arousal have previously been proved to be debilitative for the interaction between rider and horse and subsequently for safety and performance. Therefore, it is crucial for any rider to find a balance between being focussed and alert and excessive arousal. The balance will help to optimize the horse-rider interaction, and will thereby improve performance and safety.

In order to create and maintain this balance, training of cognitive processes can be useful. Similarly to other skills, it will take regular training sessions in order to reach cognitive processes that are helpful with regards to performance. This is of importance for both competitive and leisure riders, as both groups will benefit from an improved interaction with their horse.

Next to riders, also trainers should value the findings of the current study. They should take into account that levels of arousal and focus are of influence on the safety and performance of the horse-rider combination. By paying attention to thoughts and feelings of the rider as well as physiological signs of arousal, part of the training sessions can be focussed on preventing a rider from loosing focus or reaching an excessive level of arousal. By pointing out to the rider what effects the level of arousal and focus have got on their interaction with the horse, the awareness of the rider will be increased. This is of importance, as the rider might not notice the signs by itself. By working on a rider’s individual difficulties, this will improve the horse-rider interaction, and thereby the safety and performance will increase.

8 Conclusion

Results of the current study show a significant difference for both skin conductance and skin temperature prior to and after misbehaviour of the horse. Skin conductance was lower prior to and higher after the event, and skin temperature was higher prior to and lower after the event. In addition, a difference nearing significance was found between the skin temperature prior to misbehaviour of the horse and average values. Skin temperature prior to the event was higher then the average values. Hereby, both physiological parameters showed a decrease of arousal of the rider prior the horse misbehaving and an increase of arousal after this moment. Furthermore, a relationship between high levels of heart rate and debilitative interpretations of cognitive anxiety has been found.

In addition, no significant differences were found for physiological parameters of heart rate and muscle tension at moments prior to and after the horse misbehaving. Finally, no relationship between the total percentage of the ethogram score and the average psychophysiological values of the rider was found.

Summarized, results indicate the importance for a rider to maintain alert and focused at all times when riding a horse. However, existing literature found an excessive level of arousal to be debilitative for performance as well. In order to optimize the horse-rider interaction, a balance between alertness and focus and an excessive level of arousal should be found. This will subsequently improve safety and performance.
In addition, the relation found between high average heart rate and debilitative feelings combined with existing literature indicates the importance of training cognitive processes, in order to improve performance.

References

Adolph, A., Schlösser, S., Hawighorst, M. and Pause, B.M. (2010), Chemosensory signals of competition increase the skin conductance response in humans, *Physiology & Behavior* **101**, pp 666-671

Aubert, A.E., Seps, B. and Beckers, F. (2003), Heart rate variability in athletes, *Sports Med* **33**, pp 889-919

Byers, J.A. (1997), *American Pronghorn, Social Adaptations and the Ghosts of Predation Past*, Chicago USA, University of Chicago Press

Boissy, A. (1995), Fear and fearfulness in animals, *Quarterly Review of Biology* **70**, pp 165–191.

von Borstel, U.U.K., Duncan I.J.H., Lundin, M.C., Keeling, L.J. (2010), Fear reactions in trained and untrained horses from dressage and show-jumping breeding lines, *Applied Animal Behaviour Science* **125**, pp 124-131

Boucsein, W. (1992), *Electrodermal Activity*, New York, Plenum Press

Boudewijns, P.A. (1976), A comparison of the Effects of Stress vs. Relaxation Instruction on the Finger Temperature Response, *Behavior therapy* **7**, pp 54-67

Brandt, K. (2004), A Language of Their Own: An Interactionist Approach to Human-Horse Communication, *Society & Animals* **12**, pp 299-316

Bridgeman, D.J. (2009), The working relationship between horse and rider during training and competition for equestrian sports, University of Southern Queensland

Buchel, C., Morris, J., Dolan, R., Friston, K. (1998), Brain systems mediating aversive conditioning: an event-related fMRI study, *Neuron* **20**, pp 947–957.

Christensen, J.W., Malmkvist, J., Nielsen, B.L., Keeling, J.L. (2008), Effects of a calm companion on fear reactions in naïve test horses, *Equine vet. J.* **40**, pp 46-50

Christensen, J.W., Rundgren, M., Olsson, K. (2006), Training methods for horses: habituation to a frightening stimulus, *Equine vet. J.* **38**, pp 439-443

Compas, B. E. (1987), Coping with stress during childhood and adolescence, *Psychological Bulletin* **101**, pp 393–403.

Consumentveiligheid (2010), Blessures paardensport vaak ernstig, (online), Available: http://www.veiligheid.nl/over-ons/blessures-paardensport-vaak-ernstig (21.06.2011)

Cooper, J.J., Albentosa, M.J. (2005), Behavioural adaptation in the domestic horse: potential role of apparently abnormal responses including stereotypic behaviour, *Livestock Production Science* **92**, pp 177-182

Cox RH, Martens MP and Russell WD (2003), Measuring anxiety in athletics: the revised competitive state anxiety inventory-2, *Journal of Sport and Exercise Psychology* **25**, pp 519-533

Critchley, H.D., Elliott, R., Mathias, C.J., Dolan, R.J. (2000), Neural activity relating to generation and representation of galvanic skin conductance responses: A functional magnetic resonance imaging study, *The journal of neuroscience,* **20**, pp 3033-3040

Dawson, M.E., Schell, A.M., Filion, D.L. (2007), The electrodermal system, In: Cacioppo JT, Tassinary LG, Bernston GG, editors. *Handbook of Psychophysiology*, 3rd ed. Cambridge: Cambridge University Press

Endler, N. S. (1983), Interactionism: a personality model, but not yet a theory, *Personality – current theory and research*, pp 155-200

Endler, N.S., Edwards, J.M., Vitelli, R. (1991*), Multidimensional Anxiety Scales (EMAS): Manual*, Los Angeles, CA: Western Psychological Services

Falewee, C., Gaultier, E., Lafont, C., Bougrat, L., Pageat, P. (2006), Effect of a synthetic equine maternal pheromone during a controlled fear-elicting situation, *Applied Animal Behaviour Science* **101**, pp 144-153

Fureix, C., Jego, P., Sankey, C., Hausberger, M. (2009), How horses (Equus caballus) see the world: humans as significant 'objects', *Anim Cogn* **12**, pp 643-654

Gautier, C.H., Cook III, E.W. (1997), Relationship between startle and cardiovascular Activity, *Psychophysiology* **34**, pp 87–96

Giesen, M., Rollison, M. A. (1980), Guilty knowledge versus innocent associations: effects of trait anxiety and stimulus context on skin conductance, *Journal of research in personality* **14**, pp 1-11

Goodwin, D. (1999), The importance of ethology in understanding the behaviour of the horse, *Equine vet. J. Suppl.* **28**, pp 15-19

Hanton, S., Mellalieu, S.D., Hall, R. (2004), Self-confidence and anxiety interpretation: A qualitative investigation, *Psychology of Sport & Exercise* **5**, pp 477-495

Hardy, L., Jones, G. and Gould, D. (1996), *Understanding psychological preparation for sport: Theory and practice of elite performers*. John Wiley and Sons, New York

Hausberger, M., Roche, H., Henry, S., Visser, K.E. (2008), A review of the human-horse relationship, *Applied Animal Behaviour Science* **109**, pp 1-24

Jones, G., Hanton, S., Swain, A. (1994), Intensity and interpretation of anxiety symptoms in elite and non-elite sports performers, *Person. Individ. Diff.* **17**, pp 657-663

Jones, G., Swain, A.B.J. (1992), Intensity and direction dimensions of competitive anxiety and relationships with competitiveness, Perceptual *and Motor Skills* **74**, pp 467-472

Keaveney, S.M. (2008), Equines and their human companions, *Journal of Business Research* **61**, pp 444-454

Keeling, J.K., Jonare, L., Lanneborn, L. (2009), Investigating horse-human interactions: The effect of a nervous human, *The veterinary journal* **181**, pp 70-71

Keeling, L.J., Blomberg, A., Ladewig, J. (1999), *Horse-riding accidents: when the human-animal relationship goes wrong!*, In: 33rd International Congress of the International Society for Applied Ethology

KNHS (2008), Rijtechniek dressuur, *Instructeursopleidingen*, Ermelo

Larsson, S.E., Larsson, R., Zhang, Q., Cai, H., Oberg, A. (1995), Effects of psychophysiological stress on trapezius muscles blood flow and electromyography during static load, *Eur J Appl Physiol* **71**, pp 493-498

Lundberg, U., Kadefors, R., Melin, B., Palmerud, G., Hasmén, P., Engström, M., Dohns, I.E. (1994), Psychophyiological Stress and EMG Activity of the Trapezius Muscle, *International journal of behavioral medicine* **4**, pp 354-370

Martens, R (1977) *Sport competition anxiety test,* Chicago Human Kinetics Publishers

McCall, C.A., Hall, S., McElhenney, W.H., Cummins, K.A. (2006), Evaluation and comparison of four methods of ranking horses based on reactivity, *Applied Animal Bahaviour Science* **96**, pp 115-127

McGreevy, P.D. (2007), Review The advent of equitation science, *The Veterinary Journal* **174**, pp 492-500

McGreevy, P., McLean, A. (2005), Behavioural problems with the ridden horse, In: Mills DS, McDonnell SM (eds) *The domestic horse, the origins, development and management of its behaviour*. Cambridge University Press, Cambridge, pp 196–211

McNaughton, N. (1989), Biology and emotion, Cambridge: Cambridge University Press

Meyers, M.C., Bourgeois, A.E., LeUnes, A., Murray, N.G. (1999), Mood and psychological skills of elite and sub-elite equestrian athletes, *J. Sport Behav.* **22**, pp 399–409.

Miller, R.M. (2009), Equine psychology and its application to veterinary practice, *AAEP Proceedings* **55**, 349-351

Mittelmann, B. Wollf, H.G. (1942), Emotions and skin temperature. Observations on patietns during psychotherapeutic (psychoanalytic) interviews, *Colloquium of psychodynamics* and *Experimental medicine of N.Y. psychoanalytical society*, pp 211-231

Morris, L., Davis, D. and Hutchings, C. (1981), Cognitive and emotional components of anxiety: literature review and revised worry-emotionality scale, *Journal of Educational Psychology* **75**, pp 541–555

Nagai, Y., Critchley, H.D., Featherstone, E., Trimble, M.R., Dolan, R.J. (2004), Activity in ventromedial prefrontal cortex covaries with sympathetic skin conductance level: a physiological account of a ‘default mode’ of brain function, *NeuroImage* **22**, pp 243-251

Navare, S.M., Thompson, P.D. (2003), Acute cardiovascular response to exercise and its implications for exercise testing, *Journal of Nuclear Cardiology* **10**, pp 521-528

Oishi, K., Maeshima, T. (2004), Autonomic nervous system activities during motor imagery in elite athletes, *Journal of Clinical Neurophysiology* **21**, pp 170-179

Poczwardowski, A., Conroy, D.E. (2002), Coping responses to failure and success among elite athletes and performing artists, Journal of applied sport psychology **14**, pp 313-329

Rang, H.P., Dale, M.M. (1991), The circulation, *Pharmacology* **2,** pp 346-368

Saslow, C.A. (2002), Understanding the perceptual world of horses, *Applied Animal Behaviour Science* **78**, pp 209-224

Skinner, B.F. (1953), *Science and Human Behavior*. Macmillan, New York, USA.

Smoll, F. L., and Smith, R. E. (1991), Stress and the adolescent athlete, *Adolescent Medicine* **2**, pp 47-62.

Sorli JM (2005). Equestrian injuries: a five year review of hospital admissions in British Columbia, Canada, *Injury Preview* **6**, pp 59–61

Spielberger, C. D. (1966), Theory and research on anxiety, In C. D. Spielberger, *Anxiety and behavior.* New York: Academic Press.

Taelman, J., Vandeput, S., Spaepen, A. and Van Huffel, S. (2008), Influence of mental stress on heart rate and heart rate variability, *IFMBE Proceedings* **22**, pp 1366-1369

Taylor, J. (1987), Predicting Athletic Performance with self-confidence and somatic and cognitive anxiety as a function of motot and physiological requirements in six sports, *Journal of Personality* **55**, pp 139-153

Terada, K. (2000), Comparison of head movement and EMG activity of muscles between advanced and novice horseback riders at differet gaits, *J. Equine Sci.* **4**, pp 83-90

Thompson, J.M., von Hollen, B. (1996), Causes of horse-related injuries in a rural western community, *Can. Fam. Physician*. **42**, pp 1103-1109.

Trotter, M.A., Norman, S., Endler (1999), An emperical test of the interaction model of anxiety in a competitive equestrian setting, *Personality and individual differences* **27**, pp 861-875

VaezMousavi, S.M., Barry, R.J. and Clarke, A.R. (2009), Individual differences in task-related activation and performance, *Physiology & Behavior* **98**, pp 326-330

Visser, E.K., Van Reenen, C.G., Rundgren, M., Zetterqvist, M., Morgan, K., Blokhuis, H.J. (2003), Responses of horses in behavioural tests correlate with temperament assessed by riders, *Equine vet. J.* **35**, pp 176-183

Weiss, S.M., Reber, A.S., Owen, D.R. (2008), The loss of focus: The effect of switching from a preferred to a nonpreferred focus of attention, *Journal of sports sciences* **26**, pp 1049-1057

Williams, L.M., Phillips, M.L., Brammer, M.J., Skerrett, D., Lagopoulos, J., Rennie, C., Bahramali, H., Olivieri, G., David, A.S., Peduto, A., Gordon, E. (2001), Arousal dissociates amygdala and hippocampal fear responses: evidence from simultaneous fMRI and skin conductance recording, *NeuroImage* **14**, pp 1070-1079

Wolframm, I.A., Micklewright,D. (2010), Pre-competitive arousal, perception of equine temperament and riding performance: do they interact?, *Comparative Exercise Physiology* **7**, pp 27-36

Wolframm, I.A., Micklewright,D. (2009), Pre-competitive levels of arousal and self-confidence among elite and non-elite equestrian riders, *Journal of Sports Sciences* **21**, pp 443-457

Wolframm, I. A., Shearman, J., Micklewright, D. (2010), A Preliminary Investigation into Pre-Competitive Mood States of Advanced and Novice Equestrian Dressage Riders, *Journal of Applied Sport Psychology* **22: 3**, pp 333-342

Woodman, T., Hardy, L. (2003), The relative impact of cognitive anxiety and self-confidence upon sport performance: a meta-analysis, *Journal of Sports Sciences* **21**, pp 443-457

10 Annex

10.1 Table 1 Overview differences and correlations found

10.2 Table 2 Overview measured values per physiological parameter 9.3

10.3 Table 3 Differences in heart rate between prior to and after a moment of the horse misbehaving and average values (one-way ANOVA, $p > 0.05$)

10.4 Table 4 Differences in skin conductance between prior to and after a moment of the horse misbehaving and average values (one-way ANOVA, $p > 0.05$)

10.5 Table 5 Differences in skin conductance between prior to and after a moment of the horse misbehaving and average values (t-test, $p > 0.05$)

10.6 Table 6 Differences in skin temperature between prior to and after a moment of the horse misbehaving and average values (one-way ANOVA, $p > 0.05$)

10.7 Table 7 Differences in skin temperature between prior to and after a moment of the horse misbehaving and average values (t-test, $p < 0.05$)

10.8 Table 8 Differences in muscle tension between prior to and after a moment of the horse misbehaving and average values (one-way ANOVA, $p > 0.05$)

10.9 Table 9 Correlations between CSAI-2R questionnaire scores and average physiological values (Pearson correlation, $p > 0.05$)

10.10 Table 10 Correlations between total ethogram scores and average physiological values (Pearson correlation, $p > 0.05$)

10.11 CSAI-2R questionnaire

10.12 Obstacle course Stal Smit

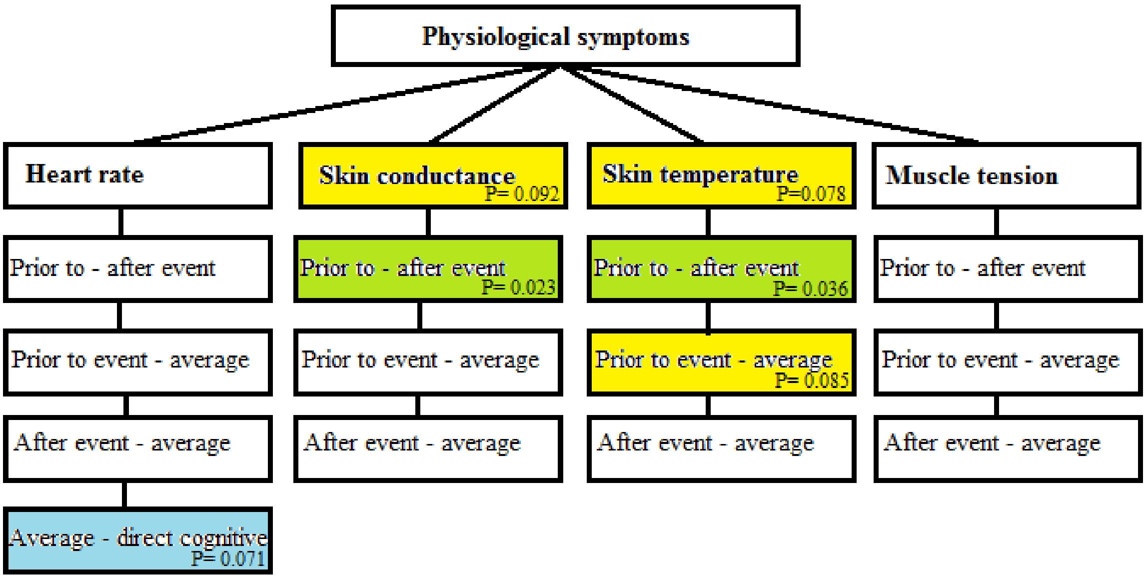
10.13 Obstacle course stal ten Bosch

10.14 Path obstacle course Stal Smit

10.15 Path obstacle course stal ten Bosch

10.16 Ethogram obstacle course

10.1 Table 1: Overview differences and correlations found



Yellow= Nearing significance, Green= significant, Blue= Correlation nearing significance

10.2 Table 2: Overview measured values per physiological parameter

Physiological parameter	**Measured values**
Heart rate (beats per minute)	
Average	149.41
Before event	153.43
After event	150.01
Skin conductance (micro-mho)	
Average	7.07
Before event	5.37
After event	5.59
Skin temperature (degree Celsius)	
Average	23.89
Before event	24.33
After event	24.16
Muscle tension (HZ, surface EMG signals)	
Average	17.20
Before event	32.56
After event	-3.58

10.3 Table 3: Differences in heart rate between prior to and after a moment of the horse misbehaving and average values (one-way ANOVA, p > 0.05)

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
factor1	Pillai's Trace	,183	1,460[a]	2,000	13,000	,268
	Wilks' Lambda	,817	1,460[a]	2,000	13,000	,268
	Hotelling's Trace	,225	1,460[a]	2,000	13,000	,268
	Roy's Largest Root	,225	1,460[a]	2,000	13,000	,268

a. Exact statistic

b. Design: Intercept
Within Subjects Design: factor1

10.4 Table 4: Differences in skin conductance between prior to and after a moment of the horse misbehaving and average values (one-way ANOVA, p > 0.05)

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
factor1	Pillai's Trace	,352	2,984[a]	2,000	11,000	,092
	Wilks' Lambda	,648	2,984[a]	2,000	11,000	,092
	Hotelling's Trace	,543	2,984[a]	2,000	11,000	,092
	Roy's Largest Root	,543	2,984[a]	2,000	11,000	,092

a. Exact statistic

b. Design: Intercept
Within Subjects Design: factor1

Yellow = nearing significance

10.5 Table 5: Differences in skin conductance between prior to and after a moment of the horse misbehaving and average values (t-test, p < 0.05)

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	SCbeforetense - SCaftertense	-,21179	,30671	,08197	-,38887	-,03470	-2,584	13	,023
Pair 2	SCbeforetense - SCaverage	-1,70754	3,67821	1,02015	-3,93026	,51518	-1,674	12	,120
Pair 3	SCaftertense - SCaverage	-1,48415	3,49164	,96841	-3,59413	,62582	-1,533	12	,151

Yellow = nearing significance, green = significant

10.6 Table 6: Differences in skin temperature between prior to and after a moment of the horse misbehaving and average values (one-way ANOVA, p > 0.05)

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
factor1	Pillai's Trace	,325	3,125[a]	2,000	13,000	,078
	Wilks' Lambda	,675	3,125[a]	2,000	13,000	,078
	Hotelling's Trace	,481	3,125[a]	2,000	13,000	,078
	Roy's Largest Root	,481	3,125[a]	2,000	13,000	,078

a. Exact statistic

Yellow = nearing significance

10.7 Table 7: Differences in skin temperature between prior to and after a moment of the horse misbehaving and average values (t-test, p < 0.05)

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	TEMPbeforetense - TEMPaftertense	,16900	,28158	,07270	,01306	,32494	2,324	14	,036
Pair 2	TEMPbeforetense - TEMPaverage	,43433	,90755	,23433	-,06825	,93692	1,854	14	,085
Pair 3	TEMPaftertense - TEMPaverage	,26533	,85707	,22129	-,20930	,73996	1,199	14	,250

Yellow = nearing significance, green = significant

10.8 Table 8: Differences in muscle tension between prior to and after a moment of the horse misbehaving and average values (multivariate test, p > 0.05)

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
factor1	Pillai's Trace	,065	,451[a]	2,000	13,000	,647
	Wilks' Lambda	,935	,451[a]	2,000	13,000	,647
	Hotelling's Trace	,069	,451[a]	2,000	13,000	,647
	Roy's Largest Root	,069	,451[a]	2,000	13,000	,647

a. Exact statistic

b. Design: Intercept

Within Subjects Design: factor1

10.9 Table 9: Correlations between CSAI-2R questionnaire scores and average physiological values (Pearson correlation, p > 0.05)

Correlations

		HRaverage	MTaverage	SCaverage	TEMPaverage	DirSom	DirCog	DirSC
HRaverage	Pearson Correlation	1	,004	-,169	,019	-,362	-,435	-,379
	Sig. (2-tailed)		,988	,546	,941	,140	,071	,121
	N	18	17	15	18	18	18	18
MTaverage	Pearson Correlation	,004	1	-,001	-,039	-,137	,044	-,100
	Sig. (2-tailed)	,988		,997	,882	,601	,866	,703
	N	17	17	14	17	17	17	17
SCaverage	Pearson Correlation	-,169	-,001	1	,084	-,150	,028	-,120
	Sig. (2-tailed)	,546	,997		,765	,593	,922	,669
	N	15	14	15	15	15	15	15
TEMPaverage	Pearson Correlation	,019	-,039	,084	1	,020	-,094	-,131
	Sig. (2-tailed)	,941	,882	,765		,937	,711	,604
	N	18	17	15	18	18	18	18
DirSom	Pearson Correlation	-,362	-,137	-,150	,020	1	,755**	,681**
	Sig. (2-tailed)	,140	,601	,593	,937		,000	,002
	N	18	17	15	18	18	18	18
DirCog	Pearson Correlation	-,435	,044	,028	-,094	,755**	1	,789**
	Sig. (2-tailed)	,071	,866	,922	,711	,000		,000
	N	18	17	15	18	18	18	18
DirSC	Pearson Correlation	-,379	-,100	-,120	-,131	,681**	,789**	1
	Sig. (2-tailed)	,121	,703	,669	,604	,002	,000	
	N	18	17	15	18	18	18	18

**. Correlation is significant at the 0.01 level (2-tailed).

Yellow = nearing significance

10.10 Table 10: Correlations between total ethogram scores and average physiological values (Pearson correlation, p > 0.05)

Correlations

		Percetho	HRaverage	MTaverage	SCaverage	TEMPaverage
Percetho	Pearson Correlation	1	-,129	-,206	,098	-,170
	Sig. (2-tailed)		,610	,427	,728	,501
	N	18	18	17	15	18
HRaverage	Pearson Correlation	-,129	1	,004	-,169	,019
	Sig. (2-tailed)	,610		,988	,546	,941
	N	18	18	17	15	18
MTaverage	Pearson Correlation	-,206	,004	1	-,001	-,039
	Sig. (2-tailed)	,427	,988		,997	,882
	N	17	17	17	14	17
SCaverage	Pearson Correlation	,098	-,169	-,001	1	,084
	Sig. (2-tailed)	,728	,546	,997		,765
	N	15	15	14	15	15
TEMPaverage	Pearson Correlation	-,170	,019	-,039	,084	1
	Sig. (2-tailed)	,501	,941	,882	,765	
	N	18	18	17	15	18

10.11 CSAI-2R questionnaire

GRAAG VOORAFGAANDE AAN JE DRESSUUR PROEF INVULLEN

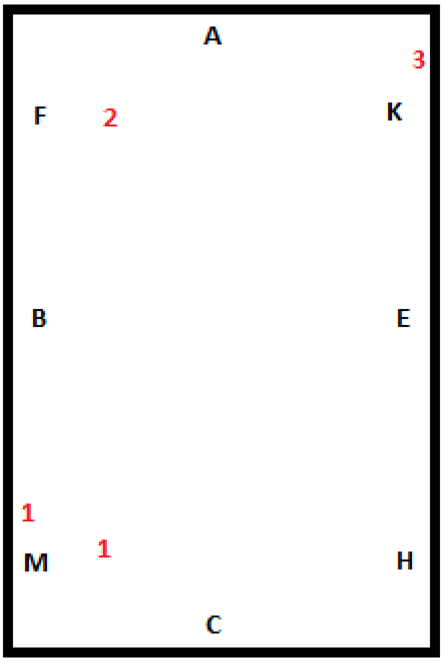
B

NAAM:
EMAIL (als je geinteresseert bent in de uitslag van het onderzoek):
LEEFTIJD:
JOUW "GEWONE" DISCIPLINE:
JOUW GEWONE WEDSTRIJD NIVEAU:

Hieronder vind je enkele beschrijvingen van hoe een athleet zich kan voelen voor een wedstrijd. Kun je aangeven welke beschrijving *op dit moment* voor jou van toepassing is. Kun je daarnaar aangeven of jouw gevoel onbehulpzaam (negatief) of behulpzaam (positief) is voor jouw prestatie. Er bestaan geen juiste of foute antwoorden maar het is belangrijk dat je jouw eigen gevoel zo precies mogelijk aangeeft.

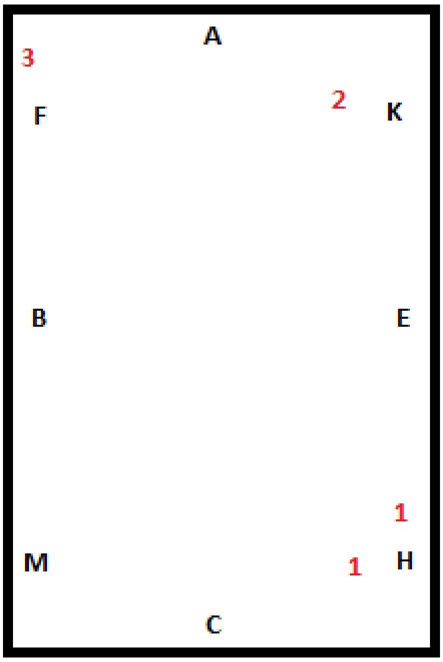
	1 = helemaal niet	2 = een beetje	3 = klopt ongeveer	4 = klopt helemaal	-3 = zeer onbehulpzaam	-2 = matig onbehulpzaam	-1 = iets onbehulpzaam	0 = neutraal	1 = iets behulpzaam	2 = matig behulpzaam	3 = zeer behulpzaam
Ik ben beverig	1	2	3	4	-3	-2	-1	0	1	2	3
Ik ben bezorgd dat ik in deze wedstrijd niet zo goed zou kunnen presteren als ik kan	1	2	3	4	-3	-2	-1	0	1	2	3
Ik heb zelfvertrouwen	1	2	3	4	-3	-2	-1	0	1	2	3
Mijn lichaam voelt gespannen aan	1	2	3	4	-3	-2	-1	0	1	2	3
Ik ben bezorgd dat ik verlies	1	2	3	4	-3	-2	-1	0	1	2	3
Ik voel mijn maag samenknijpen	1	2	3	4	-3	-2	-1	0	1	2	3
Ik heb vertrouwen dat ik de uitdaging aankan	1	2	3	4	-3	-2	-1	0	1	2	3
Ik ben bezorgd dat ik blokkeer onder de druk	1	2	3	4	-3	-2	-1	0	1	2	3
Mijn hart klopt heel snel	1	2	3	4	-3	-2	-1	0	1	2	3
Ik heb vetrouwen dat ik goed ga presteren	1	2	3	4	-3	-2	-1	0	1	2	3
Ik ben bezorgd dat ik slecht ga presteren	1	2	3	4	-3	-2	-1	0	1	2	3
Ik voel de moed in mijn schoenen zakken	1	2	3	4	-3	-2	-1	0	1	2	3
Ik heb vertrouwen want ik zie voor me dat ik mijn doel bereik	1	2	3	4	-3	-2	-1	0	1	2	3
Ik ben bezorgd dat anderen teleurgesteld zullen zijn met mijn prestatie	1	2	3	4	-3	-2	-1	0	1	2	3
Mijn handen zijn klam	1	2	3	4	-3	-2	-1	0	1	2	3
Ik heb zelfvertrouwen dat ik onder druk door kan gaan	1	2	3	4	-3	-2	-1	0	1	2	3
Mijn lichaam staat onder spanning	1	2	3	4	-3	-2	-1	0	1	2	3

10.12 Obstacle course Stal Smit



1 = Balloons
2 = Umbrellas
3 = Plastic

10.13 Obstacle course stal ten Bosch



1 = Balloons
2 = Umbrellas
3 = Plastic

10.14 Path obstacle course Stal Smit

1 E	halthouden, omdraaien
2 E-H-C	binnenkomen in arbeidsdraf op de rechterhand
3 M-F	gebroken lijn 5 meter
4 K-X-M	van hand veranderen en enkele passen middendraf
5 H-K	gebroken lijn 5 meter
6 B-E-B	grote volte
7 E-F	van hand veranderen
8 E-B-E	grote volte
9 Tussen M-B	overgang arbeidsstap
10 C	halthouden

10.15 Path obstacle course Stal ten Bosch

1 B	halthouden, omdraaien
2 B-M-C	binnenkomen in arbeidsdraf op de linkerhand
3 H-K	gebroken lijn 5 meter
4 F-X-H	van hand veranderen en enkele passen middendraf
5 M-F	gebroken lijn 5 meter
6 E-B-E	grote volte
7 M-E	van hand veranderen
8 B-E-B	grote volte
9 Tussen H-E	overgang arbeidsstap
10 A	halthouden

10.16 Ethogram obstacle course

Resistance to riders aids

1 Willing to work, reacts immediately to riders aids, tail swings loosely, ears relaxed
2 Short delay to riders aids, some minor resistance such as ears flicking, tail swish
3 Delay to riders aids, show of resistance through tension of neckline, big periods of tail swishing
4 Extreme resistance to riders aids through bucking, rearing, continues swishing of tail

Flight behaviour

1 passes obstacle without hesitation and follows correct path
2 passes obstacle but changes in tempo or strays from path
3 passes obstacle only after hesitation/stopping/ considerable speeding or after first moving away in opposite direction
4 Refuses to pass, turns around, moves away in opposite direction

Rider behaviour

1 Rider sits quietly, quietly insisting that the horse obeys
2 Rider increases force of aids (short kicks with legs, obvious half halt)
3 Rider uses the whip to reinforce aids, obvious use of seat
4 Rider uses hands, legs, seat and whip together, appears hectic and forceful